

**Online Appendix for:**

**The Importance of Deep Integration in Preferential Trade Agreements:  
the case of a successfully implemented Ukraine-Turkey Free Trade Agreement**

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# Appendix A: Description of the Model

## 1. Introduction

We build a 45-sector small open economy (SOE) model of trade and foreign direct investment (FDI) for Ukraine, with seven external regions including Turkey. The central model is a model that includes large group monopolistically competitive sectors with homogeneous firms that builds on, but extends, the model of Krugman (1980) and also contains perfectly competitive sectors. There are two important extensions from Krugman (1980) that allow this model to better conform with econometric evidence: (i) there is a fixed cost of operating in Ukraine, which allows this model to avoid the property that all varieties in the world are available in Ukraine. This assumption allows trade and FDI policy to influence the number of varieties in Ukraine; and (ii) there is a sector-specific factor in all monopolistically competitive sectors foreign and Ukrainian (we explain below the impact of this assumption). We also produce a model with all sectors perfectly competitive for the purposes of comparison.

Here we provide a primarily descriptive explanation of the model with limited equations. We focus on the features of the model that distinguish it from a perfect competition model without foreign direct investment. Since the Armington model approach, that we use for the perfectly competitive sectors, is very well-known, we focus this discussion on the monopolistically competitive sectors. A mathematical description of the trade and FDI models may be found in Movchan *et al.* (2020b). For detailed derivations, both in perfect competition and monopolistic competition, see Balistreri and Tarr (2020). The model is solved using the GAMS/MPSGE software developed by Rutherford (1999).

Regions and sectors are listed in tables 1 and 2 of the main text, respectively. In the perfect competition model, all sectors are perfectly competitive. In the monopolistic competition style model, there are three categories of sectors: (1) 23 perfectly competitive goods and services sectors; (2) 13 monopolistically competitive goods sectors; and (3) nine business services sectors where foreign services may be provided both by foreign direct investment under monopolistic competition<sup>1</sup> and by cross-border services under perfect competition.

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<sup>1</sup>All services provided cross-border are modeled as perfectly competitive. The computer programming sector is modeled as a business services sector where FDI can occur, but it is modeled as perfectly competitive. It is grouped with the business services sectors.

Primary factors are skilled labor, unskilled labor and capital. Land and natural resources are treated as sector-specific and included as part of capital.<sup>2</sup> Analogous to the Armington assumption on imports, Ukrainian exports are also differentiated from Ukrainian products produced for the home market. For Ukrainian exports and domestic goods, we use a constant elasticity of transformation production function with elasticity of transformation equal to four for all perfectly competitive sectors.

The representative Ukrainian consumer maximizes a Cobb-Douglas utility function of the 45 goods and services subject to an income constraint. The utility function is weakly separable in the 45 goods and services. Each of the 45 goods and services is a nested CES aggregate, which allows two-stage budgeting (technically multi-stage budgeting due to the nesting structure). Any CES aggregate is an Armington aggregate of regional goods and services in perfectly competitive sectors or a Dixit-Stiglitz aggregate of firm varieties in monopolistically competitive sectors.

## 2. Sector Description

### 2.1 Perfectly competitive goods and services sectors

In these sectors, we employ the “Armington” structure, with goods and services differentiated by the country of origin.

### 2.2 Imperfectly competitive goods sectors

Consistent with the Krugman model, cost functions of firms within a given sector of a region are homogeneous and their marginal costs are constant with respect to output. In these sectors, foreign firms produce in their home markets and sell in Ukraine via exports. Unlike the Krugman model, but consistent with an important feature of the Melitz model of heterogeneous firms, for all imperfectly competitive firms selling in Ukraine (both Ukrainian and foreign), we assume they have a fixed cost *of selling in Ukraine*. Consistent with the literature on monopolistic competition, we assume a linearly homogeneous and quasi-concave function that aggregates all inputs into a single composite input that is the source of both fixed and variable costs.<sup>3</sup>  $C_{kr}(\mathbf{P}_r)$  is the unit cost of this composite input when inputs in sector  $k$  of region  $r$  are purchased at minimum cost. Then, for firms from region  $r$  in sector  $k$  selling in Ukraine, total costs are:

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<sup>2</sup> These sectors with land or natural resources as inputs are agriculture, animal production, forestry and a few of the mining sectors. The share of this aggregated factor that comes from land and natural resources is taken from GTAP data and that share is always sector-specific. See Movchan *et al.* (2020a) for details.

<sup>3</sup> Theoretical models of large group monopolistic competition in a CES demand framework, such as Krugman (1980) or Melitz (2003), typically assume a single factor of production. When multiple factors of production are incorporated in monopolistic competition trade models authors (including Helpman and Krugman (1985), Costinot and Rodriguez-Clare (2013), Rutherford and Tarr (2008), Markusen, Rutherford and Tarr (2005) and Dixon *et al.*, 2019) assume a cost function that is homogeneous of degree one and quasi-concave that aggregates all input

$$TC_{kr} = C_{kr}(\mathbf{P}_r) [f_{kr} + q_{kr}] \quad k \in K \quad r \in R \quad (1)$$

where  $TC_{kr}$  is total costs,  $f_{kr}$  is fixed costs of selling in Ukraine in units of the composite input (purchased in region  $r$ ),  $q_{kr}$  is sales of the firm from region  $r$  in Ukraine,  $\mathbf{P}_r$  is a vector of all input prices in region  $r$ ,  $K$  is the set of Krugman goods sectors and  $R$  is the set of regions of the model.

Goods in these sectors are differentiated at the firm level. Each firm produces a unique variety that is differentiated in the demand functions of users of the goods. Users of the differentiated goods have an elasticity of substitution (Dixit-Stiglitz) for the different varieties. Ukrainians may purchase goods produced domestically or imported from any region in the model. All foreign firms selling in Ukraine compete with Ukrainian firms in a large-group monopolistically competitive framework. Firms in these industries set prices such that marginal cost equals marginal revenue. There is free entry, which drives profits to zero on operations in Ukraine. Define  $MR_{kr}$  as the marginal revenue of a firm from region  $r$  selling in sector  $k$  of Ukraine and  $p_{kr}$  as the price of a firm from region  $r$  selling in sector  $k$  of Ukraine. The two equilibrium conditions for a firm from region  $r$  selling in monopolistically competitive sector  $k$  of Ukraine are that marginal revenue equals marginal costs:

$$MR_{kr} = \frac{\partial TC_{kr}}{\partial q_{kr}} = C_{kr}(\mathbf{P}_r) \quad \forall r \in R. \quad (2)$$

and our free-entry condition implies price equals average costs:

$$p_{kr} = \frac{TC_{kr}}{q_{kr}} \quad \forall r \in R. \quad (3)$$

Due to our extension of the standard Krugman model, the operating profits of foreign firms operating in Ukraine must cover their fixed costs of exporting to Ukraine. This breaks the property of the Krugman model that all varieties are sold in all markets and thereby allows a change in the trade costs of selling in Ukraine to significantly influence the number of varieties available in Ukraine.

The number of varieties and the Dixit-Stiglitz externality available in Ukraine in monopolistically competitive sectors is endogenously determined in the following manner. The reduction of trade costs of selling in Ukraine results in an increase in the profitability for foreign provision of goods in Ukraine, which temporarily yields price greater than average costs. This induces new entry by foreign providers of

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prices into a single value. Then, with large group monopolistic competition and CES demand equation, output per firm is constant and there are no rationalization effects. For a proof see Balistreri and Tarr (2020).

goods or services to Ukraine (through exporting from their home country). The entry continues until zero economic profits are restored on Ukrainian operations, thereby endogenously determining the change in the number of varieties sold in Ukraine from each region of the model in each monopolistically competitive sector. The additional foreign varieties lower the cost of doing business and result in a productivity improvement for users of these goods. The additional varieties also increase consumer welfare, since consumers have more choices available and can optimize their expenditures among the varieties. Mathematically, the effective cost function for users of these goods declines in the total number of varieties in the industry (see Balistreri and Tarr, 2020, section 3.4.4). These gains from additional varieties, known as the Dixit-Stiglitz variety externality, is an effect that is missing in models of perfect competition.

In all monopolistically competitive sectors (both goods and services), there is some sector-specific capital for each imperfectly competitive firm for each region of the model. In the sectors where there is sector-specific capital, the implied decreasing returns to scale in the use of the mobile factors indicates upward sloping supply. The sector-specific factor provides two empirical advantages. First, Hummels and Klenow (2005) have shown that the Krugman model overestimates the expansion of the number of varieties (which is the extensive margin in that model), since it predicts that the range of varieties of a country's exports expands in proportion to the market size of the exporting country. Our sector-specific capital and fixed costs assumptions mute the expansion of the varieties of exports of a country and allows our model to be consistent with the evidence of Hummels and Klenow. Second, there is a substantial econometric literature, begun by the paper of Coe and Helpman (1995), that indicates that the productivity gain from imports depends on the research and development stock of the exporting country and (based on Schiff *et al.*, 2002) the technological sophistication of the product.<sup>4</sup> We calibrate the elasticity of substitution between sector-specific capital and other inputs in each sector such that the elasticity of supply increases with the research and development stock of the exporting country and the research and development cost shares of the product (as our measure of technological sophistication).<sup>5</sup> Since the Dixit-Stiglitz productivity effect increases with the number of varieties, a larger elasticity of supply yields a larger productivity effect, and allows our model to be consistent with the econometric

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<sup>4</sup> The substantial econometric literature, that began with Coe and Helpman (1995), is summarized in Appendix E of Movchan (2020a). See also, Tarr (2013, 330-331).

<sup>5</sup> See table E.1 for the values of the elasticities of supply by sector and region of our model. The elasticity of supply is dependent on the share of sector specific capital and the elasticity of substitution between sector specific capital and all other factors. Based on data from the social accounts, for a given elasticity of substitution, we solve for the sector specific share of total capital payments that yields the desired elasticity of supply. See Balistreri, Jensen and Tarr (2015, 131-134) for the details of the calibration or the note at: <https://drive.google.com/drive/folders/10M3ePXtdSbvYikh8NaB-n7bMZrjbFudS>.

evidence on productivity gains from trade that depend on the technological sophistication of the partner country and product.

In order to maintain comparability between the perfectly competitive model and the model with monopolistically competitive sectors, the share of sector-specific capital in a sector is identical in the two versions of the model.

The cost structure of equation (1) and the zero-profit condition in the large group monopolistic competition model with CES demand functions yields the result that output per firm remains constant, i.e., the model does not produce rationalization gains or losses. The welfare results of the monopolistic competition model will differ from perfect competition solely due to the Dixit-Stiglitz externality from an increase in the number of varieties.

### **2.3 Imperfectly competitive service sectors in which foreign direct investment occurs**

In these services sectors, we observe that some services are provided by foreign service providers on a cross-border basis analogous to goods supply from abroad. For cross-border service providers, we assume they are perfectly competitive. For Ukrainian service providers in these sectors, the cost functions are described by equation (1) above. But a large share of business services is provided by FDI, i.e., by multinational service providers with a domestic presence.<sup>6</sup> Our model allows for both types of provision of foreign services in these sectors.<sup>7</sup>

Multinational service firms produce a Ukrainian region-specific variety in Ukraine, which is differentiated from Ukrainian varieties and the varieties of other multinational services firms. All firms (foreign and domestic) incur a fixed cost of operating in Ukraine. Multinationals service providers who establish a local presence in Ukraine use predominantly Ukrainian inputs. The knowledge capital model, however, argues that multinational firms create knowledge intensive products or processes in the headquarters country and sell these to their foreign affiliates, typically at marginal cost. (For data support, see Irarrazabal *et al.* 2013 and Markusen, 2002.) Consistent with the knowledge capital model, we assume that the multinational firms in Ukraine will also import some specialized technology or

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<sup>6</sup> One estimate puts the world-wide cross-border share of trade in services at 41% and the share of trade in services provided by multinational affiliates at 38%. Travel expenditures (20%) and compensation to employees working abroad (1%) make up the difference. See Brown and Stern (2001, table 1). In the case of U.S. firms, in 2005, two-thirds of services exports were from FDI and about one-third from cross-border sales. See Markusen and Strand (2009, table 1).

<sup>7</sup> Our model is consistent with the proximity burden literature in services that argues that a local presence is required for foreign firms to compete effectively with host country services (see Francois and Hoekman, 2010). Our Dixit-Stiglitz demand functions are nested such that services provided through FDI are better substitutes (have a larger elasticity of substitution) for Ukrainian services than cross-border services.

management expertise and intermediates of the parent firm. Analogous to equation (1), we assume that there is a composite input that is a linear homogeneous, quasi-concave function of all inputs used by the multinational. This aggregate composite input has a unit price equal to  $C_{kr}^M(\mathbf{P}_{UK}, \mathbf{p}_r)$  that depends on the vector of input prices in Ukraine  $\mathbf{P}_{UK}$  and the vector of prices of the imported foreign specialized inputs  $\mathbf{p}_r$  from the parent firm of region  $r$ . We use the superscript  $M$  to denote the multinational firm and  $K'$  is the set of Krugman business service sectors with FDI. Then the cost functions for our multinational firms that supply the Ukrainian market through FDI are:

$$TC_{kr}^M = C_{kr}^M(\mathbf{P}_{UK}, \mathbf{p}_r) [f_{kr} + q_{kr}] \quad k \in K' \quad r \in R, r \neq Ukraine \quad (4)$$

Note that in equation (4), unlike equation (1), for all firms selling in Ukraine through FDI, its costs depend on a vector of Ukrainian prices. For the multinational firms, unlike Ukrainian firms, the costs also depend on the vector  $\mathbf{p}_r$  which is the delivered price in Ukraine of the imported specialized inputs.

For Ukrainian firms operating in these sectors, their cost function and equilibrium conditions are described by the equations above for goods production. The equilibrium conditions for the multinational firms operating in Ukraine is analogous to firms selling IRTS goods to Ukraine from abroad, i.e. we must have marginal revenue equals to marginal costs and zero profits. The difference is that we use the cost function in equation (4).

$$MR_{kr}^M = \frac{\partial TC_{kr}^M}{\partial q_{kr}^M} = C_{kr}^M(\mathbf{P}_{UK}, \mathbf{p}_r) \quad \forall r \neq Ukraine \quad (5)$$

$$p_{kr}^M = \frac{TC_{kr}^M}{q_{kr}^M} \quad \forall r \neq Ukraine \quad (6)$$

In any business services sector, there are potential supplies<sup>8</sup> from 15 groups of firms: Ukrainian services, services provided through FDI and cross-border services from the seven foreign regions. First consider the reduction of discriminatory Ukrainian barriers to services supplied by foreigners from all regions, either by FDI or cross-border. The barriers are modeled by their ad valorem equivalents, so the reduction of the barriers lowers the costs of providing business services in Ukraine by multinationals. This leads to price exceeding costs by foreign suppliers of services in Ukraine. For cross-border supply

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<sup>8</sup> In some sectors there are no services supplies in the benchmark from some regions. In these cases, we exclude any services supplies in the counterfactual.

of services, the response to the positive profits by suppliers is analogous to the response of perfectly competitive foreign supply of goods. For FDI supplied services, fully analogous to the endogenous determination of the number of varieties in monopolistically competitive goods sectors, the reduction in costs induces entry by foreign suppliers of FDI services. The entry continues until the price falls such that firms do not earn positive profits on their Ukrainian operations. The additional varieties of services supplied lowers the price of services (the Dixit-Stiglitz price) to users. In the case of a preferential reduction of services barriers limited to Turkey, non-Turkish firms experience increased competition in markets where Turkish firms are active and this may induce exit by Ukrainian and non-Turkish firms. Nonetheless, in all the scenarios of this paper, we observe a welfare gain from the Dixit-Stiglitz variety externality.<sup>9</sup>

## 2.4 Structure of Production

In the figure below we show a schematic representation of the structure of production of a representative firm. There are two differences from a standard treatment, both relating to business services. First, we place business services in a nest with value-added. This allows the model to more effectively reflect the evidence presented in the main text that greater access to business services increases productivity. When the price of business services declines, its use will increase to a larger extent than if it were included with perfectly competitive services. Second, the nest for cross-border business services and business services provided with a local presence have a lower elasticity of substitution than the nest of domestic business services and multinational business services also provided locally. This captures the “proximity burden” discussed in the literature on services.

## 3. Model Closure Assumptions

### 3.1 Small Open Economy Model or Downward-Sloping Export Demand.

**3.1.1 Small Open Economy Model.** Due to the well-known problem that Armington style models exhibit excessive terms-of-trade effects that result in very high optimal tariffs, in our central model we employ the small open economy model assumption often employed in international trade. Under this assumption, Ukraine is assumed to be too small to impact the price of its exports or imports.

Regarding export demand, except in four sectors, Ukrainian exports face perfectly elastic export demand functions in foreign markets. We found the small open economy model assumption on exports untenable, however, in four sectors: dairy, meat, water transportation and computer programming. In

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<sup>9</sup> Balistreri, Jensen and Tarr (2015) have shown that it is possible to have immiserizing preferential liberalization of FDI barriers, in part due to the loss of both domestic varieties and varieties from non-partner countries, i.e., there is an analogy to trade diversion in goods and its welfare consequences. They show, however, that immiserizing preferential FDI liberalization is highly unlikely without domestic rent capture in the benchmark.

dairy and meat, Turkish tariffs exceed 176 percent on Ukrainian exports and in water transportation services, the ad valorem equivalent of the barriers is estimated to be 41 percent. Full preferential market access for Ukrainian firms in these sectors, that are substantial in Ukraine, yields unreasonable expansion in Turkish markets. Given the explosion of exports in these four sectors, we introduced downward sloping export demand for Ukraine in these sectors to all export markets. We take demand elasticities from GTAP as explained by Hertel and van der Mensbrugghe (2019). The elasticities of export demand for Ukraine in all export markets in these sectors are dairy (7.3), meat (8.25), water transportation (3.8) and computer programming (3.8).

Regarding import supply by foreign firms, all perfectly competitive goods and services are assumed to be supplied perfectly elastically, consistent with the small open economy model assumption. In the case of IRTS goods or services, foreign suppliers interact with Ukrainian and other foreign firms in a large-group monopolistic competition framework. Given the standard assumption of large-group monopolistic competition that firms believe they cannot impact aggregate price or quantity, their perceived elasticity of demand is the Dixit-Stiglitz elasticity of demand. Formally, there is no supply curve.

**3.1.2 Downward Sloping Export Demand Model.** In the sensitivity analysis, we depart from the small open economy model assumption and allow for all Ukrainian sectors to have downward-sloping export demand curves. This assumption mutes the export expansion and results in lower estimated gains.

## **3.2 Government Expenditure, Investment Demand and Balance of Trade.**

In each of our experiments we hold real investment constant; we also hold real government expenditure fixed (in both its overall size and in its commodity composition) via an endogenous lump sum transfer between the representative household and the public sector. A change in tariff or other tax revenue is compensated through a direct transfer so the benefits associated with public expenditure are unchanged. We also hold the balance of trade constant and allow the real exchange rate to freely fluctuate to equilibrate the balance of trade constraint. These assumptions allow us to measure welfare using equivalent variation in private consumption; in our model, this is equivalent to the change in real household income or real household consumption (see Balistreri and Tarr 2020, section 3.8). We use the terms welfare, Hicksian equivalent variation (EV) and the change in real household income interchangeably in this paper.

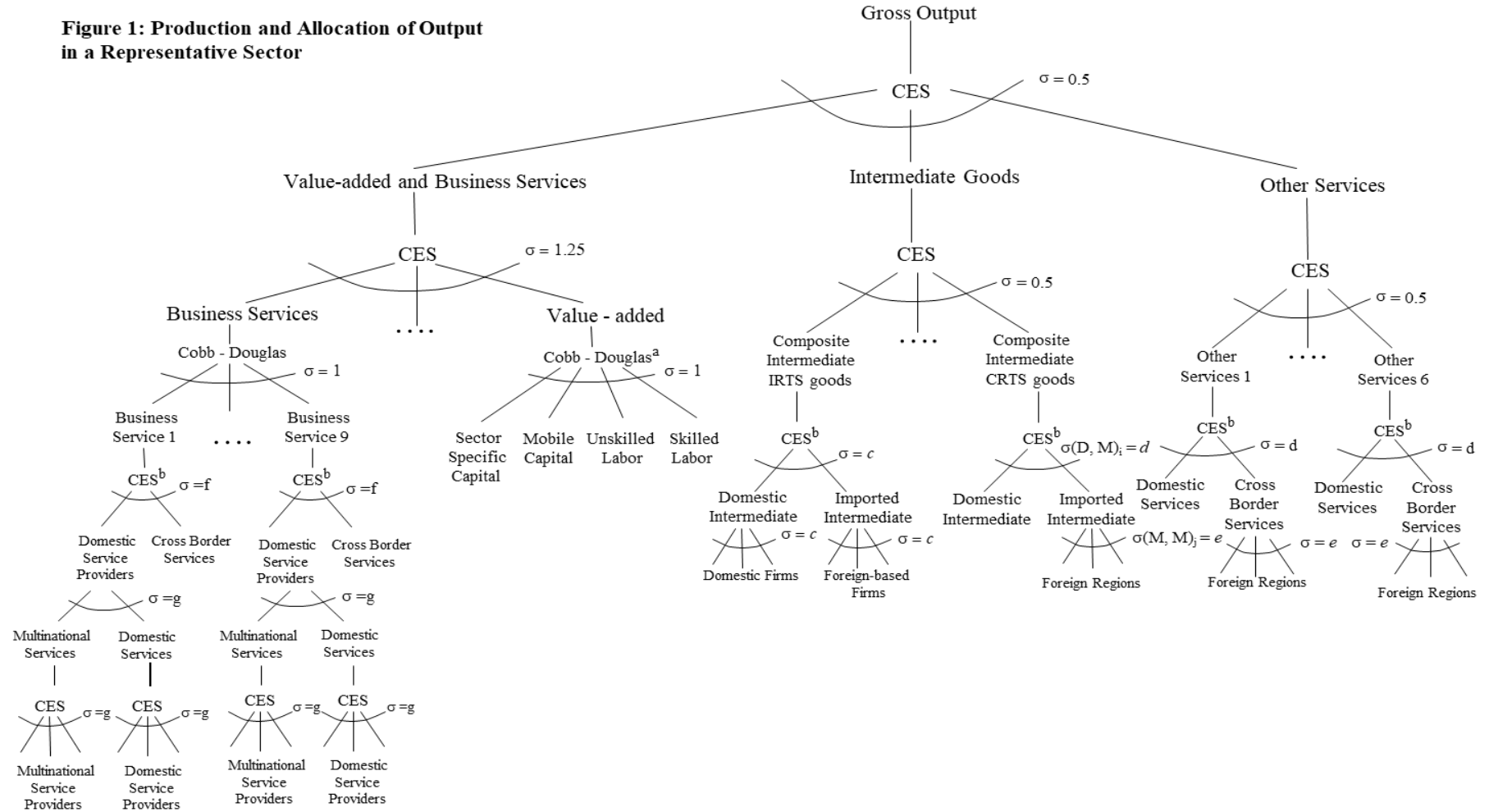
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**Figure 1: Production and Allocation of Output in a Representative Sector**



**Footnotes:**

<sup>a</sup>Primary inputs also include: import primary inputs for multinational service providers, reflecting specialized management expertise or technology of the firm; and “land or natural resources” in agriculture, forestry, fishing and mining and minerals sectors.

<sup>b</sup>Given any intermediate good  $i$ , for all sectors  $j$  that use that intermediate  $i$ , we assume they use imported and domestic intermediates in the same proportion. This is due to lack of data on the foreign versus domestic use at the sector level. See de Melo and Tarr (1992, pp. 219-220) for further details.

<sup>c,d,e,f,g</sup>See table 7 of Movchan *et al.* (2020c) for the values of: <sup>c</sup>the Dixit-Stiglitz elasticities for goods by sectors; <sup>d</sup>the Armington domestic versus foreign elasticities for CRTS goods or services by sectors; <sup>e</sup>the Armington foreign versus foreign elasticities for CRTS goods or services by sectors; <sup>f</sup>the Dixit-Stiglitz elasticities between locally provided and cross-border business services; and <sup>g</sup>the Dixit-Stiglitz elasticities between locally provided business services.

# **Appendix B: “Sensitive” Sectors and the Ukraine-Turkey Free Trade Agreement: The Impact on Ukraine of Exclusion or Partial Liberalization of the Agriculture and Food, Steel and Apparel Sectors**

## **1. Introduction.**

There are sectors in both Ukraine and Turkey that are considered “sensitive.” Sensitive sectors are sectors that are perceived to be uncompetitive compared to international competition and where governments are concerned about potentially substantial adjustment costs of labor and capital. Governments often exclude sensitive sectors from trade liberalization or only partially liberalize the barriers. It is also possible that long adjustment periods to liberalization are negotiated, with trade barriers being liberalized progressively or “sequentially.” Although sequential liberalization results in lower gains to the overall economy, sequential liberalization has the advantage of reducing adjustment costs since it provides labor and capital in these sectors with the opportunity to adjust to a more competitive environment. The normal exit of labor and capital from any sector that occurs independent of any shocks, may well accommodate the progressive decline in demand from tariff reduction resulting in much smaller involuntary displacement and adjustment costs.<sup>10</sup>

Although we do not have information from the trade negotiators of what is actually being negotiated for possible exclusion, our interviews indicate that in Ukraine the wearing apparel sector (but not textiles) could be considered sensitive. In Turkey, the agriculture and food sectors along with the steel sector are likely to be considered sensitive. In this note, we define apparel, agriculture and food, and steel as the sensitive sectors for the Ukraine-Turkey FTA.

For these “sensitive” sectors, we believe that it is useful to evaluate full exclusion of the sectors from the agreement as well as partial preferential liberalization of the sectors. Even if these

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<sup>10</sup> For example, Winters and Takacs (1991) estimate that the removal of quantitative import restrictions on British footwear imports would displace 1,064 workers in the industry. But their data show that 16.9 percent of workers in British footwear depart voluntarily each year. They calculate that this implies that the reduction in demand for labor in the British footwear industry from removing the import restrictions could be accommodated within 21 weeks without any involuntary displacement.

The impact of the voluntary movement of workers as minimizing adjustment costs is also emphasized by Artuc, Chaudhuri and McLaren (2010). They estimate substantial wage losses from trade liberalization for workers in import-competing sectors. Nonetheless, they find workers in import-competing sectors may benefit from trade liberalization. This is because there is a substantial amount of voluntary movement of workers who change jobs and sectors for reasons not explained by wage differentials, and since trade liberalization increases overall wages, the higher option value of changing jobs may overwhelm the lower wages in the import-competing sector. Regarding the intersectoral movement of workers, they note that the gross flow of workers is several multiples of the net flows, showing workers simultaneously moving in opposite directions. Bowlus and Newmann (2006) show that about 40 percent of workers who change jobs *voluntarily* move to jobs that pay less than their original job.

sectors are not fully liberalized in the FTA agreement, some partial liberalization may occur. For example, in the agriculture and food sector, the European Union typically excludes from full liberalization some of its agriculture markets in its preferential trade agreements; in these cases it often provides partial preferential liberalization with “tariff-rate quotas.” That is, up to a quota limit, the partner country may export the product to the EU under a preferred tariff regime, but above quota imports are treated on a “most-favored nation” basis. In this note, we assess the impact of full exclusion as well as partial liberalization of the sensitive sectors from the Ukraine-Turkey FTA. In particular, we evaluate reciprocal preferential tariff changes by Ukraine and Turkey as part of their FTA as follows: (i) no change in tariffs in these sectors; (ii) a twenty percent cut in the tariffs; (iii) a forty percent cut in the tariffs; (iv) a sixty percent cut in the tariffs; (ii) an eighty percent cut in the tariffs. Full cuts in tariffs in these sectors is part of the FTA Central scenario of the main paper.

It is also possible to interpret the tariff cuts we evaluate as an agreed sequential liberalization of these sectors over time to reduce adjustment costs. That is, the smallest cuts would be in the first year and with each successive year, an additional percentage tariff cut from the initial tariffs would be implemented. The number of years and the tariff cuts by years would be negotiated. Our simulations could be interpreted as successive annual cuts of twenty percent per year.

We evaluate the impact on Ukraine of reciprocal exclusion or partial liberalization of each of these three sectors separately and then the three together.

## **2. Wearing Apparel: Impact of Reciprocal Exclusion or Partial Liberalization from the Ukraine-Turkey FTA**

In table B1 we present the results of Ukraine and Turkey excluding or partially liberalizing preferentially tariffs on wearing apparel.<sup>11</sup> All other policies of our central Ukraine-Turkey FTA scenario remain unchanged.

We estimate that there is only a small impact on real household income (welfare) because of the exclusion of wearing apparel from the FTA. In table B1, column 1, we reproduce the results of FTA central, in which Ukraine is estimated to gain 2.72 percent of real household income. In column 2, there is no reduction of tariffs in wearing apparel, but all other aspects of FTA central apply. We see that the estimated change in real household income only falls to 2.71 percent, or a drop of 0.01 percent of real household income. The small change in Ukrainian welfare is explained by two considerations: (i) wearing apparel constitutes only one-third of one percent of Ukrainian value-added (see table 3); and (ii) Ukrainian tariffs against Turkish apparel imports are 9.9 percent, which are not extremely distorting. In columns 3-6, we show the results of partial reduction of tariffs in wearing apparel. As the tariff cuts deepen, the gains increase in the third

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<sup>11</sup> We have also evaluated the scenario where Turkey does not act reciprocally, that is, they fully eliminate their tariffs on wearing apparel. We find the results very close to those in table B1.

decimal of percentage change in welfare, and impact the second decimal with a twenty percent cut in tariffs..

In FTA Central, we estimate that there would be a decline in total labor employment in wearing apparel of 10.7 percent and that the earnings of labor in the sector would decline by 9.2 percent. If there were no tariff cuts in wearing apparel in the FTA, then, as shown in table B1, column 2, the decline in employment in the sector would be 5.6 percent and labor earnings would decline by 4.1 percent. Thus, although the loss of employment in wearing apparel is smaller if there are no tariff cuts in the sector, wearing apparel is still estimated to decline in FTA Central, even without tariff cuts in wearing apparel. The reason is that there are expanding sectors in the rest of the economy which offer higher wages and compete away labor from wearing apparel.

### **3. Agriculture and Food: Impact of Reciprocal Exclusion or Partial Liberalization from the Ukraine-Turkey FTA**

In table B2 we present the results of Turkey and Ukraine reciprocally excluding (partially or fully) tariffs on agriculture and food<sup>12</sup> from the FTA. We execute the steel exclusions separately from the agriculture and food policies. All other policies of our central Ukraine-Turkey FTA scenario remain unchanged.

We see in column 2 that full exclusion of *agriculture and food* from the FTA would result in a substantial reduction in Ukrainian real household income from 2.72 percent of real household income in a full FTA with all tariff eliminated to 1.78 percent of real household income with zero tariff changes in the ten agriculture and food sectors. In table B2, column 1, we see that in our FTA central scenario, we estimate weighted average factor earnings in agriculture and food would increase between 8.0 and 8.3 percent. However, if Turkey were to insist on the full exclusion of agriculture and food tariffs at all, we estimate (table B, column 2) that factor earnings in agriculture and food would increase by a more modest 3.0 to 3.5 percent.

These results are intuitive since Turkish tariffs in many of these sectors against the Ukrainian product mix are extremely high, and on the most protected products, they are also higher than the trade-weighted Most Favored Nation (MFN) tariff applied by Turkey. In particular, as we show in table 9a, the Ukrainian (and MFN in parentheses) tariffs, respectively, are: 198 (105) percent on processed meat; 177 (130) percent on dairy products; 75 (36) percent on “other food products”; 37 (36) percent on fish products; 30 (27) on fish; 26 (25) percent on animal production. Fruits and vegetables and crops are exceptions, where the Turkish MFN tariff is higher than the trade-weighted average tariff that applies to the Ukrainian product mix. Ukrainian firms would have a substantial competitive advantage over other imports in Turkey if Ukraine were to receive full tariff reduction in these products in Turkey. Further, collectively, these ten sectors account for a substantial 16.3 percent of Ukrainian value added, so the sectors are important to Ukraine.<sup>13</sup>

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<sup>12</sup>There are ten sectors in our model that are agriculture and food sectors and these are all treated as sensitive products that are not fully liberalized: Growing of crops (CRP); animal production and fishing (ANM); forestry and logging (LOG); meat products (PRM); dairy products (DAI); fish products (FIS); fruits and vegetables (PRV); fats and oils (OIL); grain mill products (MIL); and other food products (OTF).

<sup>13</sup> Calculated from data in table 3.

However, if Ukraine does not receive a reduction in Turkey's import protection in the agriculture and food sectors, it will be quite costly to Ukraine.

Even with the exclusion of tariff changes in agriculture and food from the Ukraine-Turkey FTA, we see from table B2, column 2 that real factor returns increase more in agriculture and food (3.0 to 3.5 percent) than the average for the economy (0.9 to 1.15 percent for the same factors). The reason is that reduced costs of importing and especially reduced costs of exporting are very important to the agriculture and food sectors. We estimate (see tables 13 and 16), that when we simulate the reduction of the time in trade costs, these sectors expand output and exports more than the average for the economy in an Ukraine-Turkey FTA, which explains why they fair better than average. This suggests that while negotiations on reducing the costs of trade are very important to the overall economy, they are even more important for the agriculture and food sectors. Even if little progress is made on these issues within the FTA, an avenue for reduction of these time in trade costs is for Ukraine to join the Common Transit System of the European Union.<sup>14</sup> As Turkey is a member of the Common Transit System of the European Union, but Ukraine is not currently, these results emphasize the importance of Ukraine joining the System.

#### **4. Steel: Impact of Reciprocal Exclusion or Partial Liberalization from the Ukraine-Turkey FTA**

In the case of the total exclusion of steel tariffs from the FTA with Turkey, the annual welfare gains would fall to 2.47 percent of real household income from 2.72 percent. Partial liberalization by Turkey would increase the welfare gains to Ukraine (as shown in table B2, columns 2-6) to where at 80 percent of the original tariffs in Turkey on Ukrainian steel imports Ukraine is estimated to gain 2.66 percent of real household income. Steel constitutes 2.8 percent of Ukrainian total value-added, so while it is important, its exclusion from tariff preferences in a Ukraine-Turkey FTA is not as important as agriculture and food.

#### **5. All Sensitive Products: Impact of Reciprocal Exclusion or Partial Liberalization from the Ukraine-Turkey FTA**

In table B4 we present the results of Turkey and Ukraine reciprocally excluding or partially preferentially liberalizing tariffs on wearing apparel, agriculture and food and also on steel. In these scenarios, we execute the exclusions and partial preferential liberalization of all three sectors simultaneously. All other policies of our central Ukraine-Turkey FTA scenario remain unchanged.

We see in column 2 that full exclusion of all these sectors from the FTA would result in a substantial reduction in Ukrainian real household income from 2.72 percent annual increase of real household income in a full FTA with all tariffs eliminated to 1.51 percent annual increase of real household income with full exclusion of tariff changes in all these sectors. In table B4, column 1, we see that in our FTA central scenario, we estimate weighted average factor earnings in the combined "sensitive" sectors would increase between 6.15 and 6.49 percent, depending on the factor of production. However, if all these sectors are fully excluded from the FTA we estimate

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<sup>14</sup>[https://ec.europa.eu/taxation\\_customs/business/customs-procedures/what-is-customs-transit/common-union-transit\\_en](https://ec.europa.eu/taxation_customs/business/customs-procedures/what-is-customs-transit/common-union-transit_en)

(table B4, column 2) that weighted average factor earnings in these sensitive sectors would increase by a more modest 2.57 to 3.09 percent. As we see from the results in section 3 of this appendix, over three-quarters of the reduction in welfare and factor earnings is due to the exclusion of agriculture and food.

## Tables

**Table B1: The Apparel Sector: Impact on Ukraine of Reciprocal Partial of Full Exclusion in the Ukraine-Turkey FTA**

Results are percentage change from initial equilibrium.

	Central Model with Monopolistically Competitive Sectors					
	Ukraine and Turkey's preferential tariffs on apparel imports					
Scenario definitions	FTA Central: All policies by Ukraine and Turkey	Apparel tariffs are not changed	Apparel tariffs are reduced by 20%	Apparel tariffs are reduced by 40%	Apparel tariffs are reduced by 60%	Apparel tariffs are reduced by 80%
<b>FTA Central Policies except:</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
No tariff reduction by Ukraine or Turkey on apparel imports	see table 11	Yes	No	No	No	No
20% tariff reduction by Ukraine and Turkey on apparel imports		No	Yes	No	No	No
40% tariff reduction by Ukraine and Turkey on apparel imports		No	No	Yes	No	No
60% tariff reduction by Ukraine and Turkey on apparel imports		No	No	No	Yes	No
80% tariff reduction by Ukraine and Turkey on apparel imports		No	No	No	No	Yes
<b>Aggregate welfare and real GDP</b>						
Welfare (EV as % of consumption)	2.72	2.71	2.72	2.72	2.72	2.72
Welfare (EV as % of GDP)	1.88	1.87	1.87	1.87	1.87	1.87
real GDP	2.12	2.10	2.10	2.11	2.11	2.11
<b>Aggregate trade</b>						
Real exchange rate	-0.10	-0.13	-0.12	-0.12	-0.11	-0.11
Aggregate exports	3.24	3.18	3.19	3.20	3.21	3.22
Aggregate imports	2.41	2.38	2.39	2.39	2.40	2.41
Change in imports from Turkey	30.07	27.24	27.72	28.24	28.81	29.41
Change in imports from all other countries	1.40	1.47	1.46	1.44	1.43	1.41
<b>Government budget</b>						
Tariff revenue (% of benchmark GDP)	0.69	0.70	0.70	0.70	0.70	0.69
Tariff Revenue	2.37	3.06	3.08	3.03	2.91	2.69
Value Added Taxes total	0.97	0.96	0.96	0.96	0.97	0.97
Value Added Taxes on imports	3.07	3.03	3.03	3.04	3.05	3.06
Value Added Taxes domestic	2.21	2.18	2.19	2.19	2.20	2.20
Excise Taxes on domestic	2.71	2.70	2.70	2.71	2.71	2.71
Excise Taxes on imports	2.95	2.93	2.93	2.93	2.94	2.94
Excise Taxes total	2.80	2.79	2.79	2.80	2.80	2.80
<b>Factor Earnings in Apparel</b>						
Skilled labor earnings	-9.21	-4.05	-4.89	-5.82	-6.84	-7.97
Unskilled labor earnings	-9.21	-4.05	-4.89	-5.82	-6.84	-7.97
Capital earnings	-9.21	-4.05	-4.89	-5.82	-6.84	-7.97
<b>Factor Earnings Economy-Wide</b>						
Skilled labor earnings	1.52	1.49	1.50	1.50	1.51	1.51
Unskilled labor earnings	1.78	1.76	1.76	1.77	1.77	1.78
Capital earnings	1.60	1.58	1.58	1.59	1.59	1.60
Specific Factors earnings to land and natural resources	5.20	5.15	5.16	5.17	5.17	5.18
Earnings to specific capital in domestic firms	5.28	5.21	5.22	5.24	5.25	5.26
Earnings to specific capital in multinational firms	2.97	2.98	2.98	2.98	2.98	2.98
<b>Factor Adjustments Aggregate*</b>						
Total labor	1.19	1.18	1.18	1.18	1.19	1.19
Skilled labor	1.02	1.01	1.01	1.01	1.02	1.02
Unskilled labor	1.54	1.52	1.53	1.53	1.53	1.53
Capital	1.23	1.22	1.22	1.22	1.22	1.22
<b>Factor Adjustments in Apparel*</b>						
Total labor	-10.67	-5.62	-6.44	-7.35	-8.35	-9.45
Skilled labor	-10.56	-5.51	-6.33	-7.24	-8.24	-9.35
Unskilled labor	-10.80	-5.76	-6.57	-7.48	-8.48	-9.58
Capital	-10.64	-5.59	-6.41	-7.32	-8.32	-9.43

\*Percentage of the factor that must change sectors

Source: Authors' estimates.

**Table B2: Agriculture and Food\*: Impact on Ukraine of Reciprocal Partial of Full Exclusion from a Ukraine-Turkey FTA**

Results are percentage change from initial equilibrium.	Central Model with Monopolistically Competitive Sectors					
		Ukraine and Turkey's preferential tariffs on agriculture				
	FTA Central: All policies by Ukraine and Turkey	Agriculture and food tariffs are not changed	Ag and food tariffs are reduced by 20%	Ag and food tariffs are reduced by 40%	Ag and food tariffs are reduced by 60%	Ag and food tariffs are reduced by 80%
Scenario definitions						
FTA Central Policies except:	1	2	3	4	5	6
No tariff reduction by Ukraine or Turkey on Ag. and Food imports	see table 11	Yes	No	No	No	No
20% tariff reduction by Ukraine or Turkey on Ag. and Food imports		No	Yes	No	No	No
40% tariff reduction by Ukraine or Turkey on Ag. and Food imports		No	No	Yes	No	No
60% tariff reduction by Ukraine or Turkey on Ag. and Food imports		No	No	No	Yes	No
80% tariff reduction by Ukraine or Turkey on Ag. and Food imports		No	No	No	No	Yes
Aggregate welfare and real GDP						
Welfare (EV as % of consumption)	2.72	1.78	1.84	1.92	2.05	2.26
Welfare (EV as % of GDP)	1.88	1.23	1.27	1.33	1.41	1.56
real GDP	2.12	1.31	1.35	1.42	1.53	1.71
Aggregate trade						
Real exchange rate	-0.10	-0.17	-0.18	-0.19	-0.19	-0.17
Aggregate exports	3.24	2.23	2.29	2.37	2.50	2.72
Aggregate imports	2.41	1.59	1.64	1.70	1.79	1.97
Change in imports from Turkey	30.07	26.71	27.20	27.73	28.34	29.06
Change in imports from all other countries	1.40	0.67	0.70	0.74	0.82	0.98
Government budget						
Tariff revenue (% of benchmark GDP)	0.69	0.69	0.69	0.69	0.69	0.69
Tariff Revenue	2.37	1.84	1.91	1.97	2.04	2.13
Value Added Taxes total	0.97	0.54	0.57	0.60	0.65	0.75
Value Added Taxes on imorts	3.07	2.21	2.27	2.36	2.47	2.66
Value Added Taxes domestic	2.21	1.53	1.57	1.64	1.73	1.88
Excise Taxes on domestic	2.71	0.57	0.64	0.77	1.01	1.51
Excise Taxes on imports	2.95	2.59	2.61	2.64	2.68	2.75
Excise Taxes total	2.80	1.37	1.41	1.50	1.66	2.00
Factor Earnings in Agriculture and Food						
Skilled labor earnings	8.27	3.01	3.38	3.88	4.58	5.74
Unskilled labor earnings	7.97	3.29	3.66	4.13	4.80	5.84
Capital earnings	8.05	3.53	3.89	4.35	4.99	5.99
Factor Earnings Economy-Wide						
Skilled labor earnings	1.52	0.93	0.96	0.99	1.06	1.19
Unskilled labor earnings	1.78	1.15	1.18	1.23	1.30	1.45
Capital earnings	1.60	1.08	1.10	1.14	1.20	1.32
Specific Factors earnings to land and natural resources	5.20	3.14	3.40	3.70	4.07	4.53
Earnings to specific capital in domestic firms	5.28	2.53	2.67	2.87	3.20	3.83
Earnings to specific capital in multinational firms	2.97	2.40	2.44	2.49	2.56	2.68
Factor Adjustments Aggregate**						
Total labor	1.19	0.73	0.75	0.80	0.86	0.97
Skilled labor	1.02	0.63	0.65	0.68	0.74	0.83
Unskilled labor	1.54	0.93	0.96	1.02	1.11	1.25
Capital	1.23	0.78	0.80	0.84	0.89	1.00
Factor Adjustments in Agriculture and Food**						
Total labor	6.35	2.09	2.43	2.86	3.47	4.41
Skilled labor	6.65	2.06	2.40	2.85	3.49	4.50
Unskilled labor	6.08	2.12	2.45	2.87	3.45	4.33
Capital	6.34	2.42	2.76	3.18	3.75	4.61

\*The agriculture and food products that are excluded are: Growing of crops (CRP); animal production and fishing (ANM); forestry and logging (LOG); meat products (PMT); dairy products (DAI).

\*\*Percentage of the factor that must change sectors. In the agriculture and food sectors, the percentage change is a movement of factors into the sectors.

Source: Authors' estimates.

**Table B3: The Steel Sector: Impact on Ukraine of Reciprocal Partial of Full Exclusion from a Ukraine-Turkey FTA**

Results are percentage change from initial equilibrium.	Central Model with Monopolistically Competitive Sectors					
	Ukraine and Turkey's preferential tariffs on Steel					
Scenario definitions	FTA Central: All policies by Ukraine and Turkey	Steel tariffs are not changed	Steel tariffs are reduced by 20%	Steel tariffs are reduced by 40%	Steel tariffs are reduced by 60%	Steel tariffs are reduced by 80%
<b>FTA Central Policies except:</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
No tariff reduction by Ukraine or Turkey on Steel imports	see table 11	Yes	No	No	No	No
20% tariff reduction by Ukraine or Turkey on Steel imports		No	Yes	No	No	No
40% tariff reduction by Ukraine or Turkey on Steel imports		No	No	Yes	No	No
60% tariff reduction by Ukraine or Turkey on Steel imports		No	No	No	Yes	No
80% tariff reduction by Ukraine or Turkey on Steel imports		No	No	No	No	Yes
<b>Aggregate welfare and real GDP</b>						
Welfare (EV as % of consumption)	2.72	2.47	2.51	2.56	2.61	2.66
Welfare (EV as % of GDP)	1.88	1.70	1.73	1.76	1.80	1.83
real GDP	2.12	1.96	1.99	2.02	2.05	2.08
<b>Aggregate trade</b>						
Real exchange rate	-0.10	0.05	0.02	0.00	-0.03	-0.07
Aggregate exports	3.24	2.68	2.77	2.87	2.98	3.10
Aggregate imports	2.41	1.99	2.06	2.13	2.22	2.31
Change in imports from Turkey	30.07	28.71	28.96	29.22	29.49	29.77
Change in imports from all other countries	1.40	1.01	1.07	1.14	1.21	1.30
<b>Government budget</b>						
Tariff revenue (% of benchmark GDP)	0.69	0.69	0.69	0.69	0.69	0.69
Tariff Revenue	2.37	2.12	2.18	2.23	2.28	2.32
Value Added Taxes total	0.97	0.91	0.92	0.93	0.94	0.96
Value Added Taxes on imports	3.07	2.37	2.48	2.61	2.75	2.90
Value Added Taxes domestic	2.21	1.77	1.84	1.92	2.01	2.10
Excise Taxes on domestic	2.71	2.55	2.58	2.60	2.64	2.67
Excise Taxes on imports	2.95	1.69	1.89	2.12	2.37	2.64
Excise Taxes total	2.80	2.21	2.31	2.41	2.53	2.66
<b>Factor Earnings in Steel</b>						
Skilled labor earnings	8.27	-5.44	-4.21	-2.85	-1.36	0.30
Unskilled labor earnings	7.97	-5.44	-4.21	-2.85	-1.36	0.30
Capital earnings	8.05	-5.44	-4.21	-2.85	-1.36	0.30
<b>Factor Earnings Economy-Wide</b>						
Skilled labor earnings	1.52	1.43	1.44	1.46	1.48	1.49
Unskilled labor earnings	1.78	1.67	1.69	1.71	1.73	1.75
Capital earnings	1.60	1.31	1.36	1.41	1.47	1.53
Specific Factors earnings to land and natural resources	5.20	5.75	5.66	5.56	5.45	5.33
Earnings to specific capital in domestic firms	5.28	4.86	4.93	5.00	5.09	5.18
Earnings to specific capital in multinational firms	2.97	2.64	2.69	2.75	2.82	2.89
<b>Factor Adjustments Aggregate*</b>						
Total labor	1.19	1.28	1.26	1.24	1.22	1.20
Skilled labor	1.02	1.07	1.06	1.05	1.03	1.02
Unskilled labor	1.54	1.70	1.67	1.64	1.60	1.57
Capital	1.23	1.43	1.39	1.35	1.31	1.26
<b>Factor Adjustments in Steel*</b>						
Total labor	-2.40	-6.87	-5.67	-4.35	-2.90	-1.29
Skilled labor		-6.77	-5.57	-4.25	-2.79	-1.18
Unskilled labor		-6.99	-5.80	-4.48	-3.03	-1.43
Capital		-6.66	-5.49	-4.20	-2.78	-1.22

\* Percentage of the factor that must change sectors.

Source: Authors' estimates.

**Table B4: All “Sensitive” Sectors: Impact on Ukraine of Reciprocal Partial of Full Exclusion from the Ukraine-Turkey FTA**

Results are percentage change from initial equilibrium.

		Central Model with Monopolistically Competitive Sectors				
		Both Ukraine's and Turkey's tariffs against all sensitive imports				
Scenario definitions	FTA Central: All policies by Ukraine and Turkey	sensitive tariffs are not changed	sensitive tariffs are reduced by 20%	sensitive tariffs are reduced by 40%	sensitive tariffs are reduced by 60%	sensitive tariffs are reduced by 80%
<b>Ukraine-Turkey FTA Central Policies except:</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
No tariff reduction by Ukraine and Turkey on sensitive imports	see table 11 for policies in FTA central	Yes	No	No	No	No
20% tariff reduction by Ukraine and Turkey on sensitive imports		No	Yes	No	No	No
40% tariff reduction by Ukraine and Turkey on sensitive imports		No	No	Yes	No	No
60% tariff reduction by Ukraine and Turkey on sensitive imports		No	No	No	Yes	No
80% tariff reduction by Ukraine and Turkey on sensitive imports		No	No	No	No	Yes
100% tariff reduction by Ukraine and Turkey on sensitive imports		No	No	No	No	No
<b>Aggregate welfare and real GDP</b>						
Welfare (EV as % of consumption)		2.72	1.51	1.62	1.75	1.93
Welfare (EV as % of GDP)		1.88	1.04	1.11	1.20	1.33
real GDP		2.12	1.13	1.21	1.31	1.45
<b>Aggregate trade</b>						
Real exchange rate		-0.10	-0.04	-0.07	-0.11	-0.13
Aggregate exports		3.24	1.59	1.76	1.95	2.20
Aggregate imports		2.41	1.12	1.24	1.39	1.58
Change in imports from Turkey		30.07	22.53	23.75	25.07	26.51
Change in imports from all other countries		1.40	0.33	0.41	0.52	0.66
<b>Government budget</b>						
Tariff revenue (% of GDP)		0.69	0.71	0.71	0.70	0.70
Tariff Revenue		2.37	2.26	2.40	2.48	2.48
Value Added Taxes total		0.97	0.47	0.50	0.55	0.62
Value Added Taxes on imports		3.07	1.42	1.62	1.84	2.11
Value Added Taxes domestic		2.21	1.03	1.16	1.31	1.50
Excise Taxes on domestic		2.71	0.39	0.49	0.65	0.93
Excise Taxes on imports		2.95	1.23	1.48	1.75	2.06
Excise Taxes total		2.80	0.72	0.88	1.08	1.37
<b>Factor Earnings in sensitive sectors</b>						
Skilled labor earnings		6.39	2.65	2.97	3.38	3.92
Unskilled labor earnings		6.49	3.09	3.40	3.78	4.28
Capital earnings		6.15	2.57	2.97	3.45	4.03
<b>Factor Earnings Economy-Wide</b>						
Skilled labor earnings		1.52	0.83	0.87	0.92	1.01
Unskilled labor earnings		1.78	1.02	1.07	1.14	1.24
Capital earnings		1.60	0.75	0.82	0.92	1.05
Specific Factors earnings to land and natural resources		5.20	3.65	3.82	4.04	4.30
Earnings to specific capital in domestic firms		5.28	2.03	2.24	2.54	2.97
Earnings to specific capital in multinational firms		2.97	2.07	2.16	2.27	2.40
<b>Factor Adjustments Aggregate</b>						
Total labor		1.19	0.66	0.68	0.73	0.80
Skilled labor		1.02	0.55	0.57	0.61	0.68
Unskilled labor		1.54	0.88	0.90	0.96	1.05
Capital		1.23	0.75	0.76	0.79	0.84
<b>Factor Adjustments in sensitive products**</b>						
Total labor		4.71	1.93	2.19	2.52	2.94
Skilled labor		4.81	1.80	2.08	2.43	2.88
Unskilled labor		4.62	2.05	2.30	2.61	3.00
Capital		4.47	1.81	2.13	2.51	2.95

\* Percentage of the factor that must change sectors.

Source: Authors' estimates.

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## Appendix C: Adjustment Costs: International Evidence and an Estimate for Ukraine

### C1. Adjustment Cost Evidence

We summarize the evidence on both the *social* adjustment costs of trade liberalization as well as the *private* adjustment costs. Our summary is based on the survey of more than 50 papers on adjustment costs by Matusz and Tarr (2000) and some more recent important papers. Matusz and Tarr (2000) find that both the social and private adjustment costs are dramatically smaller than the welfare gains. We explain below the factors that significantly impact the ratio of the benefits of trade liberalization to the adjustment costs.

Since we measure the social *benefits* of trade liberalization, not the private benefits, it is the social costs that are most relevant for the comparison. Social costs are the usual measure in benefit-cost analysis of other issues, such as whether to proceed on an infrastructure project. Despite our view that it is social adjustment costs that are more relevant for a benefit-cost analysis, knowledge of private adjustment costs is relevant for multiple reasons. Notably, policymakers are often concerned about the impact on the poorest members of society who might be employed in sectors that are not internationally competitive and then suffer private adjustment costs that they can ill afford. Knowledge of the private impacts may aid policymakers in the design of public assistance for adjustment or of strategies that mitigate these costs (which we discuss below). Further, policymakers often receive strong lobbying from those who suffer or fear private adjustment costs from trade liberalization, while those who gain are more diverse or may not realize they will gain from trade liberalization; so, the gainers typically do not lobby for liberalization or lobby much less vigorously. Consequently, we discuss the literature on both the private adjustment costs and social adjustment costs of trade liberalization.

Private costs borne by dislocated workers and entrepreneurs need not coincide with the social costs. For example, a commercial airplane pilot may see his or her salary fall due to deregulation of entry restrictions into air transportation services. The salary reduction for working in the same job is a private adjustment cost due to a loss of a return on specific human capital, but there is no social cost. Other examples are that some workers may enjoy a high wage due to distortions in the labor market. These distortions may include the presence of excessive union power<sup>15</sup> or the existence of inflexible government wage scales. Competitive pressures, as could occur from trade reform, may force a reduction in the size of distorted sectors. In such instances, there may be a substantial private cost from a reduction in wages, but no social cost (except that which may be associated with unemployment, relocation costs or a decline in labor force participation). Similarly, liberalization of the trading regime might induce changes in the values that an economy places on various forms of sector-specific or firm-specific human capital. Workers who have accumulated significant amounts of firm-specific or sector-specific human capital may suffer a substantial (private) loss as the demand for their skills declines. This,

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<sup>15</sup> For example, Katz and Summers (1989) estimate that auto and steel workers in the United States obtain wage premia due to union bargaining.

however, is no more a social cost than is the change in *any* price that is induced by changing market conditions.<sup>16</sup>

**C1.1. Private Adjustment Costs.** The evidence from empirical studies worldwide, summarized by Matusz and Tarr (2000), has shown that the earning losses due to trade liberalization for low wage workers, who tend to be the workers most vulnerable, are negligible. Using data for the United States, Jacobsen (1978) found that two years after involuntarily displacement, workers in low wage industries actually earned more income than their non-displaced counterparts in the original industry. Moreover, he found that six years after displacement, earnings losses had vanished for all industries, not just for low wage industries. Similarly, Orazem, Vodopivec, and Wu (1995) found that more than two-thirds of displaced Slovenian workers who found new jobs actually earned wages higher than their pre-displacement wages. Artuc, Chaudhuri and McLaren (2010) find that workers in the United States change industry a great deal, but these movements do not respond much to movements in intersectoral wage differentials.<sup>17</sup> They call these non-pecuniary job changes “idiosyncratic,” and estimate that workers in import competing industries may benefit from trade liberalization due to the increased wages in sectors to which they move.

On the other hand, Jacobson, *et al.* (1993a, 1993b) studied a sample of long job tenured American workers who were displaced from their jobs between 1980 and 1986. They found that even as long as five years after the dislocation, *workers who had long job tenure* with their previous employers were earning on average twenty five percent less than they earned in 1979. The difference in the results between the Jacobsen (1978) study and the Jacobsen *et al.* (1993a, 1993b) studies is explained by the fact that the 1993 studies restrict the sample to workers with long job tenure and who are therefore likely to have accumulated specific human capital or earn wage premia. Jacobsen’s 1978, study, however, is a broad sample of short, medium and long tenure workers who have on average much less specific human capital. Utar (2018) found similar results for Danish workers—those with important specific human capital incurred significant earnings losses. Rama and MacIsaac (1996) and Tansel (1996) have also found that workers who earn wage premia (for example, due to union wage premia or work in the central bank or state-owned enterprises) experience sustained income losses after displacement.

**C1.2. Social Adjustment Costs.** The social adjustment costs entail the lost output of society due to a period of unemployment, possible relocation or retraining costs, and a possible reduction in labor force participation (less the value of additional leisure of unemployed workers and those who drop out of the labor force). Data on adjustment costs indicate that adjustment occurs over several periods with adjustment costs progressively declining, i.e.,  $C_{t+1} < C_t$ , where

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<sup>16</sup>Further, general equilibrium models that include specific factors will account for the changing value of specific factors; then the estimated change in welfare from trade liberalization will be incorporated into the model’s estimate of the welfare gains. The model for Ukraine, accounts for the changing value of specific capital in all sectors, thereby incorporating the changes in the value of specific capital in the estimate of the welfare gains.

<sup>17</sup> Artuc *et al.* (2010) note that gross flows of intersectoral labor market movements are an order of magnitude larger than the net flows, implying large numbers of workers moving in opposite directions. Second, Bowlus and Newman (2006) show that about 40 percent of workers in the United States who change jobs voluntarily, move to a job that pays less than the job they left behind.

$C_t$  is the adjustment cost during period  $t$ . This follows since resources are likely to be gradually re-employed. On the other hand, the benefits of liberalization do not decline and are likely to grow over time as the economy grows. Letting  $B_t$  represent the benefits during period  $t$ , and  $r$  is the social rate of discount, the discounted benefits of trade reform exceed the discounted

adjustment costs if and only if: 
$$\sum_{t=1}^{\infty} \frac{B_t}{(1+r)^{t-1}} > \sum_{t=1}^{\infty} \frac{C_t}{(1+r)^{t-1}}.$$

The evidence from empirical studies worldwide, summarized by Matusz and Tarr (2000), has shown that the social adjustment costs are very substantially less than the benefits. In part, this is due to the fact that the evidence shows that the normal turnover in industries is often sufficient to accommodate the displacement without involuntary unemployment. Winters and Takacs (1991) estimate that the removal of quantitative import restrictions on British footwear imports would displace 1,064 workers in the industry. But their data show that 16.9 percent of workers in British footwear depart voluntarily each year. They calculate that this implies that the reduction in demand for labor in the British footwear industry from removing the import restrictions could be accommodated within 21 weeks without any involuntary displacement.<sup>18</sup> Dixon, Parmenter and Powell (1984) estimate that in response to a 25 percent reduction in Australian protection, between two and fourteen percent of the Australian workforce would have to change occupations within two years. This compares to a normal change of occupations in Australia in any two-year period of between 32 and 142 percent (depending on the two-year period). Finally, Artuc, Chaudhuri and McLaren (2010) show that gross flows of intersectoral labor market movements are an order of magnitude larger than the net flows, implying large numbers of workers moving in opposite directions.

An important caveat to the social adjustment cost is from the work of Autor, Dorn and Hanson (2013). Their results suggest the need to significantly augment the methodology for estimating the social costs of adjustment in high-income countries with a significant social safety net. They show that the social adjustment costs may go beyond the duration of unemployment and relocation and retraining costs. Autor *et al.* (2013) show that geographic regions in the United States with high exposure to Chinese imports experienced wage loss, higher unemployment rates, reduced labor force participation and higher transfer payments. The distortion costs associated with raising taxes used to fund the transfer payments are an additional social cost of adjustment. Then the decline in labor force participation leads to prolonged social costs of adjustment. They document that the decline in labor force participation is enabled in the United States by an increase in payments from a substantial safety net in the United States. In the regions with high exposure to Chinese imports, they estimate increase payments from the following safety net programs: Trade Adjustment Assistance (TAA), Unemployment Insurance, Social Security Disability Insurance (SSDI), federal income assistance benefits from SSI (Supplementary Security Income), temporary assistance for needy families (TANF), SNAP (Supplemental Nutrition Assistance formerly known as food stamps) and medical transfer benefits programs including Medicare and Medicaid. Autor *et al.* (2013) note that the transfer

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<sup>18</sup> Winters and Takacs estimate a benefit-cost ratio of removing the footwear restrictions of 153 with only one year of benefits, but this would rise to more than 2,000 if the infinite horizon is employed for the calculation.

payments themselves are not a net welfare loss, but the marginal value of income versus the valuation of leisure for the displaced who drop out of the labor force is a social cost and the distortion costs of raising funds for increased transfer payments is a social cost.

The results of Autor *et al.* (2013) depend on geographic isolation of a region relatively dependent on low wage manufacturing that face imports from China (or possibly other low wage regions) and the existence of a substantial social safety net. Thus, their results appear to be much less relevant to developing countries. That is, developing countries have wages closer to Chinese wages or even lower and usually possess very minimal social safety nets. In particular, for our results below for Ukraine, it is the wages of unskilled workers in Turkey that are relevant and Ukrainian wages are much closer to Turkish wages than are Chinese wages to wages in the United States, and there is a minimal social safety net in Ukraine.

## **C2. Examples of Estimates of Private and Social Costs of Adjustment**

Here we provide four concrete sector examples of the estimates of the private and social adjustment costs and their comparison to the benefits of the removal of import protection in particular sectors. These examples facilitate understanding on what influences the benefit-cost ratios. We take these examples from Tarr and Morkre (1984) which, along with the companion monograph Morkre and Tarr (1980), were the first applications of the methodology of Corden (1957) on how to estimate the costs of protection. We summarize the estimates of all four case studies in table C1 below.

**C2.1 Removal of Quotas on Textiles and Apparel.** Textile and apparel quotas in the United States were imposed under the Multi-Fibre Arrangement (MFA). The MFA was phased out by the World Trade Organization. Tarr and Morkre (1984) estimate gains to the United States economy from removal of the quotas, (but retention of the tariffs) equal to \$308 million US dollars per year (in 1980 prices) with a low Armington elasticity of substitution or \$488 million with a high Armington elasticity of substitution. If tariffs were employed instead of quotas to achieve the same level of output and employment in the textiles and apparel sector, the costs to the economy would be reduced to between \$90 - \$269 million per year.

Regarding the social costs of adjustment, the quotas, however, are estimated to protect between 8.9 and 32.4 thousand jobs in textiles and apparel. The average duration of unemployment of textile and apparel workers was 11.3 weeks or 21.7 percent of the year. Given the average wage of a textile and apparel worker of \$7,574 per year, the estimated costs of unemployment for all displaced workers are between \$16.8 million and \$60.9 million, depending on the assumed elasticity of substitution. For the benefits, we take the present value of the gains into the infinite horizon at a seven percent discount rate, which yields gains of \$4.7 billion to \$7.5 billion. These estimates yield a benefit-cost ratio of between 122 and 280. The cost per job protected is between \$230 thousand to \$530 thousand, excluding the wages; that is, the wages increase the estimate of costs per job. The estimates are summarized in table C1.

Note that the textile and apparel industry is a low-wage industry. Jacobsen (1978) estimated that displaced textile and apparel workers, on average, earned more during the first six years after displacement than their non-displaced counterparts. Thus, if Tarr and Morkre (1984)

had used the private costs of adjustment measure of average earnings losses, they would have had much lower adjustment costs and higher benefit-cost ratios. On the other hand, comparing rows 1a and 1b of table C1, shows that if protection were provided with a tariff instead of with the quotas, the benefits would be substantially reduced, lowering the benefit-cost ratios.

**C2.2 Removal of Quotas on Japanese autos.** One example of benefit-cost analysis, based on the private costs of adjustment, is the estimate of the social benefits and private adjustment costs of removing the automobile quota on Japanese auto imports that was in place in the United States in 1984. Tarr and Morkre (1984) estimate social gains of \$994 million per year (in 1984 US dollars), composed of rent transfer to Japanese producers equal to \$824 million per year and \$170 million per year of deadweight loss that would exist if the “equivalent tariff” were used to obtain the identical quantity of Japanese auto imports. If quotas were to be maintained into the indefinite future, the present value of these costs (which they take as the benefit of removing them) would be \$15.2 billion in 1984 US dollars (with a social discount rate of seven percent). Tarr and Morkre (1984) estimate that the quota protects 4,598 jobs in the auto sector. They use data from Jacobsen (1978) on the earnings losses of workers involuntarily displaced in the auto sector. The present value of the earnings losses is \$47,000 per displaced worker. These data yield an estimate of the present value of the earnings losses of displaced auto workers of \$216 million, which we take as the private adjustment costs. Then the benefit-cost ratio of removing the quotas is 70 and the cost to the US economy per job protected in the auto sector of \$3.3 million per job protected in the auto sector.

Since the auto sector is a high-wage sector, the earnings losses of displaced workers are relatively high, and this results in lower benefit-cost ratios. Further, rows 1a and 1b of table C1 show that if tariffs were employed instead of quotas, the benefit-cost ratio would be reduced to less than 20 percent of the estimate in table C1.

**C2.3 Steel Quotas.** In the early 1980s, the United States Trade Representative negotiated a network of voluntary restraint agreements with virtually all significant foreign suppliers of steel to the United States. (under threat of antidumping and countervailing duty actions). The network of agreements was designed to limit imports to 18.5 percent of United States apparent consumption of steel for a period of five years. Tarr and Morkre (1984) estimate social gains of \$803 million per year (in 1983-1984 US dollars), composed of rent transfer to foreign steel producers equal to \$573 million per year and \$230 million per year of deadweight loss that would exist if the “equivalent tariff” were used to obtain the identical quantity of steel imports. If quotas were to be maintained for the proposed five-year period, the present value of these costs (which they take as the benefit of removing them) would be \$3.52 billion in 1983-1984 US dollars (with a social discount rate of seven percent). Tarr and Morkre (1984) estimate that the quota protected 9,951 jobs in the steel sector. They use data from Jacobsen (1978) on the earnings losses of workers involuntarily displaced in the steel sector and estimate earnings losses of \$143 million. These data yield an estimate of the benefit-cost ratio of removing the quotas of 25 and the cost to the US economy per job protected in the auto sector of \$354 thousand in addition to the wages of the workers. These estimates are summarized in table C1.

These benefit-cost ratios are relatively lower due to the assumption that the quotas will only be in place for five years. Thus, the present value of the benefits is taken over five years, not the infinite horizon. Further, steel is a relatively high-wage sector, so the private costs of adjustment are relatively high, again yielding a lower benefit-cost ratio. Nonetheless, the benefit-cost ratio of 86 is high by the standards of an infrastructure project.

**C2.4 Sugar Quotas.** Tarr and Morkre (1984) estimate the impact of eliminating the U.S. quotas on sugar imports (applied against a large network of sugar exporting countries). Key to the estimates is that in the absence of a quota on imports, they assume that the tariff rate would be unchanged and, crucially, a production subsidy would be provided to the industry that would yield the same level of domestic output and employment as prevails under the quota. Given this assumption, the benefit estimate is not a comparison to the absence of government support to the sector, rather a comparison of the relative benefits of supporting a sector with a production subsidy instead of a quota.

Given this policy experiment, which retains the same level of output and employment, it implies there are no adjustment costs. Then the benefit-cost ratios are unbounded above.

**C2.5 Summary of what impacts the Benefit-Cost Ratios.** Private adjustment costs are higher in high-wage industries and for workers with specific human capital. Social adjustment costs are higher in high wage regions with disproportionate exposure to low-wage imports, especially in the presence of a substantial social safety net. Phased reduction of protection is likely to substantially reduce adjustment costs due to the relatively large movement of workers over time compared to the estimates of involuntary displacement. Benefits of trade liberalization are much higher for quota reduction or elimination than for reduction or elimination of a tariff that yields equivalent protection to the domestic industry. On budget assistance to a sector in lieu of import protection yields potentially infinitely large benefit-cost ratios since there are no estimated adjustment costs. Benefits are higher for elimination of a quota that appears permanent than for one designed to expire.

### **C3 Mitigation Strategy for Adjustment Costs.**

To address adjustment costs issues, especially for the most vulnerable in society, Hoekman, Michalopoulos, Schiff and Tarr (2002) contributed “Trade Policy Reform and Poverty Alleviation,” to the World Bank’s *Sourcebook for Poverty Reduction Strategies*. They recommend as a first best solution for displacement due to a trade shock the establishment of a social safety net to assist the most vulnerable with adjustment to shocks of various types, not only trade shocks.<sup>19</sup> In many developing countries, however, there is no effective social safety net in place. In the absence of an effective social safety net, the recommended solution is a phased reduction of liberalization over a period of time, say 2-5 years. The reason for the recommended phased reduction of liberalization is that the evidence above shows that the normal turnover in industries is often sufficient to accommodate the displacement without involuntary unemployment.

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<sup>19</sup> See also Michalopolous, Schiff and Tarr (2002).

Earlier results have shown that while regional liberalization provides a smaller benefit-cost ratio from trade liberalization, there are lower adjustment costs of regional liberalization. These lower adjustment costs explain some of the appeal of regional liberalization to policymakers, despite the usually larger net gains of broader unilateral or multilateral liberalization.<sup>20</sup> In the main text we estimate these values for the Ukraine-Turkey FTA compared to broader liberalization.

#### **C4. Estimates of Social Adjustment Costs and Benefit-Cost Ratios for Ukraine**

We estimate the adjustment costs of (i) the Ukraine-Turkey FTA; (ii) the Ukraine-Turkey FTA plus Ukrainian unilateral liberalization of FDI barriers against all FDI; and (iii) the FTA plus deeper Ukrainian regulatory reform in services to reduce non-discriminatory investment barriers. In all three cases, we compare the adjustment costs to the welfare gains.

We quantify the adjustment costs estimate for Ukraine, by adopting the unemployed resources measure of the social costs of adjustment of a trade policy change.<sup>21</sup> Given our single household model, we take an average duration of unemployment measure across all workers. Our method ignores diverse impacts across households, such as more adverse impacts on workers in regions that are more exposed to import competition as identified by Autor *et al.* (2013) for the United States.<sup>22</sup> The social safety net in Ukraine, however, is very limited in comparison to the United States. Consequently, transfer payments and the ability to drop out of the labor force is less relevant in Ukraine. Further, the wage scale is considerably lower than in the United States, especially for unskilled workers and crucially, in our policy experiments the relevant imports are from Turkey, not China. So, competition from low wage imports is likely to be less devastating to unskilled labor-intensive manufacturing than for industries in the United States heavily exposed to Chinese imports. To the extent that the reforms we consider reduce labor force participation and ignore possible relocation costs, however, our estimates are an underestimate of the social adjustment costs. Regarding our specific application in Ukraine, however, there is concern regarding apparel (not textiles) imports. In appendix B, we consider a phased reduction or zero liberalization of apparel imports.

Let  $w$  = the annual wages, including taxes paid by labor;  $L$  = the total labor force;  $\Delta L$  = the number of workers who are displaced by the trade policy change;  $\beta = \Delta L/L$  = the share of the labor force that is displaced by the trade policy change;  $\mu$  = the share of one year that a displaced worker is unemployed; and  $X$  = the value of the loss of output due to the displacement of  $\Delta L$

workers. Then, if the value of the marginal product of labor is equal to wages,  $p \left( \frac{\partial Y}{\partial L} \right) = w$ , we

have that  $X$  is given by equation (7).

<sup>20</sup> See, for example, Balistreri, Tarr and Yonezawa (2015).

<sup>21</sup> For the methodology, see Morkre and Tarr (1980, chapter 3).

<sup>22</sup> Autor *et al.* (2013) found significant expansion of transfer payments associated with lower labor-force participation in regions with high exposure to Chinese imports in the United States.

$$p\left(\frac{\partial Y}{\partial L}\right) \times \Delta L \times \mu = w \times \Delta L \times \mu = X \quad (7)$$

Data from the Ukrainian State Statistical Service shows that labor's share of GDP is 0.413;<sup>23</sup> i.e.,  $wL = .413 \times GDP$ ; and the average duration of unemployment in Ukraine was six months, i.e.,  $\mu = 0.5$ .<sup>24</sup> Substitute for  $w$  and  $\mu$  from these data and divide by GDP in equation (7) to obtain

$$(.413) \times \frac{\Delta L}{L} \times 0.5 = \frac{X}{GDP} = \text{Labor Adjustment Costs as a percent of GDP} \quad (8)$$

If  $\Delta L/L$  is the share of the labor force that is displaced due to the trade reform, we estimate the social costs of labor adjustment from equation (8). We take the estimate of  $\Delta L/L$  from our model.

From our model, we estimate (see table 3 of the main text) that in the Ukraine-Turkey FTA Central scenario about 1.19 percent of labor must change jobs, i.e.,  $\Delta L/L = .0119$ . Then from equation (1), adjustment costs as a percent of GDP ( $X/GDP$ ) are 0.246 percent. We estimate (see table 4) that about 1.21 percent of labor must change jobs when we add FDI spillovers to the world to the FTA,  $\Delta L/L = .0121$  and  $X/GDP = 0.250$  percent of GDP. In FTA Plus, where we add non-discriminatory services liberalization to the FTA, about 1.38 percent of labor must change jobs  $\Delta L/L = .0138$  (see table 4); then  $X/GDP = 0.285$  percent. The adjustment costs as a percent of GDP are in table 6, row 1; annual gains in equivalent variation as a percent of consumption and GDP are shown in rows 2 and 3 of table 6. We assume that adjustment costs are a once and for all cost, whereas the gains from the trade policy change continue into the infinite future. Taking the present value of the gains into the infinite future with a seven percent discount rate for future gains, the gains from our three principal scenarios, as a percent of GDP, are 28.7, 50.1 and 31.5 (row 4 of table 6). Then, the ratio of the real household income gains to the adjustment costs of the policy changes is as follows: Ukraine-Turkey FTA = **116.9**; Ukraine-Turkey FTA plus reduction on non-discriminatory barriers against investment in Ukrainian services = **175.9**; and Ukraine-Turkey FTA plus FDI spillovers to the World = **126.0**.

While these estimated values are extremely high by the standards of the usual benefit-cost analysis in public finance for infrastructure projects, experience has shown that benefit-cost ratios in international trade analysis are typically rather high.<sup>25</sup> We have discussed four partial equilibrium case studies that should provide intuition on why these benefit-cost ratios are very high and summarize those estimates in table C1. The benefit-cost ratios range from 70 to 280 and are infinite in one experiment. The benefit-cost ratios depend heavily on the instrument used for

<sup>23</sup> See: [http://ukrstat.gov.ua/operativ/operativ2005/vvp/vvp\\_ric/vvp\\_kd10-18.xlsx](http://ukrstat.gov.ua/operativ/operativ2005/vvp/vvp_ric/vvp_kd10-18.xlsx).

<sup>24</sup> See table 5.20 in Statistical Publication of the State Statistic Service of Ukraine "Economic Activity of the Population of Ukraine\_2018". Available at: [http://www.ukrstat.gov.ua/druk/publicat/kat\\_u/2019/zb/07/zb\\_EAN\\_2018.pdf](http://www.ukrstat.gov.ua/druk/publicat/kat_u/2019/zb/07/zb_EAN_2018.pdf).

<sup>25</sup> See Matusz and Tarr (2000) for a survey.

protection (especially whether a tariff is used for protection or a non-tariff barrier that either dissipates resources or transfers rents abroad). In the case of the estimates in the table, the benefit-cost ratio from removing protection would be between five and 55 percent of the values in the table (depending on the sector) if tariffs were employed instead of non-tariff barriers. The estimate is unbounded above in the case of sugar due to no change in number of jobs by switching from an import quota to a production subsidy that preserves the same output and employment.

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**Table C1. Examples of Estimates of the Benefits and Costs of Removing Import Protection and the Costs per job protected.**

Rows 1,2,3 and 6 in millions of US dollars	Adjustment Cost Methodology						
	Social Costs			Private Costs		No Costs	
	Textiles and Apparel <sup>a</sup>			Autos <sup>b</sup>	Steel <sup>c</sup>		Sugar <sup>d</sup>
	sigma=1.4 <sup>e</sup>	sigma=4.4 <sup>e</sup>					
1. gains to economy annual	308	488		994	803		252
1a. due to quota rents	218	218		824	573		238
1b. due to consumption distortion effect	90	269		170	230		13
2. gains over infinite horizon <sup>f</sup>	4708	7459		15194	3523		3852
3. adjustment costs	16.8	60.9		216	143		0
4. number of jobs protected in the sector	8,891	32,400		4,598	9951		0
5. Benefit-Cost Ratio: row 2 divided by row 3	280	122		70	25		unbounded
6. costs per job protected (row 2/row 4)	0.530	0.230		3.304	0.354		above

Notes: <sup>a</sup> Removal of textile and apparel quotas.

<sup>b</sup> Removal of the quotas on imports on Japanese autos.

<sup>c</sup> Removal of quotas on steel imports over a five-year period.

<sup>d</sup> Removal of quotas on sugar with replacement by a production subsidy that yields the same domestic output and employment.

<sup>e</sup> Armington elasticity of substitution between products differentiated by country of origin.

<sup>f</sup> Gains in the steel sector are over five years due to the five-year limit of the quotas.

**Source:** Calculated from data in Tarr and Morkre (1984).

## **Appendix D: Sensitivity to Imposing Unweighted Trade Barriers**

In our central model, we use trade-weighted measures of the trade barriers for five sets of the trade barriers. In this appendix, we examine the sensitivity of our results to using unweighted measures of these barriers.

Our model employs estimates of nine sets of trade barriers: (i and ii) tariffs between Ukraine and Turkey; (iii and iv) non-tariff barriers on goods by both Ukraine and Turkey; (v and vi) trade costs of Ukrainian trade due to reduced time required to import and to export goods; (vii) Ukrainian barriers on Turkish FDI in business services; and (viii and ix) barriers on cross-border provision of business services between Turkey and Ukraine. We have unweighted estimates for the three sets of services barriers and the AVEs of non-tariff barriers on Ukrainian exports in Turkey. The sets of barriers that are trade-weighted in the simulations of our central results are:

- Ukrainian tariffs on imports from Turkey;
- Turkish tariffs on imports from Ukraine;
- AVEs of non-tariff barriers on Ukrainian imports;
- AVEs of Time in Trade costs on Ukrainian Imports; and
- AVEs of Time in Trade costs on Ukrainian Exports.

We replace the trade-weighted tariffs and AVEs of these barriers with unweighted estimates and then execute the ten scenarios that comprise our central set of results for the Ukraine-Turkey FTA. The results are below in table D.1.

The estimated welfare gains from the FTA fall to 2.43 percent of consumption with the five sets of unweighted barriers. (This should be compared to 2.72 percent of consumption with trade-weighted barriers in our central results in table 3 of the main text.) The reduction in estimated gains derives from: (i) a fall (by 0.14%) in the estimated gains from tariff elimination by Turkey on Ukraine's exports; (ii) a fall (by 0.10%) due to less gains from lower time in trade costs on Ukrainian imports; and (iii) a fall (by 0.04%) due to less gains from lower time in trade costs on Ukrainian exports. We have documented that the Turkish trade-weighted tariff rates on meat products, dairy products and "other food products" are much higher than their unweighted tariff rates, so the tariff result is expected. These results show that the of time-in-trade costs of trade between Turkey and Ukraine are higher on the products they trade intensively.

**Table D.1 Sensitivity to Imposing Unweighted Trade Barriers: the impact on Ukraine of the Ukraine-Turkey FTA**

(results are percentage change from initial equilibrium)		Central Model with Monopolistically Competitive Sectors								
Scenario definitions	FTA Central: All policies by Ukraine and Turkey	Ukrainian Policies Toward Turkey						Turkey's Policies Toward Ukraine		
		Zero Import tariffs	Reduction of Non-tariff barriers on goods	Reduction of Time in Trade on Imports	Reduction of Time in Trade on Exports	Services: Reduction of Barriers against FDI	Services: Reduction of Barriers against cross border	Zero tariffs against imports from Ukraine	Reduction of Non-tariff barriers on goods	Services: Reduction of Barriers against cross border
<b>Ukraine's Policies Toward Turkey</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
Tariff Elimination by Ukraine on imports from Turkey	Yes	Yes	No	No	No	No	No	No	No	No
Non-Tariff Barriers for goods: 20% reduction of AVE costs on imports from Turkey	Yes	No	Yes	No	No	No	No	No	No	No
Time in Trade Costs for Imports: 20% reduction from Turkey; 5% from 3rd countries*	Yes	No	No	Yes	No	No	No	No	No	No
Time in Trade Costs for Exports: 20% reduction from Turkey; 5% to 3rd countries*	Yes	No	No	No	Yes	No	No	No	No	No
Services Liberalization of FDI: 50% reduction of barrier against FDI from Turkey	Yes	No	No	No	No	Yes	No	No	No	No
Cross-Border Barriers for services: 50% reduction of AVEs on imports from Turkey	Yes	No	No	No	No	No	Yes	No	No	No
<b>Turkey's Policies Toward Ukraine</b>										
Import Tariff Elimination by Turkey on Ukrainian exports	Yes	No	No	No	No	No	No	Yes	No	No
Non-Tariff Barriers for goods: 20% reduction on AVEs for Ukrainian exports to TUR.	Yes	No	No	No	No	No	No	No	Yes	No
Services: Cross-Border: 50% reduction of Turkish AVEs on eports to Turkey	Yes	No	No	No	No	No	No	No	No	Yes
<b>Aggregate welfare and real GDP</b>										
Welfare (EV as % of consumption = % change in real household income)	2.43	0.00	0.04	0.58	0.50	0.03	0.15	1.00	0.05	0.02
Welfare (EV as % of GDP)	1.68	0.00	0.03	0.40	0.35	0.02	0.10	0.69	0.04	0.02
change in real GDP as % of GDP	1.93	0.01	0.03	0.41	0.36	0.03	0.14	0.83	0.04	0.03
<b>Aggregate trade</b>										
Real exchange rate	-0.06	0.05	0.01	0.13	-0.33	0.02	0.12	-0.02	-0.03	0.01
Aggregate exports	2.91	0.19	0.03	0.55	0.53	0.06	0.15	1.23	0.09	0.04
Aggregate imports	2.18	0.06	0.02	0.44	0.36	0.01	0.14	1.02	0.07	0.03
Change in imports from Turkey	27.59	10.99	3.79	0.65	1.20	-0.02	8.59	1.08	0.03	0.05
Change in imports from all other countries	1.25	-0.34	-0.11	0.43	0.32	0.01	-0.17	1.02	0.07	0.03
<b>Government budget</b>										
Tariff revenue (% of GDP)	0.60	0.58	0.64	0.65	0.64	0.64	0.64	0.64	0.64	0.64
Tariff Revenue	2.08	-1.24	0.19	1.83	0.76	0.01	0.04	0.80	0.07	0.01
Value Added Taxes total	0.96	0.01	0.01	0.15	0.26	0.01	0.02	0.48	0.02	-0.01
Value Added Taxes on imorts	2.70	0.14	0.01	0.35	0.77	0.01	0.04	1.19	0.12	0.01
Value Added Taxes domestic	1.99	0.09	0.01	0.27	0.56	0.01	0.03	0.90	0.08	0.00
Excise Taxes on domestic	2.61	-0.04	0.02	0.23	0.03	0.01	0.05	2.20	0.03	0.01
Excise Taxes on imports	2.49	0.03	0.01	0.31	0.53	0.00	0.08	1.15	0.18	0.16
Excise Taxes total	2.56	-0.01	0.01	0.26	0.22	0.01	0.06	1.78	0.09	0.06
<b>Factor Earnings</b>										
Skilled labor earnings	1.49	0.07	0.02	0.39	0.13	0.02	0.13	0.61	0.02	0.05
Unskilled labor earnings	1.71	0.08	0.03	0.41	0.26	0.02	0.13	0.68	0.04	0.04
Capital earnings	1.43	0.06	0.02	0.32	0.09	0.02	0.14	0.65	0.04	0.04
Return to land and natural resources	4.07	0.12	0.03	0.41	2.18	0.04	0.11	1.16	0.02	-0.07
Specific Factors earnings in domestic firms	5.10	0.10	0.06	0.69	0.93	0.01	0.20	2.84	0.07	0.03
Specific Factors earnings in multinational firms in Ukraine	2.75	0.25	0.05	0.61	0.36	0.49	0.15	0.69	0.05	0.08
<b>Factor Adjustments*</b>										
Total labor	1.12	0.03	0.01	0.14	0.48	0.01	0.01	0.59	0.05	0.07
Skilled labor	0.97	0.03	0.01	0.13	0.39	0.01	0.01	0.51	0.04	0.06
Unskilled labor	1.44	0.04	0.01	0.17	0.66	0.01	0.02	0.76	0.07	0.10
Capital	1.11	0.03	0.01	0.13	0.46	0.01	0.01	0.54	0.06	0.07

\*Percentage of the factor that must change sectors.  
Source: Authors' estimates.