IMPACT ASSESSMENT OF A POTENTIAL FREE TRADE AGREEMENT (FTA) BETWEEN UKRAINE AND TURKEY

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Contacts:

William (Bill) Seas III
Chief of Party

Evgenia Malikova
Contracting Officer's Representative
USAID/Ukraine

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Final Report: Impact Assessment of a Potential Free Trade Agreement (FTA) between Ukraine and Turkey

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Authors: Veronika Movchan, Thomas F. Rutherford, David G. Tarr and Hidemichi Yonezawa with contributions from Zoryana Olekseyuk, Iryna Kosse and Vitaliy Kravchuk.

Editor: David Tarr

Project Managers: Miles Light and Anna Gladshtein

This Research Conducted by:

INSTITUTE FOR ECONOMIC RESEARCH AND POLICY CONSULTING

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Executive Summary

Ukraine and Turkey are negotiating a modern Free Trade Agreement (FTA). In addition to negotiation of reciprocal tariff removal or reduction, as with other modern FTAs like the DCFTA between Ukraine and the European Union, the parties are negotiating "deep integration." Importantly, deep integration includes measures to lower the costs of trading and access to important inputs that would lower the cost of production or consumption. In particular, the Ukraine-Turkey FTA will impact: (i) non-tariff barriers on goods; (ii) barriers that increase the time costs of trade; and (iii) barriers on foreign providers of business services, including foreign direct investment (FDI).

To assess these deep integration issues along with tariffs in the Ukraine-Turkey Free Trade Agreement, the project develops an innovative 45-sector small open economy computable general equilibrium model of Ukraine with seven external regions.[1] The model incorporates tariffs as well as the three central aspects of deep integration: (i) non-tariff barriers on goods; (ii) barriers that increase the time costs of trade; and (iii) barriers on foreign direct investment (FDI) and cross-border business services. The report decomposes the FTA into nine reform components.[2] The report assesses the impact of all nine of the potential reforms in the FTA collectively. In addition, to assess the relative importance of each of the components of the FTA, the report assesses the contribution of each of the nine components of the FTA. All economy-wide results of all the reforms separately and together are in table 11. Results for all of the 45 specific sectors on sector variables are presented in tables 13-21. These sector variables are the percent changes in sector output, imports, exports, prices, number of varieties, skilled labor earnings, unskilled labor earnings and the pattern of household consumption.

The key results are the following:

Successful completion of the Ukraine-Turkey FTA would yield substantial gains. We estimate that successful inclusion of deep integration in the Ukraine-Turkey FTA would (along with tariff elimination) yield significant *annual* increases in real household incomes of Ukraine by 2.72 percent of household real income.

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[1] Our regions are Ukraine, Turkey, the European Union, the Russian Federation, the United States, China, the group of countries with which Ukraine has a FTA and an aggregate Rest of the World.

[2] The nine reform components are the following. First, by Ukraine with respect to Turkey: (i) tariff elimination; (ii) 20 percent reduction in ad valorem equivalents (AVEs) of non-tariff barriers; (iii) 20 percent reduction of AVEs of the time in trade costs on imports from Turkey and five percent reduction on third countries; (iv) 20 percent reduction in the AVEs of time in trade costs on exports to Turkey and five percent reduction on exports to third countries; (v) 50 percent reduction in the AVEs of discriminatory barriers against foreign direct investment (FDI) from Turkey in business services; and (vi) 50 percent reduction in the AVEs of discriminatory barriers against cross-border business services from Turkey. Then by Turkey with respect to Ukraine: (vii) tariff elimination; (viii) 20 percent reduction in ad valorem equivalents (AVEs) of non-tariff barriers; and (ix) 50 percent reduction in the AVEs of discriminatory barriers against cross-border business services from Ukraine.

Reduction in time in trade costs (or Trade Facilitation Measures) are among the most important reforms. The reduction of the time costs of trade would contribute 1.22 percent of real household income annually to the gains and is the largest component of the gains from the FTA. The time cost of trade is especially important for the food sector. Since Turkey is already a member of the European Union's "Common Transit System," to fully capitalize on the improved market access and increased trade offered by the FTA, Ukraine would benefit from its intended accession to this Common Transit System that includes as a component the New Computerized Transit System (NCTS).

Reduction on non-discriminatory barriers to investment in business services would yield larger gains than any component of the FTA. Non-discriminatory barriers in business services are barriers that apply to both Ukrainian investors and to FDI. These annual gains would increase to 4.76 percent of household real income if, in addition to the Ukraine-Turkey FTA being implemented, the ad valorem equivalents of *non-discriminatory* barriers to investment in business services were reduced by 25 percent. This is an additional annual increase of 2.04 percent of real household income due to increases in FDI and Ukrainian investment in business services. We cite extensive international empirical evidence (including a firm-level study of Ukraine) that shows that better access to business services leads to productivity increases in manufacturing and the economy generally. These results highlight the importance of continuing the momentum of reform in business services, not just for foreign investors, but also for Ukrainian investors in business services. The large gains from the reduction of barriers to investment in business services are derived in significant part from our innovative model that incorporates endogenous productivity effects from additional varieties of goods or services supplied in imperfectly competitive sectors.

Economy-wide output will increase but sector impacts are diverse. If all tariffs are removed reciprocally between Turkey and Ukraine, we estimate that real GDP would increase by 2.12 percent annually. Impacts across sectors are diverse. The four sectors with the largest increase in output are: dairy products, other food products, fruits and vegetables and fats and oils. The sectors that are estimated to contract output the most are: electronic components, electric equipment and motors, wearing apparel, manufacture of machinery, and manufacture of electric motors and equipment and computer programming. Due to the very rapid growth of the computer programming sector in recent years, it should continue to grow for reasons independent of the Ukraine-Turkey FTA.

The estimated gains from the FTA compared to the social adjustment costs of labor are extremely high. We estimate the social adjustment costs of workers in three reforms. The adjustment costs of the Ukraine-Turkey FTA are 0.246 percent of Ukrainian GDP; they are 0.250 percent of Ukrainian GDP if reduction on discriminatory barriers against FDI in business services is combined with the FTA; and the adjustment costs increase to 0.285 percent of GDP if the reduction of non-discriminatory barriers against investment in business services is combined with the FTA. The present value of the estimated gains in real GDP in these three scenarios, however, are 28.7 percent of Ukrainian GDP from the Ukraine-Turkey FTA; they are 31.5 percent of Ukrainian GDP if reduction on discriminatory barriers against FDI in business services is combined with the FTA; and the gains increase to 50.1 percent of GDP if we include reduction of non-discriminatory barriers against investment in business services together with the FTA. These data indicate that the gains in real household income from the reforms considered are between 117 and 176 times the estimated adjustment costs, depending on the liberalization scenario we consider. That means that for each hryvnia of social adjustment costs of workers, we estimate from 117 to 176 hryvnia increase in real household income. While these are extraordinarily high benefit-cost ratios for government investment projects, they are not unusual for an evaluation of international trade and investment reforms.

Strategies to mitigate adjustment costs are elaborated. Worldwide evidence on adjustment costs shows that adjustment costs of workers are considerably less than anticipated, especially in low wage industries where the most vulnerable workers are likely to be located; and the benefit-cost ratios of trade liberalization tend to be very high. Nonetheless, a concern remains for vulnerable workers in heavily impacted sectors. A broad-based social safety net to protect the most vulnerable in society is the first best public policy to address adjustment costs of the vulnerable for any shock, not only trade policy shocks. Failing adequate resources for an effective social safety net, the evidence shows that a program of phased liberalization over time in sensitive sectors with especially vulnerable workers would likely reduce adjustment costs to extremely small values. We assess the impacts of a phased reduction of tariffs in one such sector in Ukraine.

The project has produced a new 85-sector input-output table of the Ukrainian economy that should be a significant public good for Ukrainian analysts. The most disaggregated input-output table for Ukraine is the 42-sector table for 2017. As a basis for the model, the project has disaggregated this table as an independent output.

The project has produced three studies of the ad valorem equivalents of barriers to trade which should facilitate subsequent trade policy analysis of Ukraine. These studies, which are essential

inputs into the model results, are of the ad valorem equivalents of each of these three types of non-tariff barriers to trade: time in trade (appendix A); non-tariff barriers in goods (appendix B); and barriers to investment in business services, both discriminatory and non-discriminatory (available on-line).

Results with a conventional perfect competition model are considerably smaller. The project has developed a model of perfect competition as a basis of assessing the importance of our innovative approach to modeling trade policy that endogenously takes the productivity effects of additional trade in goods and business services into account. Depending on the scenario, the estimated gains in our central model are between 157 and 214 percent of the gains in the model with pure perfect competition. The model of perfect competition, which contains all the data of our central model, including the extensive tax data that we collected, is also an output of the project that may be used by Ukrainian or other researchers.

The reader who wishes to focus on the policy results, may skip to sections 5-7. The central results for the Ukraine-Turkey FTA are in section 5. Sensitivity to spillovers or wider liberalization and model assumptions are in section 6. A discussion and estimation of adjustment costs of the reforms is in section 7.

Table of Contents

Economic Impact Assessment of a Potential Free Trade Agreement (FTA) between Ukraine and Turkey

1. Introduction

Ukraine and Turkey are negotiating a modern free trade agreement (FTA). Modern FTAs go beyond narrow agreements on tariffs to include several aspects such as agreements on services, non-tariff measures and measures that reduce the costs of transporting goods among the partners. This includes virtually all preferential trade agreements of the European Union and the United States, including the DCFTA between the European Union and Ukraine. When agreements include these kinds of additional components, they are referred to as "deep" agreements.

Deep integration is an important part of preferential trade agreements since there is considerable evidence that non-tariff trade costs are a greater obstacle to trade than tariffs for most countries. Hummels and Schaur (2013) and Hummels *et al.,* (2007) show the trade facilitation costs alone (what they and we call the "time in trade" costs) are greater than tariffs as an obstacle to trade for most countries. The estimates of Kee *et al.,* (2009) show that ad valorem equivalents of non-tariff barriers are also typically larger than tariffs. Jafari and Tarr (2015) have comparable results for "behind the border" barriers against FDI in services. Reducing barriers to investment and FDI in services is very important since economic theory and a substantial and growing empirical literature based on firm level data show that barriers to foreign direct investment of business services result in total factor productivity losses to the manufacturing sector and the economy of the host country more broadly; this literature includes an excellent study using Ukrainian data by Shepotylo and Vakhitov (2015).[3]

Regarding preferential trade agreements (PTAs), there is evidence that deep integration in modern PTAs has had important impacts, including lowering trade costs and avoiding trade diversion. In his survey article, Limão (2016, pp. 307, 312) notes that in gravity models, "tariffs alone can only explain a fraction of the PTA trade impact….This justifies the widespread use of dummies in the gravity approach….but it also begs the question of what those channels are." He calls for further research on the deep integration aspects of PTAs. Two econometric papers that employ data on the deep integration content of PTAs rather than dummy variables are Mattoo, Mulabdic and Ruta (2017) and Arvis *et al.,* (2016). Mattoo *et al.,* (2017) find that the deep provisions of PTAs induce more trade creation than tariffs and that the deepening of PTAs does not appear to come at the expense of reduced trade with third

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[3] In addition to Shepotylo and Vakhitov, other studies that use firm level data support this finding including Arnold *et al.* (2011) for the Czech Republic, Fernandes and Paunov (2012) for Chile, Arnold *et al.* (2015) for India and Duggan *et al.* (2013) for Indonesia. See Francois and Hoekman (2010) for a survey of the theory and more than a dozen empirical studies that support this finding. See Markusen (2002) for the theory.

countries. Arvis *et al.,* (2016, 469) estimate that two countries that are both members of a preferential trade agreement experience trade costs that are about 16 percent lower than countries that are not members.

In response to the international trends and the experience of both Ukraine and Turkey, there are important deep integration aspects under negotiation as part of the Ukraine-Turkey FTA. In services, during the tenth round of FTA talks, the Ministry for Development of the Economy, Trade and Agriculture of Ukraine (MDETA) has been reported to be negotiating market access for services in the agreement on telecommunication and electronic commerce.[4] This confirms our own interviews regarding a broader perspective on services sector liberalization as part of the FTA. Regarding trade facilitation, it has been reported that within the FTA, both countries have agreed to align their customs procedures with the WTO Trade Facilitation Agreement.[5] Further, since Turkey is already a member of the European Union's "common transit system," the improved market access and increased trade offered by the FTA should motivate Ukraine to expedite its accession to the common transit system that includes as a component the New Computerized Transit System (NCTS).[6] The system of mutual recognition of authorized economic operators (AEO) is another promising opportunity for trade facilitation that could be negotiated. With respect to non-tariff barriers, the key barriers in the post-WTO trade environment are Technical Barriers to Trade (TBTs) in mining and manufacturing goods and Sanitary and Phyto-Sanitary (SPS) measures in agriculture and food. In 2016, Ukraine and Turkey agreed on an agenda of TBT cooperation.[7] Both countries have committed to harmonize TBTs with the EU. This suggests that cooperation on TBTs should deepen further within the FTA.[8] Given their identical underlying regulatory frameworks, an agreement on the reciprocal recognition of each country's certificates of conformity assessment seems to be the most reasonable outcome of the FTA in this area. In the area of SPS, since Turkey is not presently harmonizing with the EU, but Ukraine is, less progress is likely on SPS within the FTA. However, both countries comply with EU regulations on the export of animal products to the EU, which could facilitate an agreement on these products.

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[4] See: https://www.me.gov.ua/News/Detail?lang=uk-UA&id=0cde5e94-d8cb-49e3-9bfc-9b371db9df67&title=UkrainaITurechchinaZavershiliDesiatiiRaundPeregovorivProZvt.
[5] Ukraine See: https://www.me.gov.ua/News/Detail?lang=uk-UA&id=d40d1b31-f6a2-4bd0-a599-63f2a200fd7a&title=UkrainaITurechchinaIntensifikuvaliPeregovoriProVilnuTorgivliu
[6] For details of the common transit system, see https://ec.europa.eu/taxation_customs/business/customs-procedures/what-is-customs-transit/common-union-transit_en
[7] The agreed cooperation includes: cooperation among Ukrainian and Turkish metrological authorities, active work in international standardization bodies, information exchange regarding legal changes and experience among conformity assessment bodies. See: https://www.me.gov.ua/News/Detail?lang=uk-UA&id=a4c201b3-be5c-4c35-84fd-85fd57518512&title=UkrainaITurechchinaZatverdiliProgramuSpivpratsiUSferiTekhnichnogoReguliuvannia
[8] See Togan (2015).

To address these deep integration issues along with tariffs, we develop an innovative 45-sector small open economy computable general equilibrium model of Ukraine and seven external regions[9] to undertake an assessment of the Ukraine-Turkey Free Trade Agreement (FTA). In addition to tariffs, the model incorporates three central aspects of deep integration: (i) non-tariff barriers on goods; (ii) barriers that increase the time costs of trade; and (iii) foreign direct investment (FDI) as well as cross-border trade in business services. We produce three studies in which we estimate the ad valorem equivalents of each of these three types of non-tariff barriers to trade. Our model contains endogenous productivity effects through the "Dixit-Stiglitz" mechanism whereby additional varieties of goods or services supplied in imperfectly competitive sectors lowers the quality adjusted costs of these goods or services to their users. As such, our model is consistent with both economic theory and the substantial and growing empirical literature showing that foreign direct investment and the wide availability of business services results in total factor productivity gains to the manufacturing sector and the economy broadly. It is also consistent with the substantial literature, beginning with Coe and Helpman (1995), that has empirically shown that the purchase of intermediate inputs from industrialized countries is an important mechanism for the transmission of R&D and productivity growth in developing countries.[10]

Some of our key results are the following. A Ukraine-Turkey FTA that could achieve progress on deep integration would yield significant annual increases in real household incomes of Ukraine by 2.72 percent of household real income. The reduction of the time costs of trading contributes 1.22 percent of real household income to the gains and is the largest component of the gains. The time cost of trade is especially important for the food sector. These annual gains would increase to 4.76 percent of household real income if, in combination with the FTA, the ad valorem equivalents of non-discriminatory barriers to investment in business services were reduced by 25 percent. Non-discriminatory barriers in business services are barriers that apply to both Ukrainian investors and to FDI. We estimate the social adjustment costs of workers as the cost of the Ukraine-Turkey FTA and estimate that the benefit-cost ratio ranges from 117 to 176, depending on the liberalization scenario. That means that for each hryvnia of social adjustment costs of workers, we estimate from 117 to 176 hryvnia increase in real household income. Nonetheless, we discuss strategies to mitigate adjustment costs. We also develop a model with perfect competition and show that our innovative modeling features lead to considerably larger estimated welfare gains than perfect competition models that contain the same policy instruments.

The dataset of the model is based on an 85-sector input-output table of the Ukrainian economy that the authors constructed based on the 42-sector input-output table for 2017 of the Ukrainian Statistical

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[9] Our regions are Ukraine, Turkey, the European Union, the Russian Federation, the United States, China, the group of countries with which Ukraine has an FTA and an aggregate Rest of the World.
[10] See appendix E for a survey of this literature.

Service. These data were supplemented by several datasets from agencies of the Government of Ukraine, notably the Customs Service and the Tax Service, and other public and private data sources. The construction of the dataset is described in detail in Movchan, Rutherford, Tarr and Yonezawa (2020a). The 85-sector dataset was aggregated to the 45 sectors for the policy model we employ in this paper. The model is solved using the GAMS/MPSGE software developed by Rutherford (1999).

In section 2, we provide a selected review of the literature on PTAs, on incorporating FDI into numerical general equilibrium models and previous computable general equilibrium models of Ukraine. In sections 3 and 4, we provide an overview of the model structure and the dataset, respectively. The key central results are in section 5. In section 6, we assess sensitivity of the results to key model assumptions. Issues related to adjustment costs are analyzed in section 7. The tables of the paper follow the references. The appendices are available as a separate file.

2. Review of the Applied General Equilibrium Literature on Regional Agreements and Foreign Direct Investment Liberalization in Services

Section 2.1 is a very selective review of the vast literature of studies of preferential liberalization of goods markets. In section 2.2, we discuss the previous studies that are most closely related to our study emphasizing those that assess deep integration especially those that include liberalization of foreign direct investment in services.

2.1 Applied General Equilibrium Literature Assessing Goods Market Preferential Liberalization in Tariffs (a selective review).

The formation of the Canada-US free trade agreement led to the path-breaking work of Harris (1984) and of Cox and Harris (1986) in incorporating imperfect competition into a small open economy applied general equilibrium model. They showed that if the agreement leads to a more competitive pricing strategy by Canadian firms, there would be substantial welfare gains from rationalization that are above the estimated gains from a perfect competition model. The creation of the single market in the European Union led to innovative analysis that required the use of multi-region models with imperfect competition or dynamic effects in order to capture the impacts of the key features of the single market (see Harrison, Rutherford and Tarr, 1996; Smith and Venables, 1988; Baldwin, Forslid and Haarland, 2000). The North American Free Trade Agreement (NAFTA) led to a large number of CGE studies summarized in the Francois and Shiells (1994) volume. Among these, Levy and van Wijnbergen (1995) use their dynamic CGE model to argue that dynamic incentive problems in adjustment policies for Mexican agriculture imply that adjustment policies should focus on increasing the value of the assets of poor farmers, not their incomes. Preferential arrangements of the European Union with its Mediterranean neighbors led to policy-maker requests for CGE analysis. Using small open economy models of the developing country

under perfect competition (Harrison, Rutherford and Tarr (1997a) for Turkey; Rutherford, Rutstrom and Tarr (1993) for Morocco; and Rutherford, Rutstrom and Tarr (2000) for Tunisia), these North-South arrangements were estimated to be beneficial to the developing country due to the introduction of competition into the Southern markets. Finally, Chile has adopted a strategy of negotiating preferential arrangements with all potential partners (called "additive regionalism" or "competitive regionalism"). Using a multi-region perfect competition model, Harrison, Rutherford and Tarr (2002) estimated that Chile would lose from individual preferential trade arrangements unless they offered significant market access. Although significant market access would be obtained in an agreement with the United States or the European Union, there was insufficient market access in agreements with Southern partners. This implied that Chile would lose from individual agreements with its Southern neighbors unless it lowered its then eleven percent uniform tariff. But these authors show that the agreements with Southern partners are beneficial to Chile in the context of Chile's additive regionalism strategy due to substantial estimated terms of trade gains to Chile in the markets of Northern partners and the reduction of trade diversion costs if the Northern partners are included in the network of agreements.[11] Rutherford and Tarr (2003) showed that simply making the Chilean model dynamic will not increase the estimated gains from these agreements if there are no endogenous productivity effects.

2.2 Applied General Equilibrium Literature Assessing Deep Integration including Foreign Direct Investment in Services

Our paper is more closely related to studies that incorporate foreign direct investment in services. This includes the following. Markusen, Rutherford and Tarr (2005) developed a stylized model where foreign direct investment is required for entry of new multinational competitors in services, but they did not apply this model to the data of an actual economy. Jensen, Rutherford and Tarr (2007; 2010), Rutherford and Tarr (2008; 2010) and Balistreri, Rutherford and Tarr (2009) developed small open economy applied general equilibrium models in Russia, Kenya and Tanzania based on the Markusen, Rutherford and Tarr methodology. Konan and Maskus (2006) assessed services liberalization in Tunisia. But these models did not assess regional preferences in services. Brown and Stern (2001) and Dee *et al.* (2003) employ multi-country numerical models and attempt to include foreign direct investment. Their models contain three sectors, agriculture, manufacturing and services, and are thus also rather stylized; more importantly from a modeling perspective, they do not contain a free entry condition for firms, so do not determine entry or exit of FDI based on firm decisions.

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[11] Harrison, Rutherford, Tarr and Gurgel (2004) found similar results for Brazil.

Regarding models of FDI with endogenous productivity effects, the model described in this paper is closest to the small open economy models developed by Balistreri, Jensen and Tarr (2011) for Kenya, Jensen and Tarr (2012) for Armenia and Balistreri, Olekseyuk and Tarr (2017) for Belarus. Multi-country models that include FDI with endogenous productivity effects are Knobel, Lipin, Malokostov, Tarr and Turdyeva (2019) for the Eurasian Economic Union, Latorre and Yonezawa (2018) and Latorre, Olekseyuk and Yonezawa (2019) for Brexit. Balistreri, Jensen and Tarr (2011) have shown that there is an analogy in services to trade diversion in goods whereby preferential commitments to foreign investors in services could be immiserizing. Jensen and Tarr (2012) and Knobel *et al.* (2019) and Balistreri, Tarr and Yonezawa (2015) incorporated more general treatments of deep integration, since those papers included FDI and extended the analysis to include the impact of improved trade facilitation and the reduction of non-tariff barriers.[12] In this paper, we incorporate all features assessed in the above papers, but also include tariff analysis and market access considerations with respect to tariffs, non-tariff barriers and cross-border services.

There have been two studies in Ukraine using a similar model structure, that is, they contained imperfect competition, FDI and endogenous productivity effects from additional varieties of goods or services in imperfectly competitive sectors. The first was the analysis of WTO accession of Ukraine that appeared as Copenhagen Economics, East Europe Institute of Munich and the Institute for Economic Research and Policy Consulting (2005). The second study, Institute for Economic Research and Policy Consulting (2011), was an analysis of the regional trade policy options of Ukraine.

3. Overview of the Model

We build a 45-sector small open economy model of trade and FDI for Ukraine, with seven external regions including Turkey. External regions are characterized by vectors of prices and quantities of imports or exports, or demand and supply curves with respect to Ukraine, although the activity of imperfectly competitive foreign firms in Ukraine is endogenous. The central model is a model that includes monopolistically competitive sectors in the style of Krugman (1980) as well as perfectly competitive sectors. An important extension from Krugman is that there is a fixed cost of operating in Ukraine, so not all foreign varieties are available in Ukraine and trade and FDI policy influence the number of varieties in Ukraine. We also produce a model with all sectors perfectly competitive for the purposes of comparison. A mathematical description of the trade and FDI models may be found in Balistreri, Olekseyuk and Tarr (2017, appendix G). For detailed derivations, both in perfect competition

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[12] Wonnacott and Wonnacott (1981) have demonstrated the theoretical importance of assessing improved market access in regional agreements, and Harrison, Rutherford and Tarr (2002) have shown numerically that assessing market access is very important in determining the value of a preferential trade agreement.

and monopolistic competition, see Balistreri and Tarr (2020). Here we provide a general description of the structure.

Sectors and regions are listed in table 1. In the perfect competition model, all sectors are perfectly competitive. In the Krugman 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 in which there is monopolistic competition and foreign direct investment.[13] All firms minimize the cost of production.

Primary factors are skilled labor, unskilled labor and capital (including land and natural resources). Consistent with the Knowledge Capital model (Markusen, 2002), multinational service providers import a primary factor of production, reflecting specialized management expertise or key intermediates of the parent firm. Regarding capital, there is mobile capital and sector-specific capital in monopolistically competitive goods sectors and services sectors with FDI. There is also sector-specific capital in six sectors due to the land and natural resources component.[14] There is some sector-specific capital for each firm in sectors that are modeled as imperfectly competitive sectors. 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. We calibrate the elasticity of substitution between sector-specific capital and other inputs in each sector so that the elasticity of supply of the firms is consistent with econometric evidence that indicates that the supply response and productivity gain from trade for the importing country depends on the research and development stock of the exporting country.[15] To maintain comparability between the perfect competition model and the monopolistic competition model, when we execute the perfect competition model, we include sector-specific factors in the sectors we model as monopolistically competitive in our Krugman style model.

We assume that Ukrainian exports face perfectly elastic export demand function in foreign markets except in four sectors. In these four sectors, given the level of protection in Turkey, the expansion of Ukrainian exports is substantial and would likely face a downward sloping demand curve in Turkey. In

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[13]The computer programming sector is modeled as a business services sector where FDI can occur, but it is always modeled as perfectly competitive. It is grouped with the business services sectors.

[14] These sectors with land or natural resources as inputs are agriculture, animal production, forestry and a few of the mining sectors. Using the codes in table 1, the sectors and their shares of sector-specific capital in parentheses are: growing of crops, CRP (0.679); animal and fish production, ANM (0.686); forestry and logging, LOG (.625); coal, crude oil and gas, ENE (0.484); mining of metal ores, ORE (0.196); and other mining MIN (0.205). Given the nature of the shocks we consider (which are economy-wide), we do not believe the aggregation of capital with land and natural resources has a significant impact on the results. 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.

[15] Details are in appendix E.

these sectors we take demand elasticities from GTAP.[16] These sectors (and the demand elasticities in parentheses) are dairy (7.3), meat (8.25), water transporecttation (3.8) and computer programming (3.8).

In each of our experiments we hold real investment constant and 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 reduction in tariff 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 income or real household consumption (see Balistreri and Tarr 2020, section 3.8). We will use the terms welfare, equivalent variation (EV) and the change in real household income interchangeably in this paper.

3.1 Perfectly competitive goods and services sectors

In these sectors, we employ the "Armington" structure, with goods and services differentiated by the country of origin. Exports are also differentiated from products produced for the home market. For 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. Prices in foreign markets to exporters from Ukraine are perfectly elastic in these sectors, except where we assess that Ukraine has some monopoly power on exports or monopsony power on imports. This is relevant for Ukrainian exports in dairy products and meat products (as well as air transportation services in imperfectly competitive business services). Given the very high tariffs that Turkey imposes on Ukrainian dairy products and meat products, and the high non-tariff barriers in air transport services, the large potential export response by Ukraine in relation to the Turkish market implies the need to realistically assume a downward sloping export demand curve in these sectors at the GTAP elasticities of demand for these products. In equilibrium, there are zero profits for Ukrainian firms in each sector, so price equals average costs. Since we have constant returns to scale, price equals marginal costs as well.

3.2 Imperfectly competitive goods sectors

Firms are monopolistically competitive. 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. Firms in these industries set prices such that marginal cost equals marginal revenue; and there is free entry, which drives profits to zero.

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[16]Hertel and van der Mensbrugghe (2019).

For imperfectly competitive firms, we assume they have a fixed cost of production and that marginal costs are constant with respect to output. Then, suppressing subscripts for firms, sectors and regions, total costs are:

$$TC(q; \mathbf{p}) = q*MC(\mathbf{p}) + FC(\mathbf{p}) \qquad (1)$$

where TC is total costs, MC is marginal costs, FC is fixed costs, q is output of the firm and $\mathbf{p}$ is a vector of factor prices. FC($\mathbf{p}$) and MC($\mathbf{p}$) are identical for all firms. As is common in the literature,[17] we assume that the inputs required for both fixed and marginal costs are identical, and the costs of these inputs may be represented by a function that is a linearly homogeneous, quasi-concave composite function of all inputs.

Equation (1) and our assumption on the cost function in the Chamberlinian framework, imply that output per firm remains constant, i.e., the model does not produce rationalization gains or losses.[18] The number of varieties affects the productivity of the use of imperfectly competitive goods based on the standard Dixit-Stiglitz formulation. The effective cost function for users of goods produced subject to increasing returns to scale declines in the total number of firms in the industry.

We extend the standard Krugman model by allowing all monopolistically competitive firms that sell in Ukraine to face an additional fixed cost of selling in Ukraine. Crucially, quasi-rents on the exports of the firm to Ukraine must cover the fixed costs of exporting to Ukraine. Foreign firms produce the goods for sale in Ukraine at constant marginal cost with respect to output but incur a fixed cost of selling in Ukraine. By the zero profits assumption of foreign firms operating in Ukraine, in equilibrium the import price must cover fixed and marginal costs. 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 Ukraine to significantly influence the number of varieties available in their home market.

3.3 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. But a large share of business services is provided by service providers with a domestic presence, both multinational and local.[19] Our model allows for both types of provision of foreign services in these sectors.

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[17]See, for example, Helpman and Krugman (1985, p. 12), Costinot and Rodriguez-Clare (2013, equation 7) and Markusen, Rutherford and Tarr (2005, equations 5 and 6).

[18] For proof, see Balistreri and Tarr (2020, equation 3.23).

[19] 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).

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. 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.

Multinationals service providers who establish a local presence in Ukraine use predominantly Ukrainian inputs; but they will also import some specialized technology or management expertise and intermediates of the parent firm, as well as other intermediates. That is, foreign direct investment generally entails importing inputs of the parent firm. The cost functions for our FDI firms and Ukrainian firms differ to reflect this link of the FDI firms to their parents.

Consistent with the knowledge capital model, our source or parent companies produce specialized technology or management techniques and obtain a payment for these goods from its subsidiaries or licensees. Their affiliated firms that supply Ukraine through FDI, either sell through FDI or do not produce anything. Given the one to one correspondence between firms and varieties in the monopolistic competition models, this assumption is necessary to incorporate the proximity burden in the analysis.

For multinational firms, the barriers to foreign direct investment raise their costs of production. The reduction of the barriers lowers these costs, raises the profitability of FDI and induces entry by multinationals until zero expected profit is restored. This leads to a welfare gain from the Dixit-Stiglitz variety externality. In addition, liberalization of FDI barriers frees capital and labor that was used to overcome the barriers for use elsewhere in the economy. In all model variants, including the perfect competition model, we assume that the reduction in the constraints on foreign direct investment allows the domestic economy to capture rent rectangles. In addition, reducing barriers induces foreign entry until profits are driven to zero, so there are also "Harberger" triangles of efficiency gains.

3.4 Foreign Direct Investment in the Perfectly Competitive Business Services Sectors.

To maintain comparability with the imperfectly competitive model, we allow foreign direct investment in the business services sectors listed in table 1. The only difference in the structure of the domestic vs FDI parts of the sector is that the FDI sector imports the specialized input mentioned above. Otherwise, the FDI part of the sector is modeled just like the domestic sector producing the same output. In these sectors, the outputs of the FDI and domestic parts of the sector are differentiated analogous to the Armington assumption on imports vs domestic in the goods sectors. Entry and exit are determined for both the FDI part of the sector and the domestic part of the sector by the separate equilibrium conditions where in each part we have that Price = Marginal Cost = Average Cost. When barriers to the FDI output

fall, Price > Marginal Cost for the FDI part of the sector. Then the FDI part of the sector expands until we get an equilibrium.

4. Key Data

4.1 Ad Valorem Equivalents of Barriers to Foreign Direct Investment in Services Sectors.

Estimates of the ad valorem equivalents (AVEs) of the barriers to FDI in services are important to the results. Consequently, to order to obtain a good picture of the regulatory regimes in law and in practice, staff of the Institute for Economic Research and Policy Consulting (IER)[20] conducted extensive interviews of government regulatory agencies, industry representatives, experts and associations in the relevant sectors.[21] Iryna Kosse and Vitaliy Kravchuk, with the guidance and editing of David Tarr, integrated the information from the interviews with official government reports, academic studies and the World Trade Organization (2016) *Trade Policy Review, Ukraine* in the key business services sectors in Ukraine. We focus on insurance, banking, fixed line and mobile telecommunications services, air transportation, land transportation, and water transportation services, professional services (we base the estimates on legal, accounting and auditing services), computer programming and retail services.

As a first step in the process, the methodology involved converting the answers and data of the questionnaires and interviews into two Services Trade Restrictiveness Indices (STRIs) indices in each industry: a non-discriminatory index and a discriminatory index. Some restrictions only apply to foreign

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[20] The IER survey team was comprised of Iryna Fedets, Viktoria Zhovtenko, Yevhen Anhel, Julia Baziuchenko, Oksana Kuziakiv.

[21] The interviews included the following: Andriy Kalenskyy, Regulatory Affairs Director, Ukrtelecom; Mykhailo Shuranov, Corporate Communications Director, Ukrtelecom; Bohdan Prokhorov, economist at Centre for Economic Strategy; Ihor Chernyahovskiy, Insurance business association; Ihor Olekhov, Partner, Head of Financial Practice, CMS Cameron McKenna Nabarro Olswang; Ivan Khoriakov, First deputy head of the commercial department at PJSC Ukrainian Railways (Ukrzaliznytsia); Kavaler Olga, head of Department of transport logistics, Star-Svit Ltd.; Kovalenko Kostyantyn, Association of International Car Carriers of Ukraine; Mykhailo Shuranov, Corporate Communications Director, Ukrtelecom; Natalia Davydenko, Head of Regulatory Policy and Relations Department, Lifecell; Natalia Vagina, Head of Monetary Policy Instrumentation Department, NBU; Kateryna Zhebanova, Deputy Director of the Department and Head of the Banking Licensing Department, NBU; Nataliia I. Isakhanova, Partner, Attorney at Law, Sergii Koziakov and Partners; Nataliya Bezpalova, expert, Alfa Bank; Oleksandr Filoniuk, President of the League of Insurance Organizations of Ukraine; Oleksandr Kava, former Deputy Infrastructure Minister, Reform Support Team of the State Agency of Automobile Roads; Oleksiy Mironenko, General Manager, PE "MIKO Group"; Olha Horbanovska, Head of People Advisory Servicer Practice in Ukraine and Halyna Khomenko, Senior Expert for Human Capital, Ernst & Young; Serhiy Korzh, aviation expert, project "Export strategies of Ukraine", Sector Technical maintenance of avia equipment; Thomas Otten, Director, Otten Consulting LLC; Valeriy Danylenko, CEO, Game Director and Producer of Storymind Entertainment; Volodymyr Demyanenko, 2D company; Volodymyr Ivanov, IT; Volodymyr Yumashev, Partner, Tax and Legal Department, and Tatiana Nagorna, tax and legal expert, Deloitte Ukraine; Yevgen Treskunov, founding partner of Aviaplan LLC; Ivan Khoryakov, First deputy head of Commercial department, Ukrzaliznytsya; Ksenia Pidruchna, Risoil Terminal; Ivan Niyakii, Maritime Chamber of Ukraine; Marianna Tolkachova, Law Department, Fozzy Group.

firms, such as maximum foreign equity shares in firms in a sector or licensing restrictions that apply to foreigners only. These kinds of restrictions are the basis of the discriminatory STRIs. Other restrictions apply to domestic as well as foreign firms regardless of their national origin. Examples include: blocking entry of all firms to a sector (e.g., reserving the sector for state firms); prohibitions on banks from selling insurance; limitations on the size of retail businesses, their market share in a region or their hours of operation. These kinds of restrictions are the basis of our non-discriminatory STRIs.

Our methodology builds on a series of studies supported by the Australian Productivity Commission, including McGuire, Schuele and Smith (2000), McGuire and Schuele (2000), Kalirajan (2000) and Nguyen-Hong (2000). We first score the regulatory barriers indices consistent with the STRI methodology employed by these Australian authors.

We then convert the STRIs into ad valorem equivalents. We rely on econometric estimates by Warren (2000) in telecommunications (for both fixed line and mobile), Kalirajan *et al.*, (2000) in financial services (for both banking and insurance), Kang (2000) in transportation services (for all four transportation sectors), Nguyen-Hong (2000) in professional services (for both accounting and auditing, and legal services) and Kalirajan (2000) for retail distribution services. Except for Warren, in all studies the authors regressed a measure of the price or costs of services against their STRIs and other control variables in a cross-country regression at a point in time to determine the impact of the regulatory barriers on the price of services.[22] Through the estimated coefficient for the STRI in their regressions, the authors estimated the ad valorem equivalents of the regulatory barriers in the countries of their sample. We calculate the AVEs by assuming that the impact of the STRIs in the regressions on these studies applies to Ukraine. Results for our business services sectors in Ukraine are in table 9.

Full documentation of the scoring for both discriminatory and non-discriminatory STRIs in Ukraine and their AVEs for our nine services sectors, see Kosse and Kravchuk (2020a). For the AVEs of barriers in services in the regions of the model other than Ukraine, we employed the estimates of Jafari and Tarr (2015).

4.2 Non-Tariff Measures (NTMs) and their Ad Valorem Equivalents (AVEs)

4.2.1 Reform of the Standards Regime in Ukraine. Traditional command and control non-tariff barriers to trade, such as quotas and bans on imports, have largely been eliminated both in Ukraine and world-wide. Research based on a new multi-agency task force database has shown, however, that regulatory measures, especially sanitary and phyto-sanitary (SPS) measures and technical barriers to trade (TBTs), have become a very important barrier to trade (see Cadot and Gourdon, 2014).

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[22]Warren estimated quantity impacts and then, using elasticity estimates and a measure of the quantity of telephone subscribers in each country, was able to obtain price impacts and ad valorem equivalents.

In Ukraine, there have been dramatic *qualitative* changes in regulations that impact SPS measures and TBTs since 2000-2005. By 2019, we assess that the regulations are dramatically more market oriented and, importantly, considerably less costly to Ukrainian firms, importers and consumers.

As a part of the former Soviet Union, after its breakup Ukraine inherited the Soviet system of product regulation known as "GOST" standards. In the absence of a market mechanism to regulate product quality, GOST standards regulated product "quality" not just safety. To regulate quality, they also regulated the production process in ways that did not impact safety. These regulations limited product innovation to better meet market demand or improve product quality, and limited production process innovation to reduce costs. As such, GOST standards have been widely criticized internationally as being non-tariff barriers on imports, and for their adverse role on innovation and growth in the economies that applied them.[23]

Significant reforms were implemented following Ukraine's accession to the WTO in 2008, but mandatory certification (see appendix B for explanation) remained for many products. Implementation of the Deep and Comprehensive Free Trade Area (DCFTA) with the European Union led to substantial further reform. By 2019-2020, Ukraine applies a system of standards aligned with EU norms and practices. Importantly, the standards that are independent of safety are voluntary; and the production process is not prescribed, i.e., different production processes that lead to the same safety level for a product are accepted; further, conformity assessment is done based on market principles, rather than exclusively by the state.

4.2.2 Quantitative Estimates of the Ad Valorem Equivalents of the TBTs—the average for manufacturing in Ukraine. We build our estimates of the AVEs of NTMs on the estimates of Kee *et al.*, (2009), but we update them. Specifically, we start with the estimates from Kee *et al.* (2009) of the Overall Trade Restrictiveness Index (OTRI) and the Tariff-only (OTRI_T) at the aggregated level of agriculture and manufacturing. The OTRI measures the uniform tariff equivalent of the country's tariff and NTMs that would generate the same level of import value for the country in a given year. The OTRI_T focuses only on tariffs of each country. Kee *et al.* (2009) provide estimates based on both applied and MFN tariffs; the measure we use is based on applied tariffs, which take into account bilateral and other trade preferences. We subtract the OTRI_T from the OTRI to obtain the uniform tariff equivalent of the non-tariff measures.

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[23] For example, the Asian Development Bank (2013, p.11) states that a major obstacle to implementing an effective functioning SPS system in CAREC is the continued use of State Standards (GOST) inherited from the Soviet Union in seven of the ten CAREC countries. "*The most significant technical barriers to adherence to SPS principles, apart from being trade barriers itself, is the GOST system.*"

In the case of an average over all manufacturing goods, Kee *et al.*, (2009) estimate that the AVE is 19.4%. That estimate, however, is based on a frequency index for Ukraine of more than 20 years ago, and in particular, prior to the reforms mentioned above. We have, however, calculated Prevalence indices of SPS measures at the ten-digit level in 2005 and 2019. Since the GOST system was still in effect in 2005, we regard it as a reasonable proxy for the year of the data of Kee *et al.* We find that there was a 59 percent decline in the Prevalence indices. That is, the Prevalence index in 2019 is only 41% of the Prevalence index in 2005. Using the estimating equation of Kee *et al.*, (2009), this implies that the AVE of the aggregate of manufacturing is 19.4% x 0.41 = 7.9%. The is the adjustment for the *quantitative* reduction in NTMs. Adapting for the qualitative reforms as well, we estimate an AVE of the TBT barriers in an aggregate of manufacturing and mining of 5.5%. In agriculture, due to the presence of agricultural support, we retain the estimate of Kee *et al*. (2009) of 3.3%.

4.2.3 Diverse AVEs of Non-Tariff Measures in Ukraine based on our Frequency and Prevalence Indices. We calculate frequency and prevalence indices of the Sanitary and Phyto-Sanitary (SPS) and Technical Barriers to Trade (TBTs) that apply on the more than 10,000 Ukrainian tariff lines. We aggregate these frequency and prevalence indices of NTMs to the 55 goods sectors of our 85-sector IO table. The frequency index summarizes the percentage of products to which one or more NTMs are applied. In some cases, there are multiple types of NTMs (SPS or TBT measures in our case) applied on a single tariff line. It would seem useful to have a measure that incorporates the information that there are multiple types of NTM measures, rather than ignoring them in the calculations. As a result, the French think tank CEPII also employs an index called the Prevalence index, see Gourdon (2014). The Prevalence index counts of the number of types of NTMs that apply to a tariff line (again only SPS and TBTs in our case).

In manufacturing and mining, we use our prevalence indices to generate diverse estimates of the AVEs of the NTMs by sector, where the average AVE for the aggregate of manufacturing and mining remains unchanged. The AVE of a sector is adjusted up or down from the average, based on the difference between the prevalence index of the sector and the average for all of mining and manufacturing. A similar approach applies in agriculture. Results for the 85-sector dataset and details of the methodology are in appendix B.

The final step is to obtain AVEs in our 45-sector model. For that we take a trade-weighted average of our estimates of the AVEs in the 85-sector model. Results are in table 9.

4.2.4 AVEs of Non-Tariff Measures on Ukrainian Exports. For these values we employ the estimates in Kee *et al.* (2009). We follow the methodology explained in section 4.2.2 and take two values for each country or region. For Turkey, the USA, China, Russia and Turkey these are unique estimates. For the European Union, FTA regions and Rest of the World, we take an average of the regions

indicated in the footnote to table 5 in appendix B. The estimates for Turkey are in table 9. The estimates for all regions of the model for our 85-sector dataset are presented in appendix B, table 5.

4.3 AVEs of Time in Trade Costs on Exports and Imports

Our estimates of the ad valorem equivalents (AVEs) of the time costs of trade are based on the path-breaking work of David Hummels and his co-authors (Hummels, 2007; Hummels and Schaur, 2013; Hummels *et al.*, 2007). Using the estimates of Hummels and his co-authors, Peter Minor (2013) provided estimates for the regions and products in the GTAP database. We use estimates from Peter Minor, which we aggregate to the sectors and regions of our model. Documentation of the steps we have taken, and a brief explanation of the methodology are explained below with more details in appendix A.

Although a central finding of the above studies is that the AVE of time in trade varies across products, most computable general equilibrium modeling of trade facilitation issues has used a single AVE across all products. By basing our estimates on the work of Hummels and Minor, we improve on the sector accuracy of the benefits of trade facilitation and show that the results are dependent on these sector estimates. We summarize the steps in the estimation of Minor and our aggregation below.

The crucial first step is the estimation of the value of one day saved in transit for each *product* ("the per-day value of time savings" by product). The key to the estimation is the premium in shipping costs that firms are willing to pay for air shipping to avoid an additional day of ocean shipping. The premium that firms are willing to pay for air shipping varies considerably across products. At one extreme, we have products like crude oil, coal and fertilizers with an AVE of zero for one day saved in transit. Evidently, no significant amounts of these products are shipped by air, which reflects no willingness to pay to save time. On the other hand, a significant share of fruits and vegetables are shipped by air, reflecting a willingness to pay to save time in shipping. Hummels *et al.*, (2007, p. 8) estimate that for an aggregate of all fruits and vegetables the AVE of one day saved in 0.9 percent; that is, one additional day in transit cost almost one percent of the value of the fruits and vegetables. Hummels has statistically significant estimates of the AVE of one day saved in transit for slightly more than 600 products defined at the four-digit level of the Harmonized System (HS4). The AVE of one day of time saved in shipping for these 600 plus products is independent of the country. For the more aggregated sectors of our model, however, the product mix of the 600 plus goods imported and exported by Ukraine to the regions of our model differ. So, the value of one day saved in shipping, will vary across the regions of our model due to the trade weights.

We multiply the ad valorem equivalent of one day saved in transit by the number of days in transit to obtain the AVE by product and region. We develop a new dataset in which we estimate the number of days in transit from Ukraine to 182 countries of the world and we apply this to the regions of our model. In the case of Turkey, which is relatively close compared with the USA or China, the AVEs

tend be small, since the number of days in transit is considerably less than for the USA or China. The results, for imports and exports, are presented in table 10.

4.4 Ukrainian Tariffs by Region of the Model and Turkish Tariffs on Ukrainian exports

4.4.1 Ukrainian Tariffs. We employ a trade-weighted aggregation of the tariffs rates at the six-digit level of the Ukrainian tariff schedule (as reported by WITS) to the 55 goods sectors of our 85-sector dataset. We use the WITS dataset as the basis of the six-digit data. The results for the 55 goods sectors of the 85-sector dataset are in table 9B. These rates are based on the *legal* tariff rates of the Ukrainian tariff schedule. Since the product-mix of the underlying goods at the ten-digit level vary by region of the model, the trade-weighted tariff rates on imports also vary by region of our model. Although the European Union is progressing toward zero tariffs with Ukraine, it had not reached zero tariffs in 2017 or 2018. Nor had some of the regions in the Free Trade Region reached zero tariffs on their exports to Ukraine. Consequently, we produce legal tariff rates for all external regions of our model. We use the shares of Ukrainian imports by sector and by region of our model to construct import share-weighted average *legal* tariff rates by sector for each of the 55 sectors in the 85-sector dataset.

In response to our request, the Ukrainian Customs Service kindly provided the value of *collected* import duties at the six-digit level. We aggregated this information on collected duties to the 55 goods sectors of our 85-sector dataset. We used the value of collected tariffs together with data on the total value of imports at the sector level to calculate the average collected tariff rate for the 55 goods sectors in the 85- sector dataset.

For each sector, we calculate the ratio of the collected rate to the legal rate. Call this ratio the scaling factor. We then scaled the legal rates applying to each of the seven external regions of our model by this scaling factor, which results in the import-share weighted average legal tariff rates at the sector level equal to the collected tariff rate at the sector level. We impose an upper limit of 1 on the scaling factor in each sector so that the collected rate does exceed the adjusted weighted-average legal rate.

For our policy model, these tariff rates are further aggregated to the 36 goods sectors of our 45-sector policy model, again on an import-share weighted basis. The applied average tariff rate for each of the 36 sectors and the applied rates for Turkey are presented in table 9.

4.4.2. Turkish Tariffs on Ukrainian Exports. We aggregate the tariffs in the Turkish tariff schedule to the sectors of our model using two approaches. In the first column of data in table 9A, we report Turkey's Most-Favored Nation (MFN) tariff rates. In the second column of data in table 9A, we report the tariff rates that apply on Ukrainian exports to Turkey, where these tariff rates are calculated based on the trade weights of Ukrainian exports within the sector. The tariff rates are aggregated to the sectors of the 45-sector policy model on a trade weighted basis and presented in the first two columns of data in table 9. Importantly, there are three food sectors where tariff rates in Turkey are extraordinarily

high and, in these sectors, the Ukrainian export mix is skewed toward the products with the higher tariffs. These products and the trade-weighted duties faced by Ukrainian exporters are meat products (198%), dairy products (176%) and other food products (75%). In these three sectors, Ukrainian producers face substantially higher tariffs than Turkey's MFN tariff. Ukrainian producers of fish (30%), animals (26%), fish products (36%) and grain mill products (26%) also face high duties on their exports to Turkey.

4.5 Input-Output Table for Ukraine of 85-sectors and 45-sector Policy Model

4.5.1 Construction of an 85-Sector Input-Output Table for Ukraine.

The construction of the table, including technical details, is documented in Rutherford *et al.* (2020). To provide a non-technical overview, the construction begins with the 2017 input-output table for Ukraine which contains 42 sectors. In order to create a dataset that can address a wider set of policy issues, we expanded the number of sectors to 85. This entailed the use of the 2005 input-output table that contains 81 sectors. These input-output tables are publicly available from the Ukrainian Statistical Service.[24] One sector in the 2005 table (motor vehicle maintenance) was aggregated with trade, reducing the number of sectors to 80. We used the 2005 input-output table for the *technology* of the sectors that are disaggregated, but value-added from 2018 for the shares of the subsectors. For example, in the 2017 table, mining of metal ores and other mining and quarrying is one sector. In the 2005 table, it is decomposed into four sectors: mining of metal ores; quarrying of stone, sand and clay; mining of chemical and fertilizer materials; and other mining and quarrying. The value-added shares of these four disaggregated sectors, were calculated based on data for 2018 in the RUSLANA database, which contains more than 350,000 Ukrainian firms. The documentation of the calculation of the value-added of the subsectors is available in appendix F). The value-added results for the sub-sectors were scaled such that the total value-added equals the value-added of the aggregate sector of the 2017 input-output table.

On the other hand, there are three cases where the 2017 table is more disaggregated than the 2005 table. For example, post and telecommunications are two separate sectors in the 2017 table, but they are one aggregate sector in the 2005 table.[25] We retain all sectors in the 2017 table, increasing the number of sectors by four to 84. Finally, given its importance to trade policy, we disaggregate textiles and apparel, resulting in 85 sectors in the IO table we construct.

Our constructed input-output table contains data on an extensive array of collected taxes, which are either not available in the input-output tables of the Ukrainian Statistical Service or not available at

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[24] See IO2005: http://ukrstat.gov.ua/operativ/operativ2009/vvp/an_tvv/IOT05exp.rar;
IO2017: http://ukrstat.gov.ua/druk/publicat/kat_u/2019/zb/05/zb_tvvoz2017xl.zip

[25] In addition: (i) activities in the field of information is one sector in the 2005 table, but is split into motion pictures and recording; and computer programming and information service activities in the 2017 table. (ii) Services to legal entities is one sector in the 2005 table, but is split into legal and accounting activities; advertising and market research; and administrative and support activities in the 2017 table.

the level of detail we present them. The information on collected tax revenues was obtained on request from the State Tax Service of Ukraine (STSU) or, for all taxes collected at the border, the State Customs Services of Ukraine (SCSU). We requested and received data on tax revenues and other fiscal revenues both by type of tax[26] and for taxes that are paid at the sector level, by disaggregated sectors. From the State Tax Service, we received data for fully disaggregated NACE codes and from the Customs Service, we received the data at the six-digit Harmonized System (HS) level. These disaggregated data were aggregated to the 85-sectors of our IO table, by type of tax. As a result, the following taxes are in our 85-sector input-output table: personal income tax (total); personal income tax on non-wage income; personal income tax on wages; military tax; unified social contribution; enterprise profit tax; simplified tax for SMEs; excise taxes paid by domestic producers and retail; excise taxes on imports; VAT on domestic production; VAT on imports; VAT refund; import duties; and export duties. All these taxes except the first two are included in the 85-sector input-output table at the sector level.

The data on imports and exports were obtained from WITS.[27] These were obtained at the ten-digit level and aggregated to the sectors of our model. The final 85-sector input-output table is available on-line.[28]

4.5.2 Data decomposition for the Policy Model. There were two additional data steps for the development of the dataset for the policy model: (i) decomposition of the trade data into exports and imports to and from the seven external regions of the model; and (ii) decomposition of total labor payments into labor payments of skilled and unskilled labor. For imports and exports, we used WITS with data for 2017 to match the IO table for 2017. These data were obtained at the ten-digit level and aggregated to the sectors and regions of our model 85-sector dataset. For the decomposition of labor, see appendix G.

4.6 Share of the Output of the Sector produced by Multinational Service providers

The impact of liberalization of barriers to foreign direct investment in business services sectors will depend on the share of the output of the sector sold by multinationals. We need ownership shares for each of the regions of our model for all nine of the sectors of our model with foreign direct investment. The primary, but not exclusive, data source was the RUSLANA database. These data were supplemented from other sources where available. For example, in banking, data from the National Bank of Ukraine

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[26] There is a unique fiscal code for each tax. The tax codes are from the Classification of Fiscal Revenues, approved by the Order of the Ministry of Finance #11 dated 14 January 2011 (with the subsequent amendments). These codes allow unique identification of tax payments by type of tax through the system, as taxpayers are obliged to provide the tax code in their payment orders. The same codes appear in the Law of the State Budget defining annual fiscal plans.

[27] https://wits.worldbank.org/

[28] See http://www.ier.com.ua/ua/projects?pid=6377.

also was very helpful. The results are in table 1. Details of the data sources and calculations may be found in Kosse and Kravchuk (2020b).

4.7 Elasticities

4.7.1 Elasticities of Substitution in Demand. Since we do not have rationalization gains in the monopolistic competition model, results will differ from a competitive model only to the extent that there is a Dixit-Stiglitz variety externality. Higher Dixit-Stiglitz elasticities, in general, mean the gains from variety are smaller and the results will be closer to perfect competition. Thus, we classify goods sectors as perfectly competitive if the estimates of the elasticity of substitution between varieties is high or imperfectly competitive for low values. We take our estimates of the elasticities from the GTAP dataset, documented in Hertel and van der Mensbrugghe (2019). The results for the 85-sector dataset are in table 2. These elasticities are aggregated based on a trade-weighted basis for the 45-sector policy model and presented in table 7.

4.7.2 Supply Elasticities. Beginning with the path-breaking work of Coe and Helpman (1995), a rich literature now exists that has empirically investigated the transmission of knowledge through the purchase of imported intermediate goods and through foreign direct investment. In Appendix E, we survey this literature. In summary, this literature shows that FDI and the purchase of intermediate inputs from industrialized countries is an important mechanism for the transmission of R&D and productivity growth in developing countries. Since the data show that OECD countries have the vast majority of R&D stocks,[29] it implies that for developing countries, trading with large technologically advanced countries such as the U.S. and the EU, at least indirectly, is crucial for total factor productivity growth. But for products in which developing countries have a comparative advantage, developing country trade may be equally important for spillovers.

Based on these considerations, we first classify the increasing returns to scale sectors of our manufacturing sectors into low, medium-low, medium-high and high technology sectors. The classification is defined by the share of R&D expenditures in total sales. For R&D intensity in goods sectors, we obtain the data from the paper by Alexander Loschky (2010) of the Joint Research Institute of the European Commission. For services, our estimates are based on similar data from the U.S. National Science Foundation.[30]

We use this information to set the elasticities of firm supply in each region by sector. In our model, the number of varieties endogenously impacts the productivity of firms who use the output of the sector. For example, if there are more firms/varieties that supply telecommunications or insurance

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[29] Coe, Helpman and Hoffmaister (1997) calculate that 96 percent of the world's R&D expenditures took place in industrial countries in 1990 and this number stood at 94.5 percent in 1995.

[30] National Science Foundation, Division of Science Resources Statistics, Survey of Industrial Research and Development, 2005, Data Tables.

or accounting services, then users of these services are able to purchase a quality adjusted unit of the services at a lower price. This is equivalent to an endogenous productivity increase. The greater the elasticity of firm supply in a sector the more varieties will be received in response to a price increase with respect to that country. The estimates of Schiff *et al.* (2002) indicate that for technologically complex products, technology transfer occurs at between 3 to 6 times faster rates when trading with R&D intensive countries compared with than countries that do little R&D; but for technologically simple products, the relative rates of technology transfer is closer to a ratio of 1. Unless otherwise noted, we take the elasticity of supply as 3 for Ukraine, Turkey, China and Russia[31] in all IRTS sectors. We assume that the elasticity of supply is between 1 and 6 times the Ukrainian elasticity of supply for other regions, depending on the R&D intensity of the sector and the R&D intensity of the foreign region. The detailed elasticity values, by sector and region, are in appendix E, table E.1 We conduct sensitivity analysis on these parameters, to determine the impact of these parameters on the results.

4.7.3 Other Elasticities. Unless otherwise specified, other elasticities are taken from the GTAP database.

5. Results for Ukraine-Turkey Free Trade Agreement

5.1 The Ukraine-Turkey Free Trade Agreement (FTA): An Assessment of Deep Preferential Integration

We execute several scenarios to assess the impacts on Ukraine of deep integration within the Ukraine-Turkey FTA. (We do not evaluate the impacts on Turkey.) We decompose the FTA into multiple categories: (i) the reduction in trade costs due to reduced time required to import or export goods, both on the Ukrainian and the Turkish sides; (ii) the reduction of non-tariff barriers on goods by both Ukraine and Turkey; (iii) the mutual elimination of tariffs between Ukraine and Turkey; and (iv) the reduction of barriers on foreign providers of services. Regarding services, we consider both barriers against foreign direct investment and barriers to cross-border trade in services.

In the case of time in trade costs, as we explain in more detail in appendix A, there are several reasons to take modest cuts in these barriers. These include that the most efficient countries in the world, such as Singapore, South Korea and Hong Kong have not cut the time cost of trade to zero; and part of the costs are due to infrastructure deficiencies which can't be addressed through policy alone. Consequently, we assume a 20 percent cut in the ad valorem equivalents of the time cost of trade between Ukraine and Turkey. Since there is likely a spillover benefit of these measures that will cut the time costs of trade for Ukraine's trade with other countries, we take a five percent cut in these costs for trade with 3rd countries.

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[31]Telecommunications in Russia is an exception where we take a higher value since Russian companies are technologically advanced.

Non-tariff measures, however, have become much more subtle in the post-Uruguay Round world. Measures such as bans, quotas and import licensing are increasingly rare among WTO members. Most non-tariff measures in effect in Ukraine and Turkey have a legitimate regulatory function to protect health, safety or the environment. Distinguishing the legitimate regulations and standards from protective or inefficient regulations is complicated. In the cases of Ukraine and Turkey, both are harmonizing product standards and regulations on manufactured goods with the European Union, and the Ukraine-Turkey FTA is likely to accelerate mutual acceptance of the standards and regulations of each other on these products and to a lesser extent on agriculture and food products. Weighing these considerations, we take a modest 20 percent reduction in the ad valorem equivalent of these barriers, by both Ukraine and Turkey.

A hallmark of modern preferential trade agreements, including all agreements with the European Union or the United States, is the inclusion of commitments to suppliers of services in countries that are partners to the agreement. Consequently, we also assess the impact of a 50 percent cut in the ad valorem equivalents of the barriers against FDI and cross-border services.

Of course, the mutual reduction of tariff protection has been and continues to be the core aspect of preferential trade agreements. In this scenario, we assume the full mutual elimination of tariffs between Ukraine and Turkey.

5.1.1 Aggregate Welfare Effects of a Deep FTA with Turkey. Our aggregate results are in table 11. Results for all of the 45 sectors of the model are available in the tables 13-21. Tables 13-21 report the estimates for the percentage change in output, prices, imports, exports, product varieties available by source region, skilled labor earnings, unskilled labor earnings and household consumption

In table 11, column 1, we present our aggregate results for the impact on Ukraine of all the policies we consider in a deep liberalization FTA. We estimate an *annual recurring* gain to Ukraine of 2.72 percent of Ukrainian consumption. That is, this estimate is neither a growth rate nor a one-time gain. The welfare gains are presented as Hicksian equivalent variation as a percent of consumption, which is equivalent in our model to the change in real income of the representative household. This estimate is for the combined impact from reciprocal tariff elimination, cuts in the time in trade costs, non-tariff barriers and services barriers in both Ukraine and Turkey. To examine the source of these gains and their relative importance to Ukraine, we execute nine additional scenarios. We have one scenario for each of the nine components of the FTA, in which we allow only one of the reforms to be implemented in each of these additional scenarios. The results of these additional scenarios are shown in table 11, columns 2-10.

5.1.2 Preferential Reduction of Time in Trade Costs. The reduction in time in trade costs constitute the largest share of the gains—the estimated gains are equal to 1.22 percent of the real income of the representative consumer's real income from the reduction of time in trade costs (0.68 percent from

imports and 0.54 percent on exports). Part of the gains derive from our assumption that the time in trade costs consume capital and labor in the home country—these are referred to as the "rents" of the barriers. For example, if trucks are stalled at the border or ships wait in the harbor to unload, capital and labor resources are used. These costs are equal to the ad valorem equivalent of the time costs of the imported product (from a country) times the benchmark value of the imports plus the time costs of the exported product (to a country) times the benchmark value of the exports. Reduction of the time in trade costs by 20 percent on trade with Turkey and by 5 percent for third countries, leads to freeing up of 20 percent of the capital and labor devoted to overcoming the time costs of trade with Turkey on both imports and exports and five percent of the capital and labor devoted to overcoming the time costs of trade with third countries on both imports and exports. To provide concrete values for these estimates, in table 22 we show the total value of the rents in the benchmark as a percent of total Ukrainian consumption and the amount of the rents that are recaptured by any of the policies simulated. In the case of reduced time in trade costs, see in table 22, column 4 that rents recaptured on imports as a percent of domestic consumption are 0.35 percent of the benchmark value of consumption and on exports from column 5, they are 0.30 percent of the value of benchmark consumption. These are referred to as "rectangles" of gains for each good because they are approximately equal to the percent reduction in the AVE of the time in trade cost of the good times the value of the initial trade in the good. In addition, the reduction of the time costs of trade results in an increase in the returns to exporting relative to domestic sales and a decrease in the cost of imports relative to domestic production. As a result, there are also "triangles" of efficiency gains from increased trade. Table 11 shows that aggregate exports increase due to the reduction in time in trade costs on exports by about 0.5 percent and by 0.7 percent due to time in trade cost reduction on imports.[32] A third and final component of the gains is the fact that in our imperfect competition model, additional varieties of goods, from both Ukrainian and foreign sources, leads to a lower quality adjusted price of goods.

5.1.3 Elimination of Tariffs between Ukraine and Turkey. We decompose reciprocal elimination of tariffs between Turkey and Ukraine into its two components: Turkey's elimination of tariffs against Ukrainian exports to Turkey and Ukraine's elimination of tariffs against imports from Turkey. One the one hand, in table 11, column 8, we see that Ukraine is estimated to gain 1.14 percent of real consumption from the elimination of tariffs against Ukrainian exporters. That is, *improved market access that Ukrainian exporters obtain in the Turkish market from Turkey's preferential elimination of its own substantial tariffs leads to substantial gains to Ukrainian exporters*. There are several products where Turkey's tariffs on the product mix of Ukraine's exports are high or very high. The very high

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[32] An increase in the real exchange rate represents a real depreciation.

tariffs are: meat (198 percent); dairy (176 percent); and other food products (75 percent).[33] Ukrainian producers then would obtain higher prices for their products in Turkey, contributing to larger Ukrainian incomes.[34] We estimate, see table 16, column 8, that Ukraine would substantially expand its exports in these sectors due to Turkish tariff removal: the estimated export expansion from the removal of Turkish tariffs is: meat (74 percent); dairy (154 percent); and other food products (48 percent).

On the other hand, we estimate very small gains to Ukraine from the preferential reduction of its own tariffs on imports from Turkey; in table 11, column 2, we show a rather small estimated gain of 0.01 percent or real household income. This is because *preferential* liberalization of tariffs is not free trade. It involves gains from the expansion of trade with the preferred trade partner (known as trade creation), but typically leads to a contraction of trade with excluded partners who face increased competition from the preferred trade partner. The loss of trade with the third country trade partners is known as trade diversion and this leads to a welfare loss that can be measured by the lost tariff revenue for the lost trade with third countries. In table 11, column 2, we can see that Ukraine's preferential elimination of tariffs against Turkey leads to a reduction of imports from third countries by 0.4 percent and a loss of tariff revenue of 1.3 percent. Our quantitative assessment is that Ukrainian *unilateral* preferential tariff elimination toward Turkey results in a very small gain in welfare. But reciprocal preferential tariff elimination with Turkey would result in gains due to the improved market access in Turkey for Ukrainian exporters.

5.1.4 Reduction of Non-Tariff Measures. The estimates are that the gains from the reciprocal reduction of non-tariff measures between Turkey and Ukraine are equal to 0.09 percent of consumption. These gains are approximately evenly divided between: (i) gains from Ukrainian preferential reduction of non-tariff measures barriers against imports of Turkish goods, shown in table 11, column 3 to be 0.04 percent of household income; and improved market access for Ukrainian exports in Turkey from the reduction by Turkey of its non-tariff measures against Ukrainian exports of goods, shown in table 11, column 9 to be 0.05 percent of Ukrainian household income. There are two reasons for the small gains. First, the estimates of the ad valorem equivalents of the non-tariff measures in both Turkey and Ukraine are small. Both countries are harmonizing their regulations and standards with the European Union on manufactured goods and have relatively low remaining non-tariff measures. Second, as with tariffs, there is a trade diversion impact from the preferential reduction of non-tariff measures.

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[33] On these products, Turkey's MFN tariff is considerably lower, reflecting that the products Ukraine exports to Turkey within these product categories is on products with higher tariffs within the group. Turkey's tariffs on Ukrainian exports for the sectors of our model are listed in table 9.

[34] Wonnacott and Wonnacott (1981) have demonstrated the theoretical importance of assessing improved market access in regional agreements, and Harrison, Rutherford and Tarr (2002) have shown numerically that assessing market access is very important in determining the value of a preferential trade agreement.

The results in table 11, column 3 exhibit a reduction of trade with third countries of 0.1 percent from Ukraine's reduction of non-tariff measures with Turkey.

5.1.5 Preferential Reduction of Barriers in Services. As shown in table 11, columns 6 and 7, the impact of fifty percent preferential reduction toward Turkey of the discriminatory barriers against FDI in Ukrainian services and cross-border services results in a combined gain to Ukraine of 0.18 percent of real consumption. Of this total, 0.03 percent of the gains derive from preferential liberalization of barriers against Turkish FDI. These estimated gains are rather small compared with the results of the studies cited in section 2 for liberalization of barriers against FDI in services. The reason is, as shown in table 1, Turkey's market share of Ukrainian business services is less than one-half of one percent in all our business services sectors except for telecommunication and air transport services. (Turkey's market share is 12 and 11 percent in these two sectors.) In telecommunications, the ad valorem equivalent of the Ukraine's discriminatory barriers is a relatively small at 2.5 percent. Only in air transport services is the ad valorem equivalent of the barriers high and Turkey has a significant market share of the Ukrainian market.

Ukrainian cross-border imports of business services from Turkey represent only four-tenths of one percent of total Ukrainian imports.[35] Consequently, the estimated economy-wide gains from reduction of the AVEs of these barriers are not large.

5.2. Reduction of Non-Discriminatory Barriers to Investment in Business Services to Ukraine and all Regions

Non-discriminatory regulatory barriers in Ukraine are barriers faced by both Ukrainian nationals as well as all foreigners in the Ukrainian market. In these scenarios we evaluate the impact of a 25 percent reduction of Ukrainian non-discriminatory barriers to investment in business services (that is, reducing regulatory barriers that impact both Ukrainian and all foreign investors). We evaluate this policy change first to identify where the largest gains can be made by Ukrainian policymakers in the sphere of business services policies. In addition, in negotiations such as WTO accession and services commitments for WTO members under the "GATS," barriers that are non-discriminatory are included as part of the negotiations.[36] It is possible that a focus on business services in the FTA with Turkey will encourage policy-makers to review barriers to services that are non-discriminatory and reduce non-discriminatory barriers in business services.

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[35] Calculated from data in table 4.

[36] The WTO Guidelines Scheduling Services Commitments notes that non-discriminatory measures that limit market access of WTO members fall under the purview of the GATS scheduling negotiations. In particular, World Trade Organization (2001, p.4) states "all measures falling under any of the categories listed in Article XVI:2 must be scheduled, whether or not such measures are discriminatory."

We show in table 12, column 3 that Ukraine would gain an estimated 2.03 percent of annual real household income per year from a 25 percent reduction of Ukrainian non-discriminatory barriers to investment in business services. The impacts of the FTA with Turkey are estimated to provide gains of 2.72 percent of annual real household income; but combined with a 25 percent reduction of Ukrainian non-discriminatory barriers to investment in business services the gains would increase to 4.76 percent of real household income (table 12, column 2). Clearly, this is a very substantial potential addition to the gains and considerably larger than preferential reduction of barriers to FDI from Turkey alone. In section 6.2 below, we also consider reduction of the barriers against *all* FDI in business services, i.e., non-preferential reduction of barriers against FDI in business services.

The intuition for this result is that the reduction of non-discriminatory regulatory barriers in business services applies to all suppliers of business services in Ukraine, both foreign and domestic. This is different from the preferential liberalization limited to Turkey, where only two sectors were significantly impacted due to low Turkish market shares in Ukraine. With non-discriminatory barriers, 100 percent of the market is impacted. Then the reduction of non-discriminatory regulatory barriers in business services increases profitability for the provision of business services in Ukraine, thereby inducing new entry by service providers who wish to establish a domestic presence in Ukraine—by both Ukrainian firms and foreign firms through FDI. The entry continues until zero economic profits are restored. Ukrainian businesses will then have improved access to business services in areas like telecommunication, financial services and transportation services. The additional service varieties in the business services sectors lower the cost of doing business and result in a productivity improvement for users of these goods. Consequently, more output is produced and available for household consumption, thereby increasing household real incomes. The additional varieties also increase consumer welfare, since consumers have more choices available and can optimize their expenditures among the varieties. These gains from additional varieties is known as the Dixit-Stiglitz variety externality, an effect that is missing in models of perfect competition and is the source of the difference between our central model and the model of perfect competition with which we compare in section 6.1. We estimate that, in the scenario where we only reduce non-discriminatory barriers in business services by 25 percent, the number of varieties increases in all of the business services sectors, with the range of increase between 1.3 to 4.0 percent, depending on the sector. In the scenario where we combine FTA Central with non-discriminatory reduction of barriers in services by 25 percent, the number of business services varieties increases by between 2.6 and 5.0 percent, depending on the sector.

As with time in trade costs, in our central scenario, we assume that it takes domestic capital and labor to overcome the costs of the barriers against foreign providers of services, both those that supply the

domestic markets through FDI and also through cross-border services. Thus, there are "rectangles" of recaptured rents from reducing the regulatory barriers on all suppliers of services in Ukraine.

Box: How Interindustry Linkages and Productivity Gains from Additional Varieties Induce Output Increases

Consider the scenario where we reduce the ad valorem equivalents of the non-discriminatory barriers against investment and FDI in business services, without changing any of the barriers impacting the goods sectors. Because of the reduction in the barriers to investment in services, the prices of most business services fall in both the perfect competition model and our central model with imperfect competition. But the prices fall by more in the imperfect competition model due to the fact that additional varieties are available and the price that is relevant to users is adjusted for the quality. (This quality adjustment to the price is only present in the imperfect competition model). For example, the price declines in percent that we estimate in the imperfect (prefect) competition models, respectively, in this scenario are: land transport services -7.2 (-4.7); telecommunications -2.6 (-0.8); insurance -3.8 (-1.5); banking -1.4 (-0.7); and legal and professional services -1.1 (-0.8).

Despite the fact that there is no reform impacting the goods sectors in this scenario, the output of almost all the goods sectors increases. In the perfect competition model, the output of 32 of 36 goods sectors expands --between 0.1 percent and 7.9 percent, depending on the sector, and two sectors show no change. The output expansion of the goods sectors in the perfect competition model is due to the decline in the price of business services inputs in the production of goods. Goods sector output also increases since consumers have additional income to spend and increase final demand for goods. These impacts on goods sectors are the interindustry linkage effects and they are present in the perfect competition model.

In the imperfect competition model, the interindustry linkage effects are also present, but they are magnified in comparison with the perfect competition model due to the larger price declines in the imperfect competition model. Further, when input prices fall in imperfectly competitive goods sectors, this will induce expansion and additional varieties of these goods. That implies lower prices for users of these goods that then interacts with all sectors with feedback effects that typically expand output further. Some examples of the output change in percent that we estimate in the imperfect (prefect) competition models, respectively are: processed fruits and vegetables 4.7 (1.6); other foods 1.8 (0.9); pharmaceuticals 1.5 (0.6); fish products 1.8 (1.1); paper products 1.2 (0.6); and chemical products 2.1 (1.2).

Source: Model estimates.

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6. Sensitivity to Model Assumptions

6.1 Comparison with a Perfect Competition Model

In order to assess the impact of our modern model that incorporates endogenous productivity effects from additional varieties in imperfectly competitive goods and services sectors, we evaluate the impact of the Ukraine-Turkey FTA in a perfect competition model. The results are in table 23. We also use the perfect competition model to evaluate the impact of a 25 percent reduction of non-discriminatory barriers to all providers of business services in Ukraine: both Ukrainian and foreign.

The results in table 23 are directly comparable to the results in table 11. The only difference in the model and data assumptions is that the results in table 26 are in a purely perfectly competitive model. Comparing table 23 to table 11, we see that the aggregate annual welfare gains are 1.73 percent of real household income in the perfectly competitive model but are equal to 2.72 percent in the model with imperfective competition. That is, the imperfect competition model shows welfare gains that are 157 percent of the estimates in the perfect competition model.

We showed that if we combine a 25 percent reduction on non-discriminatory barriers to Ukrainian investment and FDI in business services from all regions with the FTA, the annual gains are 4.76 percent in the model with imperfect competition (table 12, column 2). In the perfect competition model, the same scenario results in an estimated gain of 2.7 percent of real household income. In this case, the imperfect competition model shows welfare gains that are 176 percent of the estimates in the perfect competition model.

If we focus on the reform of the reduction in non-discriminatory barriers in business services *alone*, the imperfect competition model shows annual welfare gains of 2.03 percent of household income compared to 0.95 in the perfect competition model. That is, our central model produces welfare gains that are 214 percent of the estimates in the perfect competition model. The reason that the ratio of the gains increases when we include reform on non-discriminatory barriers to investment is that in these cases, we focus on reforms that significantly impact the flow of FDI and Ukrainian investment and thus the gains from additional varieties.

6.2 Spillovers or Wider Liberalization

6.2.1 Conceptual Issues on Wider Liberalization and Spillovers.
The combined 2019 GDP of Ukraine and Turkey is 913.2 billion US dollars. This was only 1.0 percent of the world GDP in 2019 of 87.8 trillion US dollars.[37] Thus, the combined Ukraine-Turkey market is not a large market in comparison to the world market. Economic theory indicates that there should be gains from integrating into the world trading environment, something that leaders in Ukraine have recognized by Ukraine's competitive admission to the WTO and its DCFTA with the European Union and other free trade agreements. In this section, we evaluate the benefits to Ukraine of further extending their liberalization efforts to the wider world market, especially the deep integration aspects.

Baldwin (2014) has argued that compared to regional preferences regarding tariffs, the deep integration aspects of 21st century regional agreements are relatively difficult to limit to partners to the agreement; and, global value chain considerations lead to a "multilateralization" of some of the deep integration aspects of 21st century regional agreements. That is, "spillovers" of regional preferences will

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[37] In 2019, World Bank data indicates that the GDPs of Ukraine and Turkey were (in millions of US dollars) 159 for Ukraine and 754 for Turkey. See https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?view=map.

convey to third countries. For example, we argued above that measures that reduce the time in trade costs would inevitably convey at least a partial benefit to non-members. In particular, partly in an effort to reduce time in trade costs to reap greater benefits from the FTA with Turkey, Ukraine could join the European Union Common Transit System. This would then convey mutual transit benefits to Ukraine and all the members of the System. Regarding preferential liberalization of barriers against foreign investors in services, Fink and Jansen (2009) and Fink and Molinuevo (2007) argue that it is an unsettled question of how feasible it is to exclude third countries from preferential liberalization in services and that, in practice, some spillovers have occurred.[38]

6.2.2 Aggregate Spillover or Wider Liberalization Results. In this section we estimate the impacts of spillovers or wider liberalization to all third countries, i.e., to all external regions other than Turkey. In our scenarios with spillovers, we continue to take the same reduction in the AVEs of the barriers with respect to Turkey as we do in the FTA Central scenario. But we extend reductions in the AVEs of the barriers to the other regions of the model. In this manner we assess the impact of combining the reforms of the FTA with extensions to third countries. The extension of the reforms may arise either through unintended extensions, legal requirements to extend the reforms or intentional liberalization. We evaluate the impact of spillovers in five reforms plus the reduction of barriers to FDI in business services together with the FTA. These results are summarized in table 24.

With spillovers in services, either through FDI or cross-border, we allow a 25 percent reduction in the ad valorem equivalents of the barriers against service providers in the regions outside of Turkey. That is, we take a 25 percent reduction in the AVEs of the barriers in services with respect to the EU, China, USA, Russia, the Free Trade Regin and the Rest of the World. With time in trade costs, we allow a five percent reduction to regions other than Turkey. Finally, regarding non-tariff measures, we allow a ten percent reduction in the ad valorem equivalents to all third countries or regions except the European Union. The European Union is excluded from the spillovers in non-tariff measures because under the terms of the DCFTA between Ukraine and the EU, Ukraine is harmonizing its standards and regulations to the system of the EU.

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[38] If the preferential agreement grants equivalent rights to third country firms located in the partner region, the preferential arrangement becomes somewhat multilateral. The rules of origin would impact how multilateral the preferential liberalization becomes. What rules of origin apply in practice is an unsettled question both in the literature and in practice. Fink and Jansen (2009) note that typically, FTAs require that enterprises eligible for the agreement's preference are incorporated under the laws of one of the partner countries. Further, to qualify for preferences, the enterprise must have "substantial business activities" within the region. This indicates that preferences do not extend to enterprises located in third countries if they are not incorporated with substantial business interests in the region. As an example of these principles, Fink and Molinuevo (2007) note that in East Asia non-parties can benefit from the preferences provided in the FTA, as long as they establish a juridical person in one of the FTA member countries and are commercially active in that country. But again, the preferences for non-parties are enterprise specific and do not extend to enterprises without a commercial preference with substantial business interest.

Compared to FTA Central, the wider liberalization of FDI, cross-border services and non-tariff barriers contributes an additional 1.38 percent to Ukrainian real household income. We explicitly evaluate FDI liberalization together with the Ukraine-Turkey FTA and find that the gains increase to 2.99 percent of real household income. These results show the importance of wider liberalization.

6.3 Impact of the Rent Capture Assumption

In our central scenarios we assume that: it takes capital and labor to overcome the barriers; the rents from the barriers are "dissipated;" and the rents are recaptured by the domestic economy in the central scenarios. An equivalent assumption for the analysis would be that the rents are captured by foreign agents. The latter could occur if licenses for imports are awarded to foreigners, as with the Multi-Fiber Agreement (MFA) in textiles and apparel or as the United States did with voluntary export restraints on products such as on autos an steel before these instruments were outlawed by the WTO. It is possible, however, that some of the barriers do not cause rents to be dissipated or are not captured by foreigners, but instead generate rents that are captured by domestic agents in our initial equilibrium. If so, then the rents that are captured initially by domestic agents would not be available as a net welfare gain to the domestic economy since they are already part of the income of domestic agents. When the barriers are eliminated, the domestic agents who captured the rents lose those rents, but the resources become available to the general population, for no net welfare gain. In this case, the welfare analysis for rents is analogous to a tariff reduction. The "triangle" of efficiency gains will remain, but the welfare gains should be smaller when there are initial rents captured by domestic agents.

In the case of time in trade costs, however, there is a strong presumption in the theory and empirical work that these barriers involve real resource costs, i.e., the rents are dissipated. Thus, we continue to assume that ad valorem equivalents of the time in trade barriers are dissipated. We also assume that Ukrainian agents do not capture the rents of Turkish non-tariff barriers, either on goods or on cross-border services. In table 22, we can see that what remains in the benchmark are rents equal 0.13 of real household consumption.

We estimate that with domestic rent capture in the benchmark equilibrium, the welfare gain from the FTA decreases to 2.55 percent of real household consumption from 2.72 percent in our FTA Central scenario. Compared to the FTA, the lower estimated gains are because the household does not gain the "rectangle" of rents equal to 0.13 percent of household income, plus with lower incomes there are fewer varieties and reallocation choices available accounting for an additional loss of 0.04 percent real household income.

6.4 Distribution Issues: Impact of the Trade Reforms on Ukrainian and Foreign Owners of Sector-Specific Capital

The estimated changes in real household income is positive in all of our policy scenarios. Real household income derives from returns to factors of production, so it is not surprising that we report nonnegative returns to our factors of production. In a multi-household model, however, differences in the impacts across households will arise due to different consumption patterns and different factor endowments. With mobile factors located in declining sectors, workers can benefit from the reform by switching sectors to those sectors that are expanding and paying higher wages, and similarly with mobile capital. (We estimate adjustment costs in the next section.) On the other hand, if households are heavily endowed with sector-specific capital, since that capital is locked into the sector, the households could be significantly negatively impacted if that sector declines. Consequently, it is worthwhile to examine the returns to sector-specific capital in more detail.

In our model we assume that Ukrainians own the sector-specific capital in Ukrainian firms, but foreigners own the sector-specific capital in multinational firms operating in Ukraine. The weighted-average percentage change in the returns to sector-specific capital across all sectors in shown in tables 11, 12 and 24. We show the returns to sector-specific capital in Ukrainian firms and multinational firms separately. It is not surprising that the weighted-average percentage change in the returns to sector-specific capital in Ukrainian firms across all sectors is positive in 16 of the 18 scenarios; it is zero in the two cases of preferential liberalization of FDI barriers only (either to Turkey preferentially in table 11, column 6 or to all foreign firms in table 24, column 3).

To investigate the worst-case scenario of an adverse impact on individual households from sector-specific capital ownership, we consider the scenario where we reduce the discriminatory FDI barriers to all external regions. The reform induces an increase in multinational entry into Ukraine. Due to increased competition, there is a decline in demand for domestic varieties due to the increased competition. This decline in demand may be offset in some cases due to an increase in demand for the sector from a general expansion of the economy and the reduced composite price of the sector. But our results show a decline in the demand for sector-specific capital in six of the eight Ukrainian monopolistically competitive business services firms. The declines are less than five percent except for substantially larger estimated declines in Ukrainian returns to sector-specific capital in the air transport and water transport sectors.[39] The estimated AVEs of discriminatory barriers against FDI are dramatically

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[39]The percentage change in the returns to Ukrainian sector-specific capital in these sectors is: wholesale and retail trade (0.5); land transport (0.6); water transport (-96.4); air transport (-97.6); telecommunications (-3.3); insurance (-1.4); banking (-4.3); legal and other professional services (-0.1).

higher in air and water transport, which explains the larger estimated declines in their returns to sector-specific capital.

6.5 Sensitivity of Results to Parameter Specification

Our piecemeal sensitivity analysis in table 26 shows how the results change when we vary the value of key parameters one-by-one, with central values of all parameters except the one under consideration. We examine the sensitivity in two scenarios: FTA Central and FTA Central plus reduction on non-discriminatory barriers in services by 25 percent.

The elasticity of substitution between firm varieties in imperfectly competitive services sectors, $\sigma(q_i, q_j)$ also has a strong impact. At the low end of the elasticity range, the estimated gains increase to 4.00 per cent of consumption from FTA Central; and it falls to 2.42 percent of consumption at its high value. Unlike most other elasticities, a lower value of $\sigma(q_i, q_j)$ increases the welfare gains because lower values of this elasticity imply that varieties are less close to each other; so additional varieties are worth more.

The elasticities of firm supply are very impactful, especially in the case of "FTA Central Plus," i.e., FTA Central plus the reduction of non-discriminatory barriers in business services, where the estimates range from 3.82 to 5.31 percent increase of real household income. When the elasticities of firm supply increase, a reduction of the barriers against monopolistically competitive firms leads to a larger response and increase in varieties. The elasticity of substitution between value-added and business services, $\sigma(va, bs)$, also has a strong impact. In FTA Plus, the estimated welfare gains range from 4.37 to 5.21 percent. The more easily firms are able to substitute business services for labor and capital, the more the economy will gain from the reforms that reduce the quality adjusted price of business services. The elasticity of transformation between domestic output and export supply also has a significant impact on the results as Ukrainian firms can more easily adapt to the improved market access of the FTA with the higher elasticities.

The results are rather robust with respect to the other elasticities in the model. That is, the results are within plus or minus seven percent of the central estimate. Except for the Dixit-Stiglitz elasticity of substitution, the impact of changing elasticities follows the Le Chatelier principle, i.e., larger elasticities typically lead to larger welfare gains, as the economy can adapt more readily. For example, a larger elasticity of firm supply means that more firms will enter when profits are available, which results in more varieties and productivity increases.

7. Adjusting to Trade Liberalization: International Evidence, Policies and Estimates for Ukraine

7.1 International Evidence of Adjustment Costs and Recommended Mitigation Strategies

Matusz and Tarr (2000) summarize the evidence on adjustment costs of trade liberalization and find that adjustment costs for society as a whole are dramatically smaller than the welfare gains. Nonetheless, adjustment costs of trade liberalization are an important concern of policymakers. Policymakers often receive strong lobbying from those who suffer or fear 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. Further, 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 adjustment costs that they can ill afford.

The evidence from empirical studies worldwide, summarized by Matusz and Tarr (2000), has shown that the adjustment costs of 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.

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 these 1993 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. His 1978, study, however, is a broad sample of short, medium and long tenure workers who have on average much less specific human capital. Other studies, such as by 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.

To address these 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.[40] 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. In this manner, estimates show that the normal voluntary departure from the industry will likely be sufficient to accommodate the negative demand shock to labor with little or no adjustment costs.[41]

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 policy-makers, despite the usually larger net gains of broader unilateral or multilateral liberalization.[42] In the next subsection we estimate these values for the Ukraine-Turkey FTA compared to broader liberalization.

7.2 Estimates of Adjustment Costs and Benefit-Cost Ratios for Ukraine

In this section, we estimate the adjustment costs of the Ukraine-Turkey FTA compared to two scenarios where we add additional non-preferential liberalization to the Ukraine-Turkey FTA. In particular, we also consider the adjustment costs of the Ukraine-Turkey FTA plus: (i) liberalization of FDI barriers against all FDI; and (ii) deeper domestic regulatory reform in services to reduce non-discriminatory investment barriers to both Ukrainian and foreign investors in services in Ukraine. In all three cases, we compare the adjustment costs to the welfare gains.

To put these data for our calculation in context, the Ukrainian Statistical Service (Ukrstat) reports the unemployment rate in Ukraine was 8.8% in 2018 and 8.2% in 2019.[43] 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.[44] 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 owners of sector-specific factors in declining sectors.

Let w = the annual wages, including taxes paid by labor; L = the total labor force; ΔL = the number of workers who are displaced by the trade policy change; β = ΔL/L = the share of the labor force

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[40] See also Michalopolous, Schiff and Tarr (2002).
[41] 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.
[42] See, for example, Balistreri, Tarr and Yonezawa (2015).
[43] See: http://ukrstat.gov.ua/operativ/operativ2007/rp/ean/ean_e/osp_rik_10-19e.xls
[44] For an explanation of the methodology, see Morkre and Tarr (1980, chapter 3).

that is displaced by the trade policy change; μ = 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 ΔL workers. Then, if the value of the marginal product of labor is equal to wages, $p\left(\dfrac{\partial Y}{\partial L}\right) = w$, we have that X is given by equation (1)

$$p\left(\frac{\partial Y}{\partial L}\right) \times \Delta L \times \mu = w \times \Delta L \times \mu = X \qquad (1)$$

According to the Ukrainian Statistical Service statistics, in 2018: (i) compensation to employees (including the taxes on the payments to labor) was 41.3 percent of GDP;[45] and (ii) the average duration of unemployment in Ukraine was six months, i.e., $\mu = 0.5$ years.[46] Then

$$wL = p\left(\frac{\partial Y}{\partial L}\right)L = .413 \times GDP \quad \text{and} \quad p\left(\frac{\partial Y}{\partial L}\right) = .413 \times \frac{GDP}{L} \qquad (2)$$

Substitute for $p\left(\dfrac{\partial Y}{\partial L}\right)$ from equation (2), use $\mu = 0.5$ in (1) and divide both sides by GDP. We have that the social costs of adjustment as a share of GDP are shown by equation (3):

$$(.413) \times \frac{\Delta L}{L} \times 0.5 = (.413) \times \beta \times 0.5 = \frac{X}{GDP} \qquad (3)$$

We calculate equation (3) for Ukraine for our principal scenarios. Regarding β, in our model simulations, we estimate the number of workers that must change jobs by sector and skill type. Taking a weighted average across all sectors and skill types of labor for Ukraine, we calculate that: $\beta = 0.0119$ for the Ukraine-Turkey FTA; $\beta = .0138$ for the scenario that adds the reduction of non-discriminatory barriers against investment in Ukrainian services sectors to the Ukraine-Turkey FTA; and $\beta = .0121$ for the scenario where FDI spillovers to the world are added to the Ukraine-Turkey FTA. These values are shown in tables 11, 12 and 24, respectively. That is, in the Ukraine-Turkey FTA Central scenario, we estimate that about 1.19 percent of labor must change jobs; about 1.38 percent of labor must change jobs when we add non-discriminatory services liberalization to the FTA; and about 1.21 percent of labor must change jobs when we add FDI spillovers to the world to the FTA.

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[45] See: http://ukrstat.gov.ua/operativ/operativ2005/vvp/vvp_ric/vvp_kd10-18.xlsx.
[46] 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.

We present the results in table 25. Then, from equation (3), the social costs of adjustment, as a percent of GDP, are presented in row 1 of table 25. Equivalent variation as a percent of consumption and of GDP are taken from tables 11, 12 and 24 and presented in rows 2 and 3 of table 25. For row 4 of table 25, we recognize 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 shown in row 4 of table 25. Then, the ratio of the real household income gains to the adjustment costs of the policy changes are shown in row 5 as:

Ukraine-Turkey FTA = **116.9**

Ukraine-Turkey FTA plus reduction on non-discriminatory barriers against investment in Ukrainian services = **175.9**

Ukraine-Turkey FTA plus FDI spillovers to the World = **126.0**

These estimated values are extremely high by the standards of the usual benefit-cost analysis. If benefit-cost analysis is done for a project like building a road or bridge, a value greater than one shows a net benefit and is needed to justify the project. However, experience has shown that benefit-cost ratios in international trade analysis are typically much higher.

8. Caveats or Risks

We discuss three principal caveats or risks regarding the estimates. The title of this report, "Impact Assessment of a Successfully Implemented Potential Free Trade Agreement (FTA) between Ukraine and Turkey," highlights two of the principal risks.

Successful Conclusion of the Agreement. The Ukraine-Turkey FTA remains under negotiation. We have estimated a free trade agreement that is a modern "deep" agreement and also includes tariff elimination by both parties in our central scenario. We estimated that if some key sectors are excluded from the agreement, in particular agriculture and food, the gains would be significantly less. In addition, it remains to be seen how much of the deep reforms will be agreed, such as mutual acceptance of certificates of product conformity and measures to reduce time in trade costs. On the positive side, regarding time in trade, Ukraine could capitalize on the market opportunities afforded by the agreement independently of what is agreed on trade facilitation within the framework of the FTA. A considerable portion of the important time in trade cost reductions could be achieved by Ukraine by signing on to the European Union's "Common Transit System."

Successful Implementation of the Agreement. Even if Ukraine's trade negotiators succeed in bringing home a deep agreement with few important exclusions, successful implementation may be

challenging. Vested interests in either Ukraine or Turkey could lobby to resist reforms. A basis for optimism, however, is that Ukraine has shown that in recent years it is capable of making major transformative changes to its trade regime as part of its implementation of the DCFTA with the European Union. Access to Turkey's agriculture and food markets, however, may be challenging.

   Parameter Specification in the Model. The model requires a large number of parameters. The authors have employed the best estimates available from the literature and developed improved estimates of key AVEs for Ukraine. Nonetheless, the estimates are subject to a margin of error. In this report, the authors have quantified that margin of error by undertaking piecemeal sensitivity analysis. This analysis quantifies how the estimates vary with the parameters. The range of the estimates for the annual gains in Ukrainian real household income from the Ukraine-Turkey FTA is from 2.42 percent to 4.00 percent. With a central value of 2.72 percent gain in real household income, this preserves the principal story line of the report of significant gains from a successfully implemented potential FTA. In the case of the Ukraine-Turkey FTA plus non-discriminatory liberalization of barriers against service providers in business services, the estimated gains in the sensitivity analysis range from 4.00 to 5.81 percent increase in real household income. While this represents a larger margin of error than in FTA central, with a gain in real household income of 2.72 percent in FTA central, the conclusion that this wider liberalization of business services would significantly contribute to welfare is preserved for any estimate within that range.

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List of Tables

Table 1: Sectors, Factors of Production, Regions and their Ownership Shares in Business Services of Ukraine

Sectors (45)	model code		Regions of the Model and their Ownership Percentages in Business Services of Ukraine							
			Ukraine	Turkey	EU	USA	Russia	China	FTA regions*	Rest of World
Business Services with FDI (9)										
Telecommunication	TEL		7.04	11.75	23.30	0.17	5.36	0.00	52.00	0.38
Insurance	INS		83.64	0.00	11.46	0.51	0.00	0.00	4.39	0.00
Banking and other financial services	BNK		69.53	0.36	20.37	1.00	1.15	1.68	2.48	0.10
Air Transport	ATR		66.32	10.95	8.51	2.08	4.93	0.06	2.65	0.02
Land Transport	LTR		98.91	0.01	0.79	0.01	0.05	0.00	0.17	0.06
Water Transport	WTR		73.17	0.06	22.93	0.01	0.54	2.83	0.36	0.10
Computer programming	PRO		82.58	0.01	5.15	8.16	0.86	0.01	2.59	0.64
Professional services	LGL		94.45	0.00	2.92	0.04	0.27	0.00	2.30	0.03
Wholesale and retail trade	TRD		89.33	0.45	7.11	0.79	0.55	0.00	1.23	0.54
Imperfectly Competitive Goods (13)			*FTA regions* is the set of countries, other than the EU, with which Ukraine has a FTA.							
Fish products	FIS		FTA regions include: EFTA countries: Switzerland, Lichtenstein, Norway and Iceland;							
Fruits and vegetables	PRV		CIS countries: Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova,							
Fats and oils	OIL		Tajikistan,,Turkmenistan and Uzbekistan; Georgia, Montenegro, Macedonia.							
Grain mill products	MIL		Also included are three countries where negotiations for a FTA are underway:							
Other food products	OTF		Israel, Canada and the United Kingdom..							
Textiles	TEX									
Petroleum products and coke	COK									
Paper and prining products	PAP									
Pharmaceuticals	PHA									
Consumer electronics and optical equip.	CON				**Primary Factors of Production**					
Electronic components	ELT									
Transport Equipment	TRQ				Compensation of unskilled employees					
Electricity and gas	GAS				Compensation of skilled employees					
Perfectly Competitive Goods and Services (23)					Capital -- Gross operation surplus, mixed income					
Growing of crops	CRP				Payments to land and natural resources are included as part of capital;					
Animal production and fishing	ANM				these payments are treated as "sector-specific" capital.					
Forestry and logging	LOG									
Coal, crude oil and gas	ENE									
Mining of metal ores	ORE									
Other mining	MIN									
Meat products	PRM									
Dairy products	DAI									
Wearing apparel	WER									
Leather goods	LET									
Wood products	WOD									
Chemicals, fertilizers, rubber, plastics, paints	CHM									
Glass, clay, cement and stone	MNM									
Metals and metal products	MET									
Manufacture of Machinery	MAS									
Electric motors, equipment and batteries	ELC									
Furniture and jewelry	FUR									
Water, waste and steam activities	UTL									
Construction	CNS									
Transportation support activities	TRA									
Accomodation and food services	HOS									
Other private services	OPS									
Government services	PUB									

Source: Regional ownership share data from Kosse and Kravchuk (2020b). Sectors are aggregations in table 2 by authors' aggregation from the 85 sector Input-Output table.

Table 2: Sector Classification and Elasticities in the 85-sector dataset and mapping to the 45-sector model

Description of 85 model sectors	Mapping: 85 Sectors to 45 Sectors	45 Sector Model		85 sector model		
		3 letter code	Sector Classification	Sector Classification	4 letter code	elasticities of substitution: esub(M,M)*
Growing of crops, mixed farming	CROP+AGSP	CRP	CRTS	CRTS	CROP	5.3
Animal production; hunting, trapping and related service activities	ANIM + FISH	ANM	CRTS	CRTS	ANIM	6.7
Support activities to agriculture and post-harvest crop activities	CROP+AGSP			CRTS	AGSP	3.8*
Forestry and logging	one to one	LOG	CRTS	CRTS	LOGG	5
Fishing and aquaculture	ANIM + FISH		CRTS	CRTS	FISH	2.5
Mining of coal and lignite	COAL+CGAS	ENE	CRTS	CRTS	COAL	6.1
Extraction of crude petroleum and natural gas	COAL+CGAS			CRTS	CGAS	22.4
Mining of metal ores	one to one	ORE	CRTS	CRTS	ORES	1.8
Quarrying of stone, sand and clay	SAND+CHMN+OTMN	MIN	CRTS	CRTS	SAND	1.8
Mining of chemical and fertiliser minerals	SAND+CHMN+OTMN			CRTS	CHMN	1.8
Other mining and quarrying n.e.c., mining support service activities	SAND+CHMN+OTMN			CRTS	OTMN	1.8
Processing and preserving of meat and production of meat products	one to one	PRM	CRTS	CRTS	PRMT	8.25
Processing and preserving of fish, crustaceans and molluscs	one to one	FIS	IRTS	IRTS	PRFS	4
Processing and preserving of fruit and vegetables	one to one	PRV	IRTS	IRTS	PRFV	4
Manufacture of vegetable and animal oils and fats	one to one	OIL	IRTS	IRTS	OILS	6.6
Manufacture of dairy products	one to one	DAI	CRTS	CRTS	DAIR	7.3
Manufacture of grain mill products, starches and starch products	MILL + FEED	MIL	IRTS	IRTS	MILL	5.2
Manufacture of prepared animal feeds	MILL + FEED		IRTS	IRTS	FEED	4
Manufacture of other food products n.e.c.; beverages; tobacco products	one to one	OTF	IRTS	IRTS	OTFD	3.15
Manufacture of textiles	one to one	TEX	IRTS	IRTS	TEXT	7.5
Manufacture of wearing apparel	one to one	WER	CRTS	CRTS	WEAR	7.4
Manufacture of leather and related products	one to one	LET	CRTS	CRTS	LEAT	8.1
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of	one to one	WOD	CRTS	CRTS	WOOD	6.8
Manufacture of paper and paper products	PAPR+PRNT	PAP	IRTS	IRTS	PAPR	5.9
Printing and reproduction of recorded media	PAPR+PRNT			IRTS	PRNT	5.9
Manufacture of coke	COKE+PETR	COK	IRTS	IRTS	COKE	4.2
Manufacture of refined petroleum products	COKE+PETR			IRTS	PETR	4.2

Table 2 (continued)

Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	BSCH + AGCH + RUBB + PNTS+FIBR+SOAP	**CHM**	**CRTS**	CRTS	BSCH	6.6
Manufacture of pesticides and other agrochemical products	BSCH + AGCH + RUBB + PNTS+FIBR+SOAP		**CRTS**	CRTS	AGCH	6.6
Manufacture of paints, varnishes and similar coatings, printing ink and mastics	BSCH + AGCH + RUBB + PNTS+FIBR+SOAP		**CRTS**	CRTS	PNTS	6.6
Manufacture of man-made fibers	BSCH + AGCH + RUBB + PNTS+FIBR+SOAP		**CRTS**	CRTS	FIBR	6.6
Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations; other chemical products n.e.c.	BSCH + AGCH + RUBB + PNTS+FIBR+SOAP		**CRTS**	CRTS	SOAP	6.6
Manufacture of basic pharmaceutical products and pharmaceutical preparations	one to one	**PHA**	IRTS	IRTS	PHAR	6.6
Manufacture of rubber and plastic products	BSCH + AGCH + RUBB + PNTS+FIBR+SOAP		**CRTS**	CRTS	RUBB	6.6
Manufacture of glass and glass products	GLAS+CLAY+CEMT+STON	**MNM**	CRTS	CRTS	GLAS	5.8
Manufacture of refractoryproducts; clay building materials; other porcelain and ceramic products	GLAS+CLAY+CEMT+STON		**CRTS**	CRTS	CLAY	5.8
Manufacture of cement, lime and plaster; articles of concrete, cement and plaster	GLAS+CLAY+CEMT+STON		**CRTS**	CRTS	CEMT	5.8
Cutting, shaping and finishing of stone; manufacture of abrasive products and non-metallic mineral products n.e.c.	GLAS+CLAY+CEMT+STON		**CRTS**	CRTS	STON	5.8
Manufacture of basic metals	BSME + MEPR	**MET**	**CRTS**	CRTS	BSME	7.15
Manufacture of fabricated metal products, except machinery and equipment	BSME + MEPR		**CRTS**	CRTS	MEPR	7.5
Manufacture of general — purpose machinery	GPMA+OTMA+AGMA+MEMA+SPMA	**MAS**	**CRTS**	CRTS	GPMA	8.1
Manufacture of other general-purpose machinery	GPMA+OTMA+AGMA+MEMA+SPMA			CRTS	OTMA	8.1
Manufacture of agricultural and forestry machinery	GPMA+OTMA+AGMA+MEMA+SPMA			CRTS	AGMA	8.1
Manufacture of metal forming machineryand machine tools	GPMA+OTMA+AGMA+MEMA+SPMA			CRTS	MEMA	8.1
Manufacture of other special-purpose machinery	GPMA+OTMA+AGMA+MEMA+SPMA			CRTS	SPMA	8.1
Manufacture of computers and peripheral equipment	COMP+OPTC	**CON**	IRTS	IRTS	COMP	5.6
Manufacture of electronic components and boards, communication equipment	one to one	**ELT**	IRTS	IRTS	ELTR	5.6
Manufacture of consumer electronics, instruments and appliances for measuring, testing and navigation; watches and clocks; irradiation, electromedical and electrotherapeutic equipment; optical instruments and photographic equipment; f magnetic and optical media	COMP+OPTC			IRTS	OPTC	5.6
Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus; batteries and accumulators; wiring and wiring devices; electric lighting equipment; other electrical equipment	BATT+APPL	**ELC**	**CRTS**	CRTS	BATT	8.8
Manufacture of domestic appliances	BATT+APPL			CRTS	APPL	8.8
Manufacture of motor vehicles, trailers and semi-trailers	VEHL + TREQ	TRQ	IRTS	IRTS	VEHL	5.6
Manufacture of other transport equipment	VEHL + TREQ		IRTS	IRTS	TREQ	8.6
Manufacture of furniture; jewelry, musical instruments, toys; repair and installation of machinery and equipment	one to one	**FUR**	**CRTS**	CRTS	FURN	7.5
Electric power generation, transmission and distribution	ELEC + GAS	GAS	IRTS	IRTS	ELEC	5.6
Manufacture of gas; distribution of gaseous fuels through mains	ELEC + GAS		IRTS	IRTS	GASS	5.6
Steam and air conditioning supply	STEA+WCOL+WAST+SWRG	**UTL**	**CRTS**	CRTS	STEA	5.6
Water collection, treatment and supply	STEA+WCOL+WAST+SWRG			CRTS	WCOL	5.6
Waste collection, treatment and disposal activities; materials recovery	STEA+WCOL+WAST+SWRG			CRTS	WAST	5.6
Sewerage; remediation activities and other waste management services	STEA+WCOL+WAST+SWRG			CRTS	SWRG	5.6

Table 2 (continued)

Description	Mapping	Code				esub*
Construction	one to one	CNS	CRTS	CRTS	CNST	3.8
Wholesale and retail trade, including sale and repair of motor vehicles, parts and accessories	one to one	TRD	IRTS +FDI	IRTS +FDI	TRAD	3.8
Land transport and transport via pipelines	one to one	LTR	IRTS +FDI	IRTS +FDI	LTRA	2.0
Water transport	one to one	WTR	IRTS +FDI	IRTS +FDI	WTRA	2.0
Air transport	one to one	ATR	IRTS +FDI	IRTS +FDI	ATRA	2.0
Warehousing and support activities for transportation	one to one	TRA	CRTS	IRTS	TRAS	2.0
Postal and courier activities	PUBL+EDUC+HLTH + POST	PUB	CRTS	CRTS	POST	3.8
Accommodation and food service activities	one to one	HOS	CRTS	CRTS	HOSP	3.8
Publishing, motion picture, video, television programme production; sound recording, programming and broadcasting activities	REAL+RDEV+ADVR+RENT+ADMS+NGOS+OTHS + CRET+ARTS	OPS	CRTS	CRTS	CRET	3.8
Telecommunications	one to one	TEL	IRTS + FDI	IRTS +FDI	TELE	2.5
Computer programming, consultancy, and information service activities	one to one	PRO	IRTS + FDI	IRTS +FDI	PROG	3.8
Financial service activities, except insurance and pension funding	FINS+FAUX	BNK	IRTS + FDI	IRTS +FDI	FINS	2.9
Insurance, reinsurance and pension funding, except compulsorysocial security	one to one	INS	IRTS + FDI	IRTS +FDI	INSR	2.0
Activities auxiliary to financial services and insurance activities	FINS+FAUX			IRTS	FAUX	2.9
Real estate activities	REAL+RDEV+ADVR+RENT+ADMS+NGOS+OTHS + CRET+ARTS		CRTS	CRTS	REAL	3.8
Legal and accounting activities; activities of head offices; management consultancy activities; architectural and engineering activities; technical testing and analysis	one to one	LGL	IRTS + FDI	IRTS +FDI	LEGL	3.8
Scientific research and development	REAL+RDEV+ADVR+RENT+ADMS+NGOS+OTHS + CRET+ARTS			CRTS	RDEV	3.8
Advertising and market research; other professional, scientific and technical activities; veterinary activities	REAL+RDEV+ADVR+RENT+ADMS+NGOS+OTHS + CRET+ARTS			CRTS	ADVR	3.8
Rental and leasing activities	REAL+RDEV+ADVR+RENT+ADMS+NGOS+OTHS + CRET+ARTS			CRTS	RENT	3.8
Employment activities; travel agency, tour operator reservation service and related activities; security and investigation activities; services to buildings and landscape activities; office administrative, office support and other business support activities	REAL+RDEV+ADVR+RENT+ADMS+NGOS+OTHS + CRET+ARTS			CRTS	ADMS	3.8
Public administration and defense; compulsory social security	PUBL+EDUC+HLTH + POST			CRTS	PUBL	3.8
Education	PUBL+EDUC+HLTH + POST			CRTS	EDUC	3.8
Human health activities, residential care activities and social work activities without accommodation	PUBL+EDUC+HLTH + POST			CRTS	HLTH	3.8
Arts, entertainment and recreation	REAL+RDEV+ADVR+RENT+ADMS+NGOS+OTHS + CRET+ARTS			CRTS	ARTS	3.8
Activities of membership organisations	REAL+RDEV+ADVR+RENT+ADMS+NGOS+OTHS + CRET+ARTS			CRTS	NGOS	3.8
Other service activities; activities of households as employers of domestic personnel	REAL+RDEV+ADVR+RENT+ADMS+NGOS+OTHS + CRET+ARTS			CRTS	OTHS	3.8

Notes: *esub(M,M) in CRTS sectors is the elasticity of substitution between imports from different regions. In IRTS sectors, it is the Ukrainian Dixit-Stiglitz elasticity of substitution between different firms in the world.
Source: For elasticities, GTAP values documented in Hertel and van der Mensbrugge (2019) for all sectors except telecommunications, banking, insurance and all transportation sectors. For these latter (business services) sectors Movchan *et al*. (2020b appendix D). The mapping or aggregation from 85 to 45 sectors is defined by the authors.

Table 3: Value Added by sector and the shares of the components of value-added

Sectors	sector code	Total capital	mobile	sector specific	land and resources	skilled labor	unskilled labor	value-added % of cost	sector share of total value-added	value-added in millions UAH
			Capital components shares						**sector share of total value-added**	**value-added in millions UAH**
Business Services										
Wholesale and Retail Trade	TRD	62.2	72.1	27.9		25.1	12.8	53.2	16.1	404.7
Land transport	LTR	50.3	89.0	11.0		27.1	22.7	41.6	3.7	93.2
Water transport	WTR	38.8	95.9	4.1		33.3	27.9	19.1	0.0	1.1
Air transport,	ATR	44.6	96.5	3.5		30.2	25.3	24.6	0.6	15.1
Telecommunications,	TEL	59.4	97.2	2.8		31.7	8.9	49.4	1.0	25.0
Computer and information services	PRO	68.0	86.6	13.4		25.0	7.0	51.1	2.6	65.1
Insurance	INS	52.9	77.3	22.7		36.9	10.1	90.3	0.9	23.7
Banking and other financial services	BNK	50.7	81.9	18.1		38.7	10.6	64.7	2.1	53.4
Other professional services	LGL	37.0	86.3	13.7		46.3	16.6	45.3	1.7	43.5
Imperfectly Competitive Goods										
Fish products	FIS	11.9	94.1	5.9		48.2	39.9	6.7	0.1	1.8
Fruits and vegetables	PRV	39.1	80.4	19.6		33.3	27.5	17.6	0.2	4.7
Fats and oils	OIL	11.9	94.1	5.9		48.2	39.9	8.9	1.0	26.0
Grain mill products	MIL	11.9	94.1	5.9		48.2	39.9	19.3	0.3	7.1
Other food products	OTF	47.6	76.2	23.8		28.7	23.7	19.1	1.6	40.4
Textiles	TEX	39.5	80.3	19.7		33.1	27.4	50.6	0.2	4.1
Petroleum products and coke	COK	50.4	74.8	25.2		27.2	22.5	11.8	0.5	12.4
Paper and prining products	PAP	68.5	65.7	34.3		17.2	14.3	22.2	0.5	13.3
Pharmaceuticals	PHA	54.5	72.8	27.2		24.9	20.6	28.8	0.4	10.6
Consumer electronics and optical equip.	CON	43.0	78.5	21.5		31.2	25.8	30.9	0.3	8.1
Electronic components	ELT	18.6	90.7	9.3		44.6	36.8	16.0	0.1	2.8
Transport Equipment	TRQ	42.0	79.0	21.0		31.7	26.2	35.1	1.0	24.8
Electricity and gas	GAS	50.8	74.6	25.4		34.6	14.5	30.3	3.4	85.9
Perfectly Competitive Goods and Services										
Growing of crops	CRP	83.8	32.1		67.9	5.8	10.4	43.3	10.3	257.8
Animal production and fishing	ANM	85.7	31.4		68.6	5.3	9.1	27.7	1.3	33.2
Forestry and logging	LOG	20.8	37.5		62.5	43.5	35.7	69.2	0.6	15.7
Coal, crude oil and gas	ENE	71.4	51.6		48.4	12.4	16.2	60.2	4.4	109.6
Mining of metal ores	ORE	76.1	80.4		19.6	10.3	13.5	45.3	2.2	56.0
Other mining	MIN	27.5	79.5		20.5	31.4	41.1	32.6	0.5	13.2
Meat products	PRM	85.7	50.0		50.0	7.8	6.5	23.6	0.5	12.0
Dairy products	DAI	27.7	100.0			39.6	32.7	15.0	0.4	10.1
Wearing apparel	WER	39.5	100.0			33.1	27.4	51.5	0.3	8.2
Leather goods	LET	2.3	100.0			53.5	44.2	28.2	0.2	4.0
Wood products	WOD	17.6	100.0			45.1	37.3	17.4	0.4	9.8
Chemicals, fertilizers, rubber, plastics, paints	CHM	27.6	100.0			39.6	32.8	12.5	0.7	16.9
Glass, clay, cement and stone	MNM	38.7	100.0			33.6	27.8	16.4	0.6	15.1
Metals and metal products	MET	52.4	100.0			26.0	21.5	15.6	2.8	70.9
Manufacture of Machinery	MAS	35.6	100.0			35.3	29.1	32.5	0.8	20.4
Electric motors, equipment and batteries	ELC	9.0	100.0			49.8	41.2	30.0	0.2	3.9
Furniture and jewelry	FUR	43.8	100.0			30.8	25.4	36.1	1.0	25.8
Water, waste and steam activities	UTL	7.1	100.0			65.4	27.5	24.1	0.5	11.7
Construction	CNS	50.4	100.0			22.9	26.6	19.5	2.5	63.8
Transportation support activities	TRA	35.0	100.0			38.5	26.5	56.9	3.2	80.2
Accomodation and food services	HOS	57.4	100.0			29.5	13.1	48.1	0.7	18.3
Other private services	OPS	70.1	100.0			21.4	8.5	63.6	12.1	303.0
Government services	PUB	10.9	100.0			76.0	13.1	67.7	15.0	376.5

Source: Authors' calculations.

Table 4: Imports and Exports with Taxes on Imports: Total and with Turkey

Sector	code	Imports						Exports			
		Imports in millions of UAH	Percent of sector supply	Percent of total imports	imports from Turkey in mil. of UAH	duties as % of sector supply	import taxes % of sector supply	exports in millions of UAD	Percent of total exports	Percent of sector output	exports to Turkey mil. of UAH
Business Services	**code**										
Wholesale and Retail Trade	TRD	3.4	0.4	0.2			0.1	1.2	0.1	0.2	
Land transport	LTR	37.3	24.2	2.2				125.9	8.4	56.2	
Water transport	WTR	24.8	93.4	1.5	2.7			4.3	0.3	73.0	0.3
Air transport,	ATR	35.5	71.3	2.1	3.5			48.2	3.2	78.4	4.2
Telecommunications,	TEL	11.7	17.3	0.7	0.1			8.0	0.5	15.8	0.1
Computer and information services	PRO	17.4	20.9	1.0				72.2	4.8	56.8	
Insurance	INS	2.1	6.3	0.1	0.0			0.4	0.0	1.7	0.0
Banking and other financial services	BNK	15.0	13.9	0.9	0.1		0.0	2.1	0.1	2.6	0.0
Other professional services	LGL	9.5	8.7	0.6			0.0	13.6	0.9	14.1	
Imperfectly Competitive Goods											
Fish products	FIS	14.7	34.6	0.9	0.0	0.4	5.8	1.6	0.1	5.9	0.1
Fruits and vegetables	PRV	6.2	32.4	0.4	0.6	2.2	8.7	15.9	1.1	59.3	0.7
Fats and oils	OIL	6.3	20.2	0.4	0.0	2.6	7.0	271.8	18.2	92.7	5.1
Grain mill products	MIL	9.0	22.2	0.5	0.1	0.5	3.8	6.9	0.5	18.8	0.1
Other food products	OTF	53.8	18.2	3.2	0.8	0.3	3.2	41.9	2.8	19.8	0.9
Textiles	TEX	32.8	77.4	2.0	4.3	2.9	13.1	4.3	0.3	53.3	0.2
Petroleum products and coke	COK	141.9	44.0	8.5	0.3	0.2	24.0	11.4	0.8	10.8	0.2
Paper and prining products	PAP	29.4	35.7	1.8	0.6	0.1	6.3	13.5	0.9	22.5	0.1
Pharmaceuticals	PHA	51.9	59.4	3.1	0.7	0.1	4.6	5.3	0.4	14.4	0.0
Consumer electronics and optical equip.	CON	25.4	52.1	1.5	0.1	1.4	16.7	11.6	0.8	44.1	0.2
Electronic components	ELT	30.5	78.7	1.8	0.4	0.3	17.2	16.3	1.1	92.7	0.0
Transport Equipment	TRQ	123.6	59.6	7.4	4.3	2.2	14.6	18.1	1.2	25.6	0.5
Electricity and gas	GAS	0.0	0.0	0.0		0.0	0.0	7.8	0.5	2.8	
Perfectly Competitive Goods and Services											
Growing of crops	CRP	35.7	7.7	2.1	7.8	0.2	1.5	186.5	12.5	31.3	10.2
Animal production and fishing	ANM	6.5	5.0	0.4	0.2	0.0	0.7	0.3	0.0	0.2	0.0
Forestry and logging	LOG	0.1	0.4	0.0	0.0	0.0	0.0	1.6	0.1	7.0	0.0
Coal, crude oil and gas	ENE	201.0	46.4	12.0		0.0	8.0	7.3	0.5	4.0	
Mining of metal ores	ORE	8.9	12.7	0.5	0.0	0.2	2.3	64.4	4.3	52.1	1.8
Other mining	MIN	3.8	13.0	0.2	0.8	0.5	3.7	17.1	1.1	42.2	0.8
Meat products	PRM	6.7	12.2	0.4	0.0	0.1	1.6	4.2	0.3	8.2	0.1
Dairy products	DAI	2.7	4.5	0.2	0.0	0.0	0.7	11.3	0.8	16.8	0.5
Wearing apparel	WER	12.4	51.4	0.7	2.6	6.6	15.5	8.2	0.6	51.5	0.0
Leather goods	LET	13.8	63.4	0.8	0.3	5.9	13.7	9.3	0.6	65.8	0.0
Wood products	WOD	6.9	28.7	0.4	0.1	0.0	5.5	40.9	2.7	72.8	3.3
Chemicals, fertilizers, rubber, plastics, paints	CHM	212.5	60.3	12.7	5.0	1.0	13.5	43.9	2.9	32.6	2.0
Glass, clay, cement and stone	MNM	22.7	20.3	1.4	0.5	1.0	4.8	10.6	0.7	11.5	0.1
Metals and metal products	MET	98.6	31.4	5.9	4.8	0.5	5.2	259.2	17.4	57.0	24.2
Manufacture of Machinery	MAS	149.4	75.7	8.9	3.5	0.7	13.1	42.4	2.8	67.6	0.4
Electric motors, equipment and batteries	ELC	69.8	82.1	4.2	2.3	1.6	12.2	8.8	0.6	67.0	0.0
Furniture and jewelry	FUR	29.5	34.9	1.8	0.7	0.7	4.5	22.2	1.5	31.1	0.0
Water, waste and steam activities	UTL	2.4	4.6	0.1			0.2	0.2	0.0	0.5	
Construction	CNS	1.7	0.5	0.1				2.5	0.2	0.8	
Transportation support activities	TRA	3.0	2.1	0.2				8.6	0.6	6.1	
Accomodation and food services	HOS	30.2	46.8	1.8	8.9		0.0	5.4	0.4	14.1	0.2
Other private services	OPS	60.2	11.6	3.6	1.4		0.0	29.6	2.0	6.2	0.1
Government services	PUB	16.3	2.9	1.0	0.8		0.0	4.0	0.3	0.7	0.0

Source: Authors' calculations from data in WITS. https://wits.worldbank.org/

Table 5: Tax Rates by Sector

Sector	code	import duties		excise taxes		capital	labor	value-added taxes	
		all trade	Turkey	domestic	imports	taxes	taxes	domestic	imports
Business Services									
Wholesale and Retail Trade	TRD			0.6	36.5	8.6	37.4	3.7	
Land transport	LTR					17.3	53	9.7	
Water transport	WTR					15.7	32.3	5.3	
Air transport,	ATR					0.9	12.3	0.2	
Telecommunications,	TEL					6.9	32.3	9.8	
Computer and information services	PRO					10.9	26.2	2.3	
Insurance	INS					8.2	6.9	0.1	
Banking and other financial services	BNK					23.2	50.4	1.8	
Other professional services	LGL					25	39.6	14.8	
Imperfectly Competitive Goods									
Fish products	FIS	1.2	2.3			8.8	6.6	0.1	15.6
Fruits and vegetables	PRV	6.9	7.6			3.4	24.6	2.3	18.8
Fats and oils	OIL	12.8	16.6			5.9	3.8	0.4	19.3
Grain mill products	MIL	2.2	15.9			25	15.5	0.9	14.7
Other food products	OTF	1.6	9.9	30.6	0.8	5.9	30.4	6.2	14.9
Textiles	TEX	3.8	7.4			8.2	26	4.3	12.7
Petroleum products and coke	COK	0.6	1.2	8.9	28.3	5.6	19	0.3	25.5
Paper and prining products	PAP	0.3	2.3			5.7	47.8	2.6	17.3
Pharmaceuticals	PHA	0.1				15.2	48	0.3	7.6
Consumer electronics and optical equip.	CON	2.6	6.9			7.8	37.7	2.4	28.7
Electronic components	ELT	0.4	1.9			15.3	9.3	8.1	21.3
Transport Equipment	TRQ	3.6	11	0.1	2.9	8.3	49.4	1.7	17.2
Electricity and gas	GAS	2.6		1.7	9	18.4	35	6.5	59.6
Perfectly Competitive Goods and Services									
Growing of crops	CRP	2.1	6.7			7	45.2	3	17.6
Animal production and fishing	ANM	0.2				1.7	57.8	3.5	13.7
Forestry and logging	LOG					11.1	25.2	7.9	2.4
Coal, crude oil and gas	ENE			1.4		15.9	23.3	11.8	17.2
Mining of metal ores	ORE	2	1.4			16.6	32.4	0.1	16.1
Other mining	MIN	4	3.6			9.2	18.2	4	23.2
Meat products	PRM	0.7				1.3	59.3	1	12.5
Dairy products	DAI	0.1	13.9			7.1	23.4	1.6	14.2
Wearing apparel	WER	12.8	16.4			9.1	39.5	2.6	15.4
Leather goods	LET	9.2	12.3			25	22.6	1.9	11.3
Wood products	WOD	0.1				25	19.8	2	18.9
Chemicals, fertilizers, rubber, plastics, paints	CHM	1.7	5.5		0.6	12.4	44.3	1.5	19.8
Glass, clay, cement and stone	MNM	4.7	10.4			13	43	2.5	18.1
Metals and metal products	MET	1.5	3.7			12.1	38.5	1.2	15
Manufacture of Machinery	MAS	0.9	2.5			14.4	45	6.2	16.2
Electric motors, equipment and batteries	ELC	2	5			25	58.6	9.2	12.6
Furniture and jewelry	FUR	1.9	2.7			10.7	42.1	3.9	10.7
Water, waste and steam activities	UTL					25	56.6	5.1	5.3
Construction	CNS					11.2	35.5	2.1	
Transportation support activities	TRA					15	18.1	5.4	
Accomodation and food services	HOS			0.8		10.4	59.3	4.2	
Other private services	OPS					4.6	40.8	3.1	0.2
Government services	PUB					16.7	42.3	0.3	

Source: Authors' Calculations

Table 6: Percent of Total Imports in each Sector by Region of the Model*

Sector	code	Turkey	China	EU	Free Trade Region	Rest of World	Russia	USA
Business Services								
Wholesale and Retail Trade	TRD			66.9	9.2	22	1.2	0.6
Land transport	LTR			37.8	20.5	24	17.7	
Water transport	WTR	6.9	0.4	16.7	25.8	48		2.2
Air transport,	ATR	8.8	3	23.4	21.3	31.2		12.3
Telecommunications,	TEL	1.8		37.8	23.1	6.7	28	2.8
Computer and information services	PRO			26.8	25.7	13	1.3	33.2
Insurance	INS	2.4	2.7	50.8	18.1	17.6	1.5	7
Banking and other financial services	BNK	0.2	0.2	53	3.1	7	1.4	35.1
Other professional services	LGL			40	21	23.1	5.3	10.6
Imperfectly Competitive Goods								
Fish products	FIS	8.5		53.2	30.9	6.4		0.9
Fruits and vegetables	PRV	4.4	0.5	64.3	18.9	7.2	2.2	2.6
Fats and oils	OIL	1.9	10.1	27.6	8.2	51.8	0.1	0.4
Grain mill products	MIL	1.1	12.1	18.4	29.5	37.4	1.3	0.2
Other food products	OTF	2.1	0.7	17.9	49.8	23.7	4.1	1.7
Textiles	TEX	4.2	0.2	71.7	10	2.7	10.9	0.3
Petroleum products and coke	COK	2		79.3	6.9	8.2	3.4	0.2
Paper and prining products	PAP	0.7	0.2	29.6	29.7	6.2	33.6	
Pharmaceuticals	PHA	0.7	0.1	15.3	58.5	15.9	9	0.4
Consumer electronics and optical equip.	CON	1.4	2	32.6	12.8	25.6	11.4	14.2
Electronic components	ELT	0.2	1.7	80.2	11.7	4.5	0.7	0.9
Transport Equipment	TRQ	3	8.1	25	14.3	22.2	24.6	2.8
Electricity and gas	GAS			83.7	16	0.3		
Perfectly Competitive Goods and Services								
Growing of crops	CRP	5.5	5.8	36.2	5.7	46.7		
Animal production and fishing	ANM	4.3		34.5	8.5	46.3	0.9	5.4
Forestry and logging	LOG	2.4	0.7	94.3	1.6	0.9		
Coal, crude oil and gas	ENE			14.3	3.1	62.8	19.8	
Mining of metal ores	ORE	2.7	21.6	59.5	0.6	14.2	0.9	0.5
Other mining	MIN	4.7	0.5	47.9	11	7.8	28	
Meat products	PRM	1.8		38.2	24.9	35		
Dairy products	DAI	4.4	5.4	20.8	35.3	32.9	1	0.3
Wearing apparel	WER			91.8	3	1.4	3.2	0.6
Leather goods	LET	0.2		90.7	3.8	1.5	3.7	0.1
Wood products	WOD	8.2	6.5	65.1	8.4	9.4	1.7	0.8
Chemicals, fertilizers, rubber, plastics, paints	CHM	4.5	1.3	42.1	16.9	10.7	23.4	1.1
Glass, clay, cement and stone	MNM	1.2		43.6	32.2	1.9	20.3	0.8
Metals and metal products	MET	9.4	0.2	34.4	9.2	27.2	12.6	7.1
Manufacture of Machinery	MAS	1	2.3	29.5	19.3	9.2	38	0.7
Electric motors, equipment and batteries	ELC	0.2	0.6	80.3	6.6	2.8	8.6	0.9
Furniture and jewelry	FUR	0.1	0.2	73.1	14	4.2	7	1.5
Water, waste and steam activities	UTL					100		
Construction	CNS			23.6	43.7	27	2.9	2.8
Transportation support activities	TRA			27	34.1	23.4	14.9	0.7
Accomodation and food services	HOS	3.7		9.1	14.3	67.2	1.6	4.1
Other private services	OPS	0.4	4.6	31.3	15.5	27.5	9.1	11.5
Government services	PUB	0.9		30.1	2.8	61.6	3.3	1.3

*Shares in a sector may not sum to 100 due to rounding.
Source: Authors' calculations from data in WITS. https://wits.worldbank.org/

Table 7: Elasticities of Substitution* and Transformation

			Elasticities of substitution					
		elasticity of transformation	in CRTS sectors		IRTS goods	in IRTS Services		
Sector	code	domestic vs exports	between imports and domestic	between imports and other imports	between firms	in local: between domestic and FDI	between cross-border and local	between cross-border services
Business Services								
Wholesale and Retail Trade	TRD	4.0				3.8	1.9	3.8
Land transport	LTR	4.0				2.0	1.5	3.0
Water transport	WTR	4.0				2.0	1.5	3.0
Air transport,	ATR	4.0				2.0	1.5	3.0
Telecommunications,	TEL	4.0				2.5	1.5	3.0
Computer and information services	PRO	4.0				3.8	1.9	3.8
Insurance	INS	4.0				2.0	1.5	3.0
Banking and other financial services	BNK	4.0				2.9	1.5	3.0
Other professional services	LGL	4.0				3.8	1.9	3.8
Imperfectly Competitive Goods								
Fish products	FIS	4.0			4.0			
Fruits and vegetables	PRV	4.0			4.0			
Fats and oils	OIL	4.0			6.6			
Grain mill products	MIL	4.0			4.4			
Other food products	OTF	4.0			3.2			
Textiles	TEX	4.0			7.5			
Petroleum products and coke	COK	4.0			4.2			
Paper and prining products	PAP	4.0			5.9			
Pharmaceuticals	PHA	4.0			6.6			
Consumer electronics and optical equip.	CON	4.0			5.6			
Electronic components	ELT	4.0			5.6			
Transport Equipment	TRQ	4.0			5.8			
Electricity and gas	GAS	4.0			5.6			
Perfectly Competitive Goods and Services								
Growing of crops	CRP	4.0	2.6	5.3				
Animal production and fishing	ANM	4.0	2.2	4.5				
Forestry and logging	LOG	4.0	2.5	5.0				
Coal, crude oil and gas	ENE	4.0	7.9	15.8				
Mining of metal ores	ORE	4.0	0.9	1.8				
Other mining	MIN	4.0	0.9	1.8				
Meat products	PRM	4.0	4.1	8.3				
Dairy products	DAI	4.0	3.7	7.3				
Wearing apparel	WER	4.0	3.7	7.4				
Leather goods	LET	4.0	4.1	8.1				
Wood products	WOD	4.0	3.4	6.8				
Chemicals, fertilizers, rubber, plastics, paints	CHM	4.0	3.3	6.6				
Glass, clay, cement and stone	MNM	4.0	2.9	5.8				
Metals and metal products	MET	4.0	3.7	7.3				
Manufacture of Machinery	MAS	4.0	4.1	8.1				
Electric motors, equipment and batteries	ELC	4.0	4.4	8.8				
Furniture and jewelry	FUR	4.0	3.8	7.5				
Water, waste and steam activities	UTL	4.0	2.8	5.6				
Construction	CNS	4.0	1.9	3.8				
Transportation support activities	TRA	4.0	1.5	3.0				
Accomodation and food services	HOS	4.0	1.9	3.8				
Other private services	OPS	4.0	1.9	3.8				
Government services	PUB	4.0	1.9	3.8				

*Other elasticities of substitution: Elasticity of substitution between primary factors of production = 1; elasticity of substitution between value-added and business services = 1.25; elasticity of substitution between final goods = 1 (Cobb-Douglas); elasticity of substitution between intermediates = 0.
Source: Elasticities of substitution Authors' Calculations

Table 8: Supply elasticities by sector and region*

Sector	code	Region				Free Trade			
		Ukraine	Turkey	China	EU	Region	Russia	USA	Rest of World
Business Services									
Wholesale and Retail Trade	TRD	3.0	3.0		3.0	3.0	3.0	3.0	3.0
Land transport	LTR	3.0	3.0		3.0	3.0	3.0	3.0	3.0
Water transport	WTR	3.0	3.0	3.0	12.0	6.0	12.0	3.0	12.0
Air transport,	ATR	3.0	3.0		12.0	9.0	12.0		
Telecommunications,	TEL	3.0	3.0		18.0	9.0	18.0	9.0	18.0
Computer and information services	PRO	3.0	3.0	3.0	18.0	9.0	18.0	3.0	18.0
Insurance	INS	3.0			3.0	3.0			3.0
Banking and other financial services	BNK	2.6	2.6	2.6	2.6	7.7	2.6	2.6	2.6
Other professional services	LGL	3.0			18.0	9.0	18.0	3.0	18.0
Imperfectly Competitive Goods									
Fish products	FIS	3.0	3.0	3.0	3.0	3.0	3.0		3.0
Fruits and vegetables	PRV	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Fats and oils	OIL	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Grain mill products	MIL	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Other food products	OTF	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Textiles	TEX	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Petroleum products and coke	COK	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Paper and prining products	PAP	3.0	3.0	3.0	9.0	4.5	9.0	3.0	9.0
Pharmaceuticals	PHA	3.0	3.0	3.0	18.0	9.0	18.0	3.0	18.0
Consumer electronics and optical equip.	CON	3.0	3.0	3.0	15.8	7.9	15.8	3.0	15.8
Electronic components	ELT	3.0	3.0	3.0	15.0	7.5	15.0	3.0	15.0
Transport Equipment	TRQ	3.0	3.0	3.0	15.0	7.5	15.0	3.0	15.0
Electricity and gas	GAS	3.0				4.5		3.0	

*Elasticity of firm supply with respect to the price of output. A blank indicates no imports in goods or no FDI in business services, so no additional supply comes from these regions in response to price changes in Ukraine.
Source: Authors' calculations. For details see Movchan et al. (2020b, appendix E).

Table 9: Import Duties and Ad Valorem Equivalents of Barriers in Ukraine-Turkey Trade

Sector	code	Ukrainian import duties		Ad Valorem Equivalents (AVEs) of Ukrainian Barriers					Turkish barriers on Ukrainian exports		
		applied	applied	on imported	discriminatory	non-discriminatory	discriminatory	non-discriminatory	tariffs	AVEs of non-tariff barriers	
		average	on Turkey	goods	on FDI	on investmet	on cross-border services		on goods	on goods	cross-border services
Business Services											
Wholesale and Retail Trade	TRD				0	2.5	6.5	0			14
Land transport	LTR				0	31.4	0	56.8			41
Water transport	WTR				66	0	0	0			41
Air transport,	ATR				71	0	83	0			41
Telecommunications,	TEL				2.5	4.8	0	10.5			26
Computer and information services	PRO				0.2	0	0	0			0
Insurance	INS				11.8	10	44.2	0			26
Banking and other financial services	BNK				10.6	6.2	36.5	0			26
Other professional services	LGL				2	6.1	0	0			30
Imperfectly Competitive Goods											
Fish products	FIS	0.8	1	5.3					36.5	5.2	
Fruits and vegetables	PRV	4.8	3.5	5.4					16.4	5.2	
Fats and oils	OIL	1.1	1.2	6.1					18.6	5.2	
Grain mill products	MIL	3	9.1	5.6					20.7	5.2	
Other food products	OTF	2.3	5.8	5.6					75.2	5.2	
Textiles	TEX	2.6	4.4	6					3.9	5.2	
Petroleum products and coke	COK	0.1	0.2	6.8					1.1	5.2	
Paper and prining products	PAP			5					1.4	5.2	
Pharmaceuticals	PHA	0.1		6.1					2.8	5.2	
Consumer electronics and optical equip.	CON	2	5	7.6					2.3	5.2	
Electronic components	ELT	0.3	1.3	6.6					0.4	5.2	
Transport Equipment	TRQ	5.9	7.9	6.1					2.8	5.2	
Electricity and gas	GAS	1.9							0		
Perfectly Competitive Goods and Services											
Growing of crops	CRP	1.4	2.9	3.6					10.9	6	
Animal production and fishing	ANM	0.6		3.2					26.2	6	
Forestry and logging	LOG			3.2					5.3	6	
Coal, crude oil and gas	ENE			3.3					0	5.2	
Mining of metal ores	ORE	0.3	0.2	4.4					0	5.2	
Other mining	MIN	3.3	2.6	4.8					0	5.2	
Meat products	PRM	5.5		5.3					197.8	5.2	
Dairy products	DAI	5	7.7	5.4					176.5	5.2	
Wearing apparel	WER	7.8	9.9	7.1					11.7	5.2	
Leather goods	LET	5.2	6.3	5.8					11.1	5.2	
Wood products	WOD			4.8					0.8	5.2	
Chemicals, fertilizers, rubber, plastics, paints	CHM	1.4	4	6.1					4.3	5.2	
Glass, clay, cement and stone	MNM	3.8	7.2	4.8					3.6	5.2	
Metals and metal products	MET	1.1	2.4	5.7					7	5.2	
Manufacture of Machinery	MAS	0.7	1.6	6.9					2.7	5.2	
Electric motors, equipment and batteries	ELC	2	3.6	8.9					2.3	5.2	
Furniture and jewelry	FUR	1.2	1.4	5.4					2.2	5.2	
Water, waste and steam activities	UTL			1.6							

Source: Tariff rates are authors' calculations from data in WITS. https://wits.worldbank.org/. For AVEs in Ukrainian services from Kosse and Kravchuk (2020a); AVEs in Turkish cross-border services, Francois *et al.* (2009) except as noted in the text. AVEs on imports into Ukraine from appendix B (Movchan and Tarr, 2020); AVEs on imports of goods into Turkey from Kee *et al.* (2009).

Table 9A: Turkey's MFN Import Duties and Duties on Ukrainian Exports Compared
(Legal rates for all goods sectors in the 85-sector dataset.)

Sector Description	Sector Code	Turkey's import duty, MFN	Turkey's import duty faced by Ukraine, import weighted
Growing of crops, mixed farming	CROP	29.67	10.88
Animal production; hunting, trapping and related service activities	ANIM	25.21	26.19
Forestry and logging	LOGG	5.31	5.31
Fishing and aquaculture	FISH	26.50	30.37
Mining of coal and lignite	COAL	0.00	0.00
Extraction of crude petroleum and natural gas	CGAS	0.00	0.00
Mining of metal ores	ORES	0.07	0.00
Quarrying of stone, sand and clay	SAND	0.00	0.00
Mining of chemical and fertiliser minerals	CHMN	0.00	0.00
Other mining and quarrying n.e.c., mining support service activities	OTMN	0.02	0.00
Processing and preserving of meat and production of meat products	PRMT	105.38	197.77
Processing and preserving of fish, crustaceans and molluscs	PRFS	36.46	36.46
Processing and preserving of fruit and vegetables	PRFV	41.50	16.44
Manufacture of vegetable and animal oils and fats	OILS	17.35	18.60
Manufacture of dairy products	DAIR	130.37	176.46
Manufacture of grain mill products, starches and starch products	MILL	34.92	25.81
Manufacture of prepared animal feeds	FEED	5.09	6.81
Manufacture of other food products n.e.c.; beverages; tobacco products	OTFD	36.23	75.21
Manufacture of textiles	TEXT	6.80	3.94
Manufacture of wearing apparel	WEAR	11.02	11.74
Manufacture of leather and related products	LEAT	5.83	11.05
Manufacture of wood and wood products , except furniture	WOOD	2.92	0.80
Manufacture of paper and paper products	PAPR	0.08	1.43
Printing and reproduction of recorded media	PRNT	0.85	0.85
Manufacture of coke	COKE	0.00	0.00
Manufacture of refined petroleum products	PETR	0.81	1.10
Chemicals, fertilisers, plastics and synthetic rubber in primary forms	BSCH	4.87	4.36
Manufacture of pesticides and other agrochemical products	AGCH	5.98	6.00
Paints, varnishes and similar coatings, printing ink and mastics	PNTS	5.98	6.40
Manufacture of man-made fibres	FIBR	4.00	4.00
Soap, cleaning, polishing and toilet preparations, perfumes	SOAP	4.77	2.71
Pharmaceutical products and preparations	PHAR	1.66	2.75
Manufacture of rubber and plastic products	RUBB	4.74	4.86
Manufacture of glass and glass products	GLAS	4.92	4.03
Refractory products; clay building materials; other porcelain and ceramics	CLAY	4.19	3.45
Cement, lime and plaster and related articles	CEMT	1.69	1.70
Stone and non-metallic mineral products n.e.c.	STON	1.55	3.48
Manufacture of basic metals	BSME	4.58	6.97
Fabricated metal products, except machinery and equipment	MEPR	2.75	2.36
Manufacture of general — purpose machinery	GPMA	2.99	3.92
Manufacture of other general-purpose machinery	OTMA	1.49	0.74
Manufacture of agricultural and forestry machinery	AGMA	0.68	2.09
Manufacture of metal forming machinery and machine tools	MEMA	2.31	2.58
Manufacture of other special-purpose machinery	SPMA	1.46	2.07
Manufacture of computers and peripheral equipment	COMP	0.46	0.01
Electronic components and boards, communication equipment	ELTR	1.31	0.40
Consumer electronics, optical and electromedical equipment; instruments for measuring, testing and navigation; watches and clocks	OPTC	3.27	2.36
Electric motors, generators, transformers; batteries; other electrical equip.	BATT	2.60	2.27
Manufacture of domestic appliances	APPL	2.66	2.68
Manufacture of motor vehicles, trailers and semi-trailers	VEHL	6.49	3.12
Manufacture of other transport equipment	TREQ	2.59	2.03
Furniture; jewelry, musical instruments, toys; repair of machinery	FURN	2.45	2.23
Electric power generation, transmission and distribution	ELEC	0.00	0.00
Manufacture of gas; distribution of gaseous fuels through mains	GASS	0.00	0.00

Source: Authors' calculations based on data in WITS. https://wits.worldbank.org/.

Table 9B: Ukrainian Trade Weighted Import Duties for goods sectors of the 85-sector dataset by Region of the Model. (Legal rates in percent)

Sector Decription	Code	MFN	Turkey	China	Russia	USA	ROW	EU	Free Trade Region
Growing of crops, mixed farming	CROP	7.6	4.8	2.5	7.7	5.9	0.0	2.2	1.4
Animal production; hunting, trapping and related service activities	ANIM	4.7	1.3	0.4	2.6	0.4	4.7	1.2	0.4
Forestry and logging	LOGG	1.1	0.0	0.4	0.0	0.0	1.1	0.3	0.0
Fishing and aquaculture	FISH	2.6	0.0	15.1	15.0	6.2	2.6	0.2	0.0
Mining of coal and lignite	COAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Extraction of crude petroleum and natural gas	CGAS	0.5	0.5	0.5	0.0	0.5	0.5	0.0	0.0
Mining of metal ores	ORES	1.5	1.0	0.2	0.4	2.0	1.5	0.0	0.0
Quarrying of stone, sand and clay	SAND	8.3	6.0	7.6	9.6	10.3	9.9	2.9	0.1
Mining of chemical and fertiliser minerals	CHMN	2.0	2.0	1.6	2.0	2.0	2.0	0.0	1.0
Other mining and quarrying n.e.c., mining support service activities	OTMN	2.6	1.0	1.1	0.9	8.2	0.7	0.0	0.0
Processing and preserving of meat and production of meat products	PRMT	11.5	0.0	11.5	11.5	14.7	11.5	8.9	6.7
Processing and preserving of fish, crustaceans and molluscs	PRFS	2.9	1.7	3.2	2.9	0.7	2.9	0.9	0.6
Processing and preserving of fruit and vegetables	PRFV	10.2	5.4	11.0	11.4	6.4	12.8	4.6	0.7
Manufacture of vegetable and animal oils and fats	OILS	9.7	12.0	5.2	19.3	12.4	12.1	5.3	4.1
Manufacture of dairy products	DAIR	9.4	10.0	5.0	6.1	5.1	9.4	6.6	4.1
Manufacture of grain mill products, starches and starch products	MILL	15.3	11.5	5.0	8.0	7.7	5.0	1.9	0.0
Manufacture of prepared animal feeds	FEED	6.5	9.5	9.5	9.5	8.5	9.5	2.4	2.4
Manufacture of other food products n.e.c.; beverages; tobacco products	OTFD	8.7	7.2	4.0	3.8	3.1	4.4	2.6	0.7
Manufacture of textiles	TEXT	3.8	5.3	5.5	3.6	7.0	5.6	0.7	1.4
Manufacture of wearing apparel	WEAR	11.2	11.8	11.0	11.7	11.6	11.8	0.1	0.0
Manufacture of leather and related products	LEAT	7.7	8.8	10.6	5.5	12.7	9.6	1.5	1.9
Manufacture of wood and wood products , except furniture	WOOD	1.1	0.0	0.4	0.0	0.1	0.6	0.0	0.0
Manufacture of paper and paper products	PAPR	0.1	1.6	0.9	0.5	0.0	0.8	0.0	0.0
Printing and reproduction of recorded media	PRNT	0.8	0.4	1.1	1.5	0.0	0.0	0.0	0.0
Manufacture of coke	COKE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manufacture of refined petroleum products	PETR	1.4	0.9	1.4	1.2	0.1	0.9	0.3	0.0
Chemicals, fertilisers, plastics and synthetic rubber in primary forms	BSCH	3.1	3.4	2.2	2.5	1.8	1.1	0.4	0.1
Manufacture of pesticides and other agrochemical products	AGCH	1.0	2.1	2.0	0.0	2.0	1.8	0.0	1.0
Paints, varnishes and similar coatings, printing ink and mastics	PNTS	3.5	3.1	3.5	0.9	3.9	3.6	0.0	0.0
Manufacture of man-made fibres	FIBR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Soap, cleaning, polishing and toilet preparations, perfumes	SOAP	4.7	4.2	5.2	5.3	4.4	5.2	0.0	0.4
Pharmaceutical products and preparations	PHAR	0.9	0.0	1.2	0.1	0.0	0.0	0.0	0.0
Manufacture of rubber and plastic products	RUBB	4.8	5.0	5.3	5.2	5.4	5.0	0.7	0.4
Manufacture of glass and glass products	GLAS	8.2	8.4	7.6	8.1	6.3	7.6	3.2	0.1
Refractory products; clay building materials; other porcelain and ceramics	CLAY	7.4	5.8	7.6	6.2	7.0	7.3	0.7	0.3
Cement, lime and plaster and related articles	CEMT	6.9	9.3	5.8	9.8	5.4	5.1	0.4	0.2
Stone and non-metallic mineral products n.e.c.	STON	5.4	7.6	8.6	5.7	4.9	4.5	0.8	0.1
Manufacture of basic metals	BSME	0.5	0.1	0.2	0.1	1.0	0.8	0.0	0.0
Fabricated metal products, except machinery and equipment	MEPR	5.1	4.4	4.2	2.8	4.2	4.6	0.7	0.5
Manufacture of general — purpose machinery	GPMA	2.3	0.9	1.3	1.5	1.3	1.9	0.1	0.2
Manufacture of other general-purpose machinery	OTMA	2.6	2.0	1.8	1.3	1.0	1.1	0.3	0.1
Manufacture of agricultural and forestry machinery	AGMA	1.2	2.9	3.8	0.5	2.4	0.7	0.5	0.7
Manufacture of metal forming machinery and machine tools	MEMA	2.9	4.4	3.4	3.7	3.3	3.4	0.0	0.0
Manufacture of other special-purpose machinery	SPMA	1.7	1.0	1.3	1.0	0.4	1.6	0.4	0.3
Manufacture of computers and peripheral equipment	COMP	0.4	0.6	0.1	0.0	0.1	1.0	0.2	0.0
Electronic components and boards, communication equipment	ELTR	1.5	1.4	0.3	2.2	0.5	0.2	0.5	0.9
Consumer electronics, optical and electromedical equipment; instruments for measuring, testing and navigation; watches and clocks	OPTC	4.6	5.0	5.5	8.6	2.5	4.1	0.5	0.4
Electric motors, generators, transformers; batteries; other electrical equip.	BATT	3.4	1.8	2.2	2.7	2.0	2.2	0.9	0.4
Manufacture of domestic appliances	APPL	6.4	5.8	7.5	4.3	7.0	5.2	1.4	0.1
Manufacture of motor vehicles, trailers and semi-trailers	VEHL	6.1	8.0	4.5	5.2	7.5	8.1	5.7	3.0
Manufacture of other transport equipment	TREQ	4.2	5.1	6.9	0.5	0.6	2.7	0.7	0.1
Furniture; jewelry, musical instruments, toys; repair of machinery	FURN	6.1	1.9	2.4	3.3	1.4	2.7	0.5	0.3
Electric power generation, transmission and distribution	ELEC	3.5	3.5	3.5	2.0	3.5	3.5	0.0	0.0
Manufacture of gas; distribution of gaseous fuels through mains	GASS	2.0	2.0	2.0	2.0	2.0	2.0	0.0	0.0
Waste collection, treatment and disposal activities; materials recovery	WAST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Authors' calculations based on data in WITS. https://wits.worldbank.org/.

Table 10: Ukrainian Ad Valorem Equivalents of Time in Trade Costs by Trade Partner and Sector

Results are in percent of value of imports or exports		AVEs of Time in Trade Costs on Exports*							AVEs of Time in Trade Costs on Imports*						
Sector		Turkey	China	EU	Free Trade region	ROW	Russia	USA	Turkey	China	EU	Free Trade region	ROW	Russia	USA
Imperfectly Competitive Goods															
Fish products	FIS	3.2	38.6	4	7.2	26.5	5.8	34.5	3.4	40.7	8.1	12.3	30.5		34.8
Fruits and vegetables	PRV	3.2	38.6	4	7.2	26.5	5.8	34.5	3.4	40.7	8.1	12.3	30.5	9.9	34.8
Fats and oils	OIL	3.1	49.6	5.8	5.8	24.2	4.7	35.1	4.9	37.9	7.1	8.8	30.6	8.7	36.9
Grain mill products	MIL	3.2	38.6	4	7.2	26.5	5.8	34.5	3.4	40.7	8.1	12.3	30.5	9.9	34.8
Other food products	OTF	1.1	15.8	1.3	1.5	11	1.8	12.7	1.8	15.7	3	3.3	12.8	3.2	13.8
Textiles	TEX	0.4	3.8	1.6	1.7	7.5	1.4	9.2	1.8	19.2	3.2	3.2	12.3	3.6	8.2
Petroleum products and coke	COK	3.4	53.3	2.9	8.6	17.7	2.9	38.6	6.4	4	5.4	5.2	16.6	8.3	10.3
Paper and prining products	PAP	5.3	17	4	6.7	15.8	5.6	13.7	7.9	55.6	7.8	7.1	30.2	7.5	40.1
Pharmaceuticals	PHA	0.8	28.2	1.8	4.3	3.4	4.4	8.7	4.4	37.2	5.5	7.2	23.4	5.6	27.6
Consumer electronics and optical equip.	CON	1	12.3	1	2.1	10.2	2.2	15.8	2.1	23.4	2.9	5.1	19.5	2.9	14.6
Electronic components	ELT	1	12.3	1	2.1	10.2	2.2	15.8	2.1	23.4	2.9	5.1	19.5	2.9	14.6
Transport Equipment	TRQ	1.7	4.8	1.7	2.9	8	3.4	5.4	4.4	23.6	6.2	9.3	47.2	3.6	47.9
Electricity and gas	GAS														
Perfectly Competitive Goods and Services															
Growing of crops	CRP	5.8	39.3	9.4	6.6	42.5	4.5	36	8.8	60.1	12	14.8	48	10	62.9
Animal production and fishing	ANM	1.9	19.3	2.8	3.3	10.7	3.2	21	2	37	4	2.7	11.3	3.4	17.9
Forestry and logging	LOG	2	26.8	2	4.9	11.6	3		3.2	27.3	5.2	2.7	16	5.6	23.8
Coal, crude oil and gas	ENE														
Mining of metal ores	ORE												0.2		
Other mining	MIN												0.2		
Meat products	PRM	3.2	44.1	4.8	6.9	22.5	5				6.9	19.2	35.3		39.1
Dairy products	DAI	3.2	38.6	4	7.2	26.5	5.8	34.5	3.4	40.7	8.1	12.3	30.5	9.9	34.8
Wearing apparel	WER	1.2	18.2	1.9	4.9	10.4	2.1	16	2.2	20.4	3.3	2.6	15.6	4	16.8
Leather goods	LET	0.8	10.5	0.9	0.5	3.4	1.4	6.5	0.9	8.1	1.1	1.7	6.2	2.2	9.4
Wood products	WOD		1.9	0.4	0.3	2.6	0.5	1.7	0.8	5	1.3	1	3	1.7	9.5
Chemicals, fertilizers, rubber, plastics, paints	CHM	0.8	28.2	1.8	4.3	3.4	4.4	8.7	4.4	37.2	5.5	7.2	23.4	5.6	27.6
Glass, clay, cement and stone	MNM	3.2	33.3	2.9	5.1	13.4	3.6	28.2	2.7	45.9	5	1.9	18.7	6.9	31.9
Metals and metal products	MET		4.2	0.4	1	1.2	2.9	1.7	2.7	17	2.9	1.3	9.6	2.5	19.2
Manufacture of Machinery	MAS	0.8	11.7	1.2	2.3	8.4	1.9	14.6	1.7	18.2	3.2	4.6	11.7	3.4	23.3
Electric motors, equipment and batteries	ELC	0.8	11.7	1.2	2.3	8.4	1.9	14.6	1.7	18.2	3.2	4.6	11.7	3.4	23.3
Furniture and jewelry	FUR	1.6	25.9	2.2	2.9	8.5	2.6	7.8	3.2	26.4	4.7	2.3	17.7	3.2	20.2

*A blank indicates a value of zero.
Source: Authors trade-weighted aggregation from the estimates for the 85-sector dataset provided in appendix A.

Table 11: Impact on Ukraine of a Deep Free Trade Agreement with Turkey

(results are percentage change from initial equilibrium)

	Central Model with Monopolistically Competitive Sectors									
		Ukrainian Policies Toward Turkey						Turkey's Policies Toward Ukraine		
Scenario definitions	FTA Central: All policies by Ukraine and Turkey	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
Ukraine's Policies Toward Turkey	1	2	3	4	5	6	7	8	9	10
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
Turkey's Policies Toward Ukraine										
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
Aggregate welfare and real GDP										
Welfare (EV as % of consumption = % change in real household income)	2.72	0.01	0.04	0.68	0.54	0.03	0.15	1.14	0.05	0.02
Welfare (EV as % of GDP)	1.88	0.01	0.03	0.47	0.37	0.02	0.10	0.78	0.04	0.02
change in real GDP as % of GDP	2.12	0.02	0.03	0.48	0.38	0.03	0.14	0.92	0.04	0.03
Aggregate trade										
Real exchange rate	-0.1	0.0	0.0	0.1	-0.3	0.0	0.1	-0.1	0.0	0.0
Aggregate exports	3.2	0.2	0.0	0.7	0.5	0.1	0.2	1.5	0.1	0.0
Aggregate imports	2.4	0.1	0.0	0.5	0.3	0.0	0.1	1.2	0.1	0.0
Change in imports from Turkey	30.1	12.6	4.0	1.0	1.2	0.0	8.6	1.1	0.0	0.0
Change in imports from all other countries	1.4	-0.4	-0.1	0.5	0.3	0.0	-0.2	1.2	0.1	0.0
Government budget										
Tariff revenue (% of GDP)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Tariff Revenue	2.4	-1.3	0.2	1.9	0.8	0.0	0.0	1.0	0.1	0.0
Value Added Taxes total	1.0	0.0	0.0	0.2	0.2	0.0	0.0	0.5	0.0	0.0
Value Added Taxes on imorts	3.1	0.2	0.0	0.5	0.7	0.0	0.0	1.5	0.1	0.0
Value Added Taxes domestic	2.2	0.1	0.0	0.3	0.5	0.0	0.0	1.1	0.1	0.0
Excise Taxes on domestic	2.7	0.0	0.0	0.3	0.0	0.0	0.0	2.3	0.0	0.0
Excise Taxes on imports	2.9	0.0	0.0	0.4	0.3	0.0	0.1	1.6	0.2	0.2
Excise Taxes total	2.8	0.0	0.0	0.3	0.2	0.0	0.1	2.0	0.1	0.1
Factor Earnings										
Skilled labor earnings	1.5	0.1	0.0	0.4	0.1	0.0	0.1	0.6	0.0	0.1
Unskilled labor earnings	1.8	0.1	0.0	0.5	0.2	0.0	0.1	0.7	0.0	0.0
Capital earnings	1.6	0.1	0.0	0.4	0.1	0.0	0.1	0.8	0.0	0.0
Return to land and natural resources	5.2	0.2	0.0	0.5	2.9	0.0	0.1	1.3	0.0	-0.1
Specific Factors earnings in domestic firms	5.3	0.1	0.1	0.8	0.8	0.0	0.2	3.0	0.1	0.0
Specific Factors earnings in multinational firms in Ukraine	3.0	0.3	0.1	0.7	0.3	0.5	0.2	0.8	0.1	0.1
Factor Adjustments*										
Total labor	1.2	0.0	0.0	0.2	0.5	0.0	0.0	0.7	0.1	0.1
Skilled labor	1.0	0.0	0.0	0.2	0.4	0.0	0.0	0.6	0.0	0.1
Unskilled labor	1.5	0.1	0.0	0.2	0.7	0.0	0.0	0.9	0.1	0.1
Capital	1.2	0.0	0.0	0.2	0.5	0.0	0.0	0.6	0.1	0.1

*Percentage of the factor that must change sectors.

Source: Authors' estimates.

Table 12: Aggregate Impacts of Reduction of Non-Discriminatory Barriers to Investment in Business Services to Ukraine and all external Regions

(results are percentage change from initial equilibrium)

	Central Model with Monopolistically Competitive Sectors		
Scenario definitions	**Only FTA Central***	**FTA Central Plus Reduction of Non-Discriminatory Barriers Against Investment in Ukrainian Services for all regions including Ukraine**	**Only Reduction of Non-Discriminatory Barriers Against Investment in Ukrainian Services for all regions including Ukraine**
	1	2	2
All Policies of FTA Central	Yes	Yes	No
Services Liberalization: 25% reduction in *non-discriminatory* barriers against investment in Business Services applied to Ukraine and all regions	no	Yes	Yes
Aggregate welfare and real GDP			
Welfare (EV as % of consumption)	2.72	4.76	2.03
Welfare (EV as % of GDP)	1.88	3.28	1.40
change in real GDP as % of GDP	2.12	3.67	1.56
Aggregate trade			
Real exchange rate	-0.1	0.4	0.5
Aggregate exports	3.2	5.0	1.8
Aggregate imports	2.4	3.9	1.5
Change in imports from Turkey	30.1	32.6	2.0
Change in imports from all other countries	1.4	2.8	1.5
Government budget			
Tariff revenue (% of GDP)	0.7	0.7	0.7
Tariff Revenue	2.4	3.5	1.2
Value Added Taxes total	1.0	1.7	0.7
Value Added Taxes on imorts	3.1	4.3	1.2
Value Added Taxes domestic	2.2	3.2	1.0
Excise Taxes on domestic	2.7	4.0	1.4
Excise Taxes on imports	2.9	3.9	0.9
Excise Taxes total	2.8	4.0	1.2
Factor Earnings			
Skilled labor earnings	1.5	2.7	1.2
Unskilled labor earnings	1.8	3.0	1.3
Capital earnings	1.6	2.7	1.1
Specific Factors earnings (land and natural resoures)	5.2	7.0	1.7
Specific Factors earnings (IRTS domestic firms)	5.3	10.5	5.0
Specific Factors earnings (multinationals)	3.0	4.7	1.8
Factor Adjustments**			
Total labor	1.2	1.4	0.3
Skilled labor	1.0	1.2	0.3
Unskilled labor	1.5	1.8	0.4
capital	1.2	1.5	0.4

*See table 11 for policies in FTA central.

**Percentage of the factor that must change sectors.

Source: Authors' estimates

Table 13: Change in Ukrainian Output by sector from a Deep Free Trade Agreement with Turkey, with decomposed effects

(results are percentage change from initial equilibrium)

Scenario definitions in detail: See Summary Table Ukraine-Turkey FTA		Central Model (with imperfectly competitive sectors)									
			Ukrainian Policies Toward Turkey						Turkey's Policies Toward Ukraine		
		FTA Central: All policies by Ukraine and Turkey	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
		1	2	3	4	5	6	7	8	9	10
Business Services	code										
Wholesale and Retail Trade	TRD	2.4	0.1	0.0	0.6	0.8	0.0	0.0	0.9	0.0	0.0
Land transport	LTR	-2.9	0.0	0.0	0.1	-0.9	0.0	0.0	-1.8	-0.2	-0.1
Water transport	WTR	4.1	0.0	0.0	0.3	-0.1	0.0	0.0	-0.4	0.0	4.3
Air transport,	ATR	6.4	0.0	0.0	0.0	-0.6	-0.5	2.2	-1.1	-0.1	6.6
Telecommunications,	TEL	0.3	0.0	0.0	0.3	0.0	0.0	0.0	-0.4	-0.1	0.4
Computer and information services	PRO	-12.0	-0.2	-0.1	-1.7	-3.2	0.0	0.0	-6.3	-0.5	-0.3
Insurance	INS	1.0	0.1	0.0	0.2	0.4	0.0	0.0	0.2	0.0	0.1
Banking and other financial services	BNK	0.9	0.0	0.0	0.2	0.4	0.0	0.0	0.2	0.0	0.0
Other professional services	LGL	-0.3	0.0	0.0	0.1	-0.2	0.0	0.1	-0.3	0.0	0.0
Imperfectly Competitive Goods											
Fish products	FIS	2.0	0.0	0.0	-0.7	0.1	0.0	0.1	2.2	0.0	0.0
Fruits and vegetables	PRV	7.8	0.1	0.0	0.8	-3.2	0.0	0.0	9.2	0.3	-0.2
Fats and oils	OIL	8.2	0.9	0.2	1.7	8.7	0.0	-0.1	-2.6	-0.3	-0.2
Grain mill products	MIL	0.3	-0.1	0.0	-0.2	-0.2	0.0	0.0	0.6	0.0	0.0
Other food products	OTF	10.8	0.0	0.0	0.5	-0.2	0.0	0.1	10.0	0.0	0.0
Textiles	TEX	-6.2	0.9	0.3	-0.4	-2.6	0.0	0.0	-3.9	0.0	-0.3
Petroleum products and coke	COK	0.0	0.0	0.0	-0.5	0.0	0.0	0.1	0.3	0.1	0.1
Paper and prining products	PAP	0.7	0.1	0.0	0.2	0.3	0.0	0.0	0.2	-0.1	-0.1
Pharmaceuticals	PHA	-3.0	0.0	0.0	0.0	-0.6	0.0	0.0	-1.8	-0.2	-0.1
Consumer electronics and optical equip.	CON	-2.6	0.2	0.1	-0.3	-0.1	0.0	0.0	-2.1	0.0	-0.2
Electronic components	ELT	-27.5	-0.1	0.0	26.1	-10.0	0.3	-0.2	-28.2	-2.7	-2.0
Transport Equipment	TRQ	-4.8	-0.1	0.0	-2.1	-0.7	0.0	0.0	-1.6	0.0	-0.1
Electricity and gas	GAS	0.7	0.0	0.0	0.1	-0.2	0.0	0.0	0.7	0.1	-0.1
Perfectly Competitive Goods and Services											
Growing of crops	CRP	3.6	0.1	0.0	0.3	2.8	0.0	0.0	0.4	0.0	-0.1
Animal production and fishing	ANM	5.2	0.0	0.0	0.5	1.1	0.0	0.0	3.3	0.0	0.0
Forestry and logging	LOG	-6.8	0.1	0.0	-0.4	-2.6	0.0	-0.1	-4.1	0.5	-0.3
Coal, crude oil and gas	ENE	-1.8	0.0	0.0	-0.2	-0.8	0.0	0.0	-0.7	0.0	-0.1
Mining of metal ores	ORE	-3.2	0.0	0.0	-0.4	-2.8	0.0	-0.1	-0.1	0.5	-0.3
Other mining	MIN	-2.0	-0.1	0.0	-0.2	-1.0	0.0	0.0	-0.8	0.1	-0.1
Meat products	PRM	6.6	0.0	0.0	0.3	0.4	0.0	0.1	5.5	0.0	0.0
Dairy products	DAI	29.8	0.0	0.0	0.5	0.8	0.0	0.1	26.9	0.0	0.0
Wearing apparel	WER	-10.1	-3.6	-0.2	-0.8	-1.4	0.0	0.0	-3.6	-0.3	-0.2
Leather goods	LET	-7.9	0.2	0.1	1.0	-2.7	0.1	0.0	-5.6	-0.4	-0.3
Wood products	WOD	-8.4	0.1	0.0	-0.3	-3.2	0.0	-0.1	-5.2	0.6	-0.3
Chemicals, fertilizers, rubber, plastics, paint	CHM	1.9	0.1	0.0	0.4	0.8	0.0	0.0	0.7	0.1	-0.1
Glass, clay, cement and stone	MNM	-0.3	-0.1	0.0	-0.3	-0.3	0.0	0.0	0.4	0.1	-0.1
Metals and metal products	MET	1.2	0.0	0.0	-0.2	-2.7	0.0	-0.1	3.6	0.9	-0.3
Manufacture of Machinery	MAS	-9.3	0.2	0.1	-0.7	-3.0	0.1	0.0	-5.4	-0.1	-0.5
Electric motors, equipment and batteries	ELC	-11.5	-0.1	0.0	-0.5	-3.6	0.1	0.0	-6.4	-0.6	-0.4
Furniture and jewelry	FUR	-2.6	0.1	0.0	-0.6	-0.7	0.0	0.0	-1.2	0.0	-0.1
Water, waste and steam activities	UTL	1.1	0.0	0.0	0.9	-0.4	-0.1	0.2	-0.1	0.0	0.9
Construction	CNS	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Transportation support activities	TRA	1.8	0.1	0.0	0.3	0.6	0.0	0.0	0.6	0.0	0.1
Accomodation and food services	HOS	0.1	0.0	0.0	0.3	-0.1	0.0	0.0	0.0	0.0	0.0
Other private services	OPS	0.5	0.0	0.0	0.2	0.1	0.0	0.0	0.2	0.0	0.1
Government services	PUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Authors' estimates.

Table 14: Change in Ukrainian Prices by sector from a Deep Free Trade Agreement with Turkey

Results are the percentage change from benchmark value.

		Central Model (with imperfectly competitive sectors)									
		Ukrainian Policies Toward Turkey							Turkey's Policies Toward Ukraine		
Scenario definitions in detail: See Summary Table Ukraine-Turkey FTA		FTA Central: All policies by Ukraine and Turkey	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
		1	2	3	4	5	6	7	8	9	10
Business Services	**code**										
Wholesale and Retail Trade	TRD	0.9	0.0	0.0	0.2	0.0	0.0	0.1	0.5	0.0	0.0
Land transport	LTR	0.8	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.0	0.0
Water transport	WTR	-0.2	0.0	0.0	0.1	-0.3	0.0	0.1	-0.1	0.0	-0.1
Air transport,	ATR	-7.7	0.1	0.0	0.1	-0.2	-1.0	-6.0	0.1	0.0	-0.9
Telecommunications,	TEL	0.4	0.1	0.0	0.1	-0.1	-0.1	0.1	0.5	0.0	-0.1
Computer and information services	PRO	0.2	0.0	0.0	0.2	-0.3	0.0	0.1	0.0	0.0	0.0
Insurance	INS	0.7	0.0	0.0	0.2	-0.2	0.0	0.1	0.4	0.0	0.0
Banking and other financial services	BNK	0.9	0.1	0.0	0.3	-0.1	0.0	0.1	0.5	0.0	0.0
Other professional services	LGL	1.0	0.1	0.0	0.2	0.0	0.0	0.1	0.5	0.0	0.0
Imperfectly Competitive Goods											
Fish products	FIS	-0.3	0.0	0.0	-0.3	-0.1	0.0	0.1	0.0	0.0	0.0
Fruits and vegetables	PRV	-0.9	-0.2	-0.1	-0.5	0.2	0.0	0.1	-0.5	0.0	0.0
Fats and oils	OIL	0.1	0.0	0.0	-0.4	-0.4	0.0	0.1	0.7	0.0	0.0
Grain mill products	MIL	0.8	0.0	0.0	0.0	0.3	0.0	0.1	0.4	0.0	0.0
Other food products	OTF	-1.3	0.0	0.0	-0.1	0.0	0.0	0.1	-1.4	0.0	0.0
Textiles	TEX	-1.1	-0.6	-0.2	-0.3	-0.2	0.0	0.1	0.0	0.0	0.0
Petroleum products and coke	COK	-0.2	0.0	0.0	-0.1	-0.3	0.0	0.1	0.0	0.0	0.0
Paper and prining products	PAP	-0.4	0.0	0.0	-0.3	-0.3	0.0	0.1	0.1	0.0	0.0
Pharmaceuticals	PHA	-0.5	0.0	0.0	-0.5	-0.3	0.0	0.1	0.0	0.0	0.0
Consumer electronics and optical equip.	CON	-0.6	0.0	0.0	-0.4	-0.3	0.0	0.1	0.0	0.0	0.0
Electronic components	ELT	-1.0	0.0	0.0	-0.9	-0.3	0.0	0.1	0.0	0.0	0.0
Transport Equipment	TRQ	-1.2	0.0	0.0	-0.9	-0.3	0.0	0.1	-0.1	0.0	0.0
Electricity and gas	GAS	0.7	0.1	0.0	0.2	-0.1	0.0	0.1	0.4	0.0	0.0
Perfectly Competitive Goods and Services											
Growing of crops	CRP	1.8	0.0	0.0	0.0	1.1	0.0	0.1	0.5	0.0	0.0
Animal production and fishing	ANM	1.4	0.0	0.0	0.0	0.2	0.0	0.1	1.0	0.0	0.0
Forestry and logging	LOG	0.5	0.1	0.0	0.3	-0.2	0.0	0.1	0.1	0.1	0.0
Coal, crude oil and gas	ENE	0.2	0.0	0.0	0.1	-0.3	0.0	0.1	0.1	0.0	0.0
Mining of metal ores	ORE	1.2	0.0	0.0	0.2	-0.2	0.0	0.1	0.9	0.1	0.0
Other mining	MIN	0.9	0.0	0.0	0.2	0.0	0.0	0.1	0.6	0.0	0.0
Meat products	PRM	0.1	0.0	0.0	0.1	0.0	0.0	0.1	-0.1	0.0	0.0
Dairy products	DAI	-3.7	0.0	0.0	0.1	-0.1	0.0	0.1	-3.8	0.0	0.0
Wearing apparel	WER	-2.3	-1.8	-0.2	-0.3	-0.2	0.0	0.1	0.2	0.0	0.0
Leather goods	LET	-0.1	-0.1	0.0	-0.1	-0.2	0.0	0.1	0.2	0.0	0.0
Wood products	WOD	1.1	0.0	0.0	0.1	0.1	0.0	0.1	0.7	-0.1	0.0
Chemicals, fertilizers, rubber, plastics, paint	CHM	-0.6	-0.1	0.0	-0.4	-0.3	0.0	0.1	0.0	0.0	0.0
Glass, clay, cement and stone	MNM	0.1	0.0	0.0	-0.1	-0.1	0.0	0.1	0.3	0.0	0.0
Metals and metal products	MET	-0.2	0.0	0.0	-0.1	0.0	0.0	0.1	-0.2	-0.1	0.0
Manufacture of Machinery	MAS	-0.4	0.0	0.0	-0.3	-0.3	0.0	0.1	0.0	0.0	0.0
Electric motors, equipment and batteries	ELC	-0.6	-0.1	-0.1	-0.3	-0.3	0.0	0.1	0.0	0.0	0.0
Furniture and jewelry	FUR	0.1	0.0	0.0	-0.2	-0.1	0.0	0.1	0.3	0.0	0.0
Water, waste and steam activities	UTL	0.7	0.0	0.0	0.2	0.0	0.0	0.1	0.3	0.0	0.0
Construction	CNS	0.5	0.0	0.0	0.1	-0.1	0.0	0.1	0.3	0.0	0.0
Transportation support activities	TRA	1.1	0.1	0.0	0.3	0.0	0.0	0.1	0.5	0.0	0.0
Accomodation and food services	HOS	0.6	0.0	0.0	0.2	-0.1	0.0	0.1	0.2	0.0	0.0
Other private services	OPS	1.2	0.1	0.0	0.3	0.0	0.0	0.1	0.6	0.0	0.0
Government services	PUB	1.2	0.1	0.0	0.3	0.0	0.0	0.1	0.5	0.0	0.0

Source: Authors' estimates.

Table 15: Change in Ukrainian Imports by sector from a Deep Free Trade Agreement with Turkey, with decomposed effects

The results are percentage change from initial equilibrium		Central Model (with imperfectly competitive sectors)									
		Ukrainian Policies Toward Turkey							Turkey's Policies Toward Ukraine		
Scenario definitions in detail: See Summary Table Ukraine-Turkey FTA		FTA Central: All policies by Ukraine and Turkey	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
		1	2	3	4	5	6	7	8	9	10
Business Services	code										
Wholesale and Retail Trade	TRD	4.0	0.1	0.1	0.8	0.9	0.0	0.2	1.7	0.1	0.0
Land transport	LTR	3.7	0.1	0.0	0.6	0.7	0.0	0.1	1.9	0.1	0.0
Water transport	WTR	2.2	0.1	0.0	0.4	0.4	0.0	0.1	0.9	0.1	0.2
Air transport,	ATR	1.5	0.0	0.0	0.6	0.2	-1.0	-0.2	0.8	0.0	0.8
Telecommunications,	TEL	2.6	0.0	0.0	0.6	0.5	-0.1	0.2	1.2	0.1	0.1
Computer and information services	PRO	-6.1	-0.1	0.0	-0.6	-1.9	0.1	0.1	-3.4	-0.3	-0.1
Insurance	INS	2.9	0.1	0.0	0.7	0.6	0.0	0.2	1.1	0.0	0.1
Banking and other financial services	BNK	3.1	0.1	0.0	0.6	0.7	0.0	0.2	1.2	0.0	0.1
Other professional services	LGL	2.8	0.1	0.0	0.6	0.4	0.0	0.2	1.3	0.1	0.1
Imperfectly Competitive Goods											
Fish products	FIS	3.7	0.0	0.0	1.8	0.7	0.0	0.2	0.9	0.1	0.1
Fruits and vegetables	PRV	4.8	0.2	0.1	1.2	0.8	0.0	0.2	2.2	0.0	0.0
Fats and oils	OIL	6.6	-0.2	0.0	2.6	0.6	0.0	0.2	3.0	0.1	0.1
Grain mill products	MIL	7.1	0.1	0.1	1.8	1.8	0.0	0.2	2.8	0.1	0.0
Other food products	OTF	1.0	0.1	0.0	0.6	1.0	0.0	0.2	-1.1	0.1	0.0
Textiles	TEX	0.3	-0.6	0.0	0.4	0.1	0.0	0.2	0.3	0.0	0.0
Petroleum products and coke	COK	2.2	0.1	0.0	0.5	-0.1	0.0	0.2	1.3	0.1	0.1
Paper and prining products	PAP	5.9	0.0	0.0	0.9	0.5	0.0	0.2	4.0	0.0	0.0
Pharmaceuticals	PHA	0.9	0.0	0.0	2.3	-0.2	0.1	0.2	-0.6	-0.1	-0.1
Consumer electronics and optical equip.	CON	1.7	0.0	0.0	0.5	0.1	0.0	0.2	0.8	0.0	0.0
Electronic components	ELT	0.8	0.0	0.0	0.3	0.0	0.0	0.1	0.4	0.0	0.0
Transport Equipment	TRQ	1.3	0.0	0.0	0.2	0.2	0.0	0.2	0.7	0.0	0.0
Electricity and gas	GAS	3.2	0.1	0.0	0.5	0.2	0.0	0.1	2.0	0.2	0.0
Perfectly Competitive Goods and Services											
Growing of crops	CRP	15.0	1.4	0.3	3.7	7.1	0.0	0.1	1.8	-0.1	-0.1
Animal production and fishing	ANM	9.3	0.0	0.1	0.7	2.0	0.0	0.2	5.8	0.1	0.0
Forestry and logging	LOG	-5.0	0.2	0.0	0.6	-2.6	0.1	0.1	-3.7	0.7	-0.3
Coal, crude oil and gas	ENE	2.9	0.1	0.0	0.2	-0.3	0.0	0.1	2.3	0.2	0.0
Mining of metal ores	ORE	1.2	0.0	0.0	-0.1	-2.7	0.1	0.1	3.4	0.8	-0.3
Other mining	MIN	1.3	-0.1	0.0	0.2	-0.2	0.0	0.1	1.2	0.0	0.0
Meat products	PRM	4.8	0.0	0.0	1.8	1.5	0.0	0.3	0.9	0.1	0.1
Dairy products	DAI	-3.7	0.2	0.1	1.6	1.3	0.0	0.2	-6.8	0.1	0.1
Wearing apparel	WER	4.8	0.8	0.1	0.9	0.7	0.0	0.2	1.7	0.1	0.1
Leather goods	LET	3.2	0.0	0.0	0.6	0.7	0.0	0.2	1.5	0.1	0.1
Wood products	WOD	3.1	0.0	0.0	0.4	0.5	0.0	0.2	1.8	0.0	0.0
Chemicals, fertilizers, rubber, plastics, paint	CHM	3.0	0.1	0.0	0.3	0.8	0.0	0.1	1.7	0.0	-0.1
Glass, clay, cement and stone	MNM	3.4	0.2	0.0	0.9	0.0	0.0	0.1	1.8	0.1	0.0
Metals and metal products	MET	1.1	0.2	0.1	0.3	-0.7	0.0	0.1	0.9	0.2	-0.1
Manufacture of Machinery	MAS	0.5	0.0	0.0	-0.2	-0.1	0.0	0.1	0.6	0.0	0.0
Electric motors, equipment and batteries	ELC	0.4	-0.1	0.0	0.1	-0.1	0.0	0.1	0.3	0.0	0.0
Furniture and jewelry	FUR	4.4	0.0	0.1	1.5	0.5	0.0	0.2	1.9	0.1	0.1
Water, waste and steam activities	UTL	3.3	0.0	0.0	1.1	0.1	-0.1	0.4	1.0	0.00	0.9
Construction	CNS	1.2	0.0	0.0	0.0	0.2	0.0	0.1	0.8	0.0	0.1
Transportation support activities	TRA	3.9	0.2	0.0	0.6	0.9	0.0	0.2	1.6	0.1	0.2
Accomodation and food services	HOS	3.1	0.0	0.0	0.7	0.7	0.0	0.2	1.3	0.1	0.1
Other private services	OPS	3.5	0.1	0.0	0.7	0.6	0.0	0.2	1.7	0.1	0.1
Government services	PUB	2.5	0.1	0.0	0.5	0.4	0.0	0.1	1.1	0.1	0.1

Source: Authors' estimates

Table 16: Change in Ukrainian exports by sector from a Deep Free Trade Agreement with Turkey, with decomposed effects

The results are percentage change from initial equilibrium		Central Model (with imperfectly competitive sectors)									
			Ukrainian Policies Toward Turkey						Turkey's Policies Toward Ukraine		
Scenario definitions in detail: See Summary Table Ukraine-Turkey FTA		FTA Central: All policies by Ukraine and Turkey	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
		1	2	3	4	5	6	7	8	9	10
Business Services	code										
Wholesale and Retail Trade	TRD	-2.0	0.1	0.0	0.4	-0.9	0.0	0.1	-1.4	-0.2	-0.1
Land transport	LTR	-6.1	0.0	0.0	0.1	-2.2	0.1	0.1	-3.7	-0.4	-0.2
Water transport	WTR	4.8	0.0	0.0	0.4	-0.5	0.0	0.1	-0.6	-0.1	5.6
Air transport,	ATR	8.3	0.0	0.0	0.1	-0.9	0.1	2.5	-1.1	-0.1	7.7
Telecommunications,	TEL	-2.8	-0.1	0.0	0.0	-1.4	0.1	0.1	-2.9	-0.3	2.0
Computer and information services	PRO	-15.5	-0.2	-0.1	-2.1	-4.4	0.1	0.1	-8.1	-0.7	-0.3
Insurance	INS	-2.8	0.0	0.0	-0.5	-1.3	0.1	0.1	-2.6	-0.3	2.0
Banking and other financial services	BNK	-4.1	0.0	0.0	-0.4	-1.2	0.1	0.1	-2.4	-0.3	0.1
Other professional services	LGL	-4.7	0.0	0.0	-0.2	-1.7	0.1	0.2	-2.6	-0.2	-0.1
Imperfectly Competitive Goods											
Fish products	FIS	35.2	0.1	0.0	-0.5	0.5	0.1	0.2	32.2	0.3	-0.1
Fruits and vegetables	PRV	12.4	0.4	0.1	1.4	-3.9	0.1	0.1	13.1	0.4	-0.2
Fats and oils	OIL	10.2	1.0	0.2	1.9	9.9	0.0	0.0	-2.4	-0.3	-0.2
Grain mill products	MIL	0.7	0.0	0.0	-0.1	0.9	0.0	0.1	-0.1	-0.1	0.0
Other food products	OTF	46.2	0.1	0.0	1.0	-1.2	0.0	0.2	43.7	0.0	-0.1
Textiles	TEX	-6.5	1.7	0.5	-0.1	-3.5	0.1	0.1	-4.8	0.1	-0.4
Petroleum products and coke	COK	-0.5	0.0	0.0	-0.5	0.4	0.0	0.2	-0.7	0.1	0.1
Paper and prining products	PAP	1.4	0.3	0.1	1.3	1.0	0.0	0.1	-1.0	-0.1	-0.1
Pharmaceuticals	PHA	-3.7	0.1	0.0	0.9	-0.8	0.1	0.1	-3.3	-0.3	-0.2
Consumer electronics and optical equip.	CON	-2.5	0.3	0.2	0.4	0.1	0.1	0.1	-3.1	0.0	-0.3
Electronic components	ELT	-28.4	0.0	0.0	27.4	-10.5	0.4	-0.1	-29.3	-2.8	-2.1
Transport Equipment	TRQ	-5.0	0.0	0.0	-1.4	-0.8	0.1	0.1	-2.6	0.0	-0.2
Electricity and gas	GAS	-2.2	0.0	0.0	0.0	-1.2	0.0	0.1	-0.9	0.0	-0.1
Perfectly Competitive Goods and Services											
Growing of crops	CRP	5.4	0.0	0.0	0.2	3.3	0.0	0.1	1.4	0.2	0.0
Animal production and fishing	ANM	10.8	0.2	0.0	1.0	0.5	0.0	0.1	8.2	0.2	0.0
Forestry and logging	LOG	-7.6	0.0	-0.1	-0.7	-2.7	0.1	0.0	-4.2	0.2	-0.3
Coal, crude oil and gas	ENE	-4.2	0.0	0.0	-0.2	-1.5	0.0	0.1	-2.3	-0.2	-0.1
Mining of metal ores	ORE	-6.1	0.0	0.0	-0.3	-3.3	0.0	0.0	-2.4	0.2	-0.3
Other mining	MIN	-5.1	0.0	0.0	-0.2	-2.3	0.0	0.1	-2.7	0.1	-0.1
Meat products	PRM	73.6	0.1	0.0	0.4	1.0	0.0	0.1	68.4	0.0	0.0
Dairy products	DAI	153.8	0.1	0.0	0.5	1.8	0.0	0.1	142.4	0.1	0.0
Wearing apparel	WER	-11.8	-2.9	0.0	-0.6	-2.2	0.1	0.1	-5.4	-0.5	-0.3
Leather goods	LET	-9.8	0.4	0.1	1.5	-3.7	0.1	0.1	-7.1	-0.6	-0.4
Wood products	WOD	-10.1	0.1	0.0	-0.3	-4.2	0.1	0.0	-6.4	0.8	-0.4
Chemicals, fertilizers, rubber, plastics, pain	CHM	3.5	0.3	0.1	1.4	0.8	0.1	0.1	0.6	0.2	-0.2
Glass, clay, cement and stone	MNM	-1.2	0.1	0.0	0.2	-0.4	0.0	0.1	-1.1	0.0	-0.1
Metals and metal products	MET	3.4	0.1	0.0	0.1	-3.5	0.1	0.0	5.8	1.2	-0.4
Manufacture of Machinery	MAS	-10.7	0.4	0.1	-0.4	-3.6	0.1	0.1	-6.6	-0.1	-0.6
Electric motors, equipment and batteries	ELC	-13.2	0.0	0.0	-0.2	-4.4	0.1	0.1	-7.7	-0.7	-0.5
Furniture and jewelry	FUR	-4.8	0.2	0.0	-0.3	-1.4	0.1	0.1	-3.0	-0.2	-0.2
Water, waste and steam activities	UTL	-2.2	0.1	0.0	0.9	-1.8	0.0	0.3	-1.9	-0.2	0.8
Construction	CNS	-2.4	0.2	0.0	0.5	-1.4	0.0	0.1	-1.6	-0.1	-0.1
Transportation support activities	TRA	-2.8	0.1	0.0	0.0	-1.0	0.0	0.2	-1.8	-0.2	0.0
Accomodation and food services	HOS	-4.2	0.0	0.0	0.0	-1.9	0.0	0.1	-2.1	-0.2	-0.1
Other private services	OPS	-4.9	0.0	0.0	-0.4	-1.6	0.0	0.1	-2.6	-0.3	-0.1
Government services	PUB	-5.1	-0.1	0.0	-0.6	-1.7	0.0	0.1	-2.5	-0.2	-0.1

Source: Authors' estimates

Table 17: Change in weighted average number of total varieties in imperfectly competitive sectors from a Deep Free Trade Agreement with Turkey, with decomposed effects

(results are percentage change from initial equilibrium)		Central Model (with imperfectly competitive sectors)									
			Ukrainian Policies Toward Turkey						Turkey's Policies Toward Ukraine		
Scenario definitions in detail: See Summary Table Ukraine-Turkey FTA		FTA Central: All policies by Ukraine and Turkey	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
		1	2	3	4	5	6	7	8	9	10
Business Services	code										
Wholesale and Retail Trade	TRD	2.1	0.1	0.0	0.5	0.7	0.0	0.0	0.8	0.0	0.0
Land transport	LTR	1.0	0.0	0.0	0.3	0.2	0.0	0.0	0.4	0.0	0.0
Water transport	WTR	2.8	0.0	0.0	0.4	0.4	0.0	0.0	0.4	0.0	1.5
Air transport,	ATR	3.4	0.0	0.0	0.3	0.0	2.2	-1.8	-0.1	0.0	2.8
Telecommunications,	TEL	1.0	0.0	0.0	0.3	0.2	0.1	0.0	0.1	0.0	0.2
Computer and information services*	PRO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Insurance	INS	0.9	0.0	0.0	0.2	0.4	0.0	0.0	0.2	0.0	0.1
Banking and other financial services	BNK	1.0	0.0	0.0	0.2	0.4	0.0	0.0	0.3	0.0	0.0
Other professional services	LGL	0.4	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0
Imperfectly Competitive Goods											
Fish products	FIS	1.6	0.0	0.0	0.2	0.4	0.0	0.1	0.8	0.0	0.0
Fruits and vegetables	PRV	3.7	0.1	0.0	0.4	-0.6	0.0	0.0	3.5	0.1	0.0
Fats and oils	OIL	3.0	0.2	0.1	0.6	2.0	0.0	0.0	0.2	0.0	0.0
Grain mill products	MIL	2.0	0.0	0.0	0.3	0.2	0.0	0.0	1.3	0.0	0.0
Other food products	OTF	3.0	0.0	0.0	0.4	0.3	0.0	0.1	2.1	0.0	0.0
Textiles	TEX	0.3	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0
Petroleum products and coke	COK	1.3	0.0	0.0	0.0	0.1	0.0	0.1	0.9	0.1	0.1
Paper and prining products	PAP	2.8	0.1	0.0	0.2	0.4	0.0	0.0	2.0	0.0	0.0
Pharmaceuticals	PHA	-0.3	0.0	0.0	1.5	-0.2	0.0	0.0	-0.9	-0.1	-0.1
Consumer electronics and optical equip.	CON	0.4	0.0	0.0	-0.1	0.2	0.0	0.0	0.2	0.0	0.0
Electronic components	ELT	0.1	0.0	0.0	0.5	0.1	0.0	0.0	-0.1	-0.1	-0.1
Transport Equipment	TRQ	0.2	0.0	0.0	-0.3	0.2	0.0	0.0	0.3	0.0	0.0
Electricity and gas	GAS	0.7	0.0	0.0	0.1	-0.1	0.0	0.0	0.7	0.1	0.0

*NA = not applicable since the sector is modeled as perfectly competitive.
Source: Authors' estimates

Table 18: Change in number of varieties by regional groups in imperfectly competitive sectors from a Deep Free Trade Agreement with Turkey, with decomposed effects

(results are percentage change from initial equilibrium)		Central Model (with imperfectly competitive sectors)									
		Ukraine-Turkey FTA Central					Only FDI Liberalization with Turkey				
Scenario definitions in detail: See Summary Table Ukraine-Turkey FTA		Ukrainian varieties	Turkish varieties in Ukraine	All varieties in Ukraine	All foreign varieties in Ukraine	All foreign varieties excluding Turkish	Ukrainian varieties	Turkish varieties in Ukraine	All varieties in Ukraine	All foreign varieties in Ukraine	All foreign varieties excluding Turkish
		1	2	3	4	5	6	7	8	9	10
Business Services	code										
Wholesale and Retail Trade	TRD	2.1	2.1	2.1	2.2	2.2	0.0	0.0	0.0	0.0	0.0
Land transport	LTR	1.0	1.0	1.0	1.3	1.3	0.0	0.0	0.0	0.0	0.0
Water transport	WTR	1.6	28.6	2.8	6.1	6.1	0.0	28.4	0.0	0.1	0.0
Air transport,	ATR	-1.0	47.1	3.4	12.0	-5.0	-1.9	47.0	2.2	10.5	-7.2
Telecommunications,	TEL	-0.1	3.8	1.0	1.0	0.6	-0.1	3.7	0.1	0.1	-0.4
Computer and information services*	PRO	-6.0	-5.9	-6.6	-9.2	-9.2	0.0	0.2	0.0	0.0	0.0
Insurance	INS	0.9		0.9	1.1	1.1	0.0		0.0	0.0	0.0
Banking and other financial services	BNK	0.8	13.9	1.0	1.3	1.2	0.0	13.0	0.0	0.1	0.0
Other professional services	LGL	0.3		0.4	2.1	2.1	0.0		0.0	0.0	0.0
Imperfectly Competitive Goods											
Fish products	FIS	0.4	8.8	1.6	3.8	3.8	0.0	0.0	0.0	0.0	0.0
Fruits and vegetables	PRV	2.8	17.5	3.7	5.3	4.0	0.0	0.0	0.0	0.0	0.0
Fats and oils	OIL	2.2	12.4	3.0	5.8	5.8	0.0	0.0	0.0	0.0	0.0
Grain mill products	MIL	0.4	42.1	2.0	7.0	6.7	0.0	0.0	0.0	0.0	0.0
Other food products	OTF	3.4	22.8	3.0	1.4	1.1	0.0	0.0	0.0	0.0	0.0
Textiles	TEX	-4.4	15.4	0.3	0.9	-1.4	0.0	0.0	0.0	0.0	0.0
Petroleum products and coke	COK	0.0	8.4	1.3	2.2	2.2	0.0	0.0	0.0	0.0	0.0
Paper and prining products	PAP	0.5	8.0	2.8	6.4	6.3	0.0	0.0	0.0	0.0	0.0
Pharmaceuticals	PHA	-2.6	4.4	-0.3	1.1	1.1	0.0	0.0	0.0	0.0	0.0
Consumer electronics and optical equip.	CON	-2.2	20.3	0.4	1.9	1.9	0.0	0.0	0.0	0.0	0.0
Electronic components	ELT	-13.9	6.4	0.1	0.8	0.7	0.1	0.0	0.0	0.0	0.0
Transport Equipment	TRQ	-4.2	29.0	0.2	2.0	1.0	0.0	0.0	0.0	0.0	0.0
Electricity and gas	GAS	0.7		0.7	2.9	2.9	0.0		0.0	0.0	0.0

*NA = not applicable since the sector is modeled as perfectly competitive.
Source: Authors' estimates

Table 19: Change in Ukrainian skilled labor earnings by sector from a Deep Free Trade Agreement with Turkey, with decomposed effects

Results are percentage change from initial equilibrium.		Central Model (with imperfectly competitive sectors)									
		Ukrainian Policies Toward Turkey							Turkey's Policies Toward Ukraine		
Scenario definitions in detail: See Summary Table Ukraine-Turkey FTA		FTA Central: All policies by Ukraine and Turkey	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
		1	2	3	4	5	6	7	8	9	10
Business Services	**code**										
Wholesale and Retail Trade	TRD	2.0	0.1	0.0	0.4	0.7	0.0	0.0	0.8	0.0	0.0
Land transport	LTR	-3.3	0.0	0.0	-0.1	-1.0	0.0	0.0	-1.9	-0.2	-0.1
Water transport	WTR	2.6	0.0	0.0	0.0	-0.4	0.0	0.0	-0.9	-0.1	4.2
Air transport	ATR	2.7	-0.1	0.0	-0.2	-0.8	-0.9	0.1	-1.4	-0.1	6.2
Telecommunications,	TEL	-0.3	-0.1	0.0	0.1	-0.1	-0.1	0.0	-0.5	-0.1	0.4
Computer and information services	PRO	-12.7	-0.2	-0.1	-1.9	-3.4	0.0	0.0	-6.6	-0.6	-0.3
Insurance	INS	0.9	0.0	0.0	0.2	0.4	0.0	0.0	0.2	0.0	0.1
Banking and other financial services	BNK	0.6	0.0	0.0	0.1	0.4	0.0	0.0	0.2	0.0	0.0
Other professional services	LGL	-0.8	0.0	0.0	-0.1	-0.3	0.0	0.0	-0.4	0.0	0.0
Imperfectly Competitive Goods											
Fish products	FIS	1.2	-0.1	0.0	-1.0	0.0	0.0	0.0	1.9	0.0	0.0
Fruits and vegetables	PRV	7.2	0.1	0.0	0.5	-3.1	0.0	0.0	9.0	0.2	-0.2
Fats and oils	OIL	7.8	0.9	0.1	1.4	8.9	0.0	-0.1	-2.8	-0.3	-0.3
Grain mill products	MIL	0.0	-0.1	0.0	-0.4	0.0	0.0	0.0	0.5	0.0	0.0
Other food products	OTF	10.1	-0.1	0.0	0.2	-0.2	0.0	0.0	9.7	0.0	0.0
Textiles	TEX	-6.7	0.7	0.2	-0.6	-2.6	0.0	0.0	-4.0	0.0	-0.3
Petroleum products and coke	COK	-0.6	0.0	0.0	-0.7	-0.2	0.0	0.0	0.1	0.1	0.1
Paper and prining products	PAP	0.0	0.1	0.0	-0.1	0.2	0.0	0.0	0.0	-0.1	-0.1
Pharmaceuticals	PHA	-3.6	0.0	0.0	-0.3	-0.7	0.0	0.0	-2.0	-0.2	-0.1
Consumer electronics and optical equip.	CON	-3.2	0.2	0.1	-0.5	-0.2	0.0	0.0	-2.3	0.0	-0.2
Electronic components	ELT	-28.1	-0.1	0.0	25.6	-10.1	0.3	-0.2	-28.4	-2.7	-2.0
Transport Equipment	TRQ	-5.5	-0.2	0.0	-2.4	-0.8	0.0	0.0	-1.9	-0.1	-0.1
Electricity and gas	GAS	0.2	0.0	0.0	-0.1	-0.3	0.0	0.0	0.5	0.1	-0.1
Perfectly Competitive Goods and Services											
Growing of crops	CRP	5.1	0.1	0.0	0.2	4.4	0.0	0.0	0.5	0.0	-0.1
Animal production and fishing	ANM	6.8	0.0	0.0	0.3	1.5	0.0	0.1	4.7	0.0	0.0
Forestry and logging	LOG	-7.7	0.1	0.0	-0.5	-2.9	0.0	-0.1	-4.6	0.5	-0.3
Coal, crude oil and gas	ENE	-2.8	0.0	0.0	-0.4	-1.1	0.0	0.0	-1.0	0.0	-0.1
Mining of metal ores	ORE	-3.8	-0.1	0.0	-0.6	-3.1	0.0	-0.1	-0.1	0.5	-0.3
Other mining	MIN	-2.6	-0.1	0.0	-0.4	-1.1	0.0	0.0	-1.0	0.1	-0.1
Meat products	PRM	7.4	-0.1	0.0	0.1	0.4	0.0	0.1	6.6	0.0	0.0
Dairy products	DAI	28.8	-0.1	0.0	0.2	0.7	0.0	0.1	26.4	0.0	0.0
Wearing apparel	WER	-10.6	-3.7	-0.2	-1.0	-1.4	0.0	0.0	-3.6	-0.3	-0.2
Leather goods	LET	-8.3	0.1	0.1	0.8	-2.8	0.1	0.0	-5.7	-0.4	-0.3
Wood products	WOD	-8.8	0.1	0.0	-0.5	-3.3	0.0	-0.1	-5.3	0.6	-0.3
Chemicals, fertilizers, rubber, plastics, pain	CHM	1.1	0.1	0.0	0.0	0.6	0.0	0.0	0.5	0.1	-0.2
Glass, clay, cement and stone	MNM	-0.8	-0.1	0.0	-0.5	-0.4	0.0	0.0	0.3	0.0	-0.1
Metals and metal products	MET	0.6	0.0	0.0	-0.4	-2.7	0.0	-0.1	3.4	0.8	-0.3
Manufacture of Machinery	MAS	-9.8	0.2	0.0	-0.9	-3.0	0.1	-0.1	-5.6	-0.1	-0.5
Electric motors, equipment and batteries	ELC	-12.1	-0.1	-0.1	-0.7	-3.7	0.1	0.0	-6.6	-0.6	-0.5
Furniture and jewelry	FUR	-3.1	0.0	0.0	-0.8	-0.7	0.0	0.0	-1.4	-0.1	-0.1
Water, waste and steam activities	UTL	0.6	0.0	0.0	0.7	-0.4	-0.1	0.2	-0.3	-0.1	0.8
Construction	CNS	-0.4	0.0	0.0	-0.2	-0.1	0.0	0.0	-0.1	0.0	0.0
Transportation support activities	TRA	1.5	0.1	0.0	0.1	0.5	0.0	0.0	0.6	0.0	0.1
Accomodation and food services	HOS	-0.2	0.0	0.0	0.1	-0.1	0.0	0.0	-0.1	0.0	0.0
Other private services	OPS	0.3	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0
Government services	PUB	-0.2	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0

Source: Authors' estimates

Table 20: Change in Ukrainian unskilled labor earnings by sector from a Deep Free Trade Agreement with Turkey, with decomposed effects

Results are percentage change from initial equilibrium.		Central Model (with imperfectly competitive sectors)									
		Ukrainian Policies Toward Turkey							Turkey's Policies Toward Ukraine		
Scenario definitions in detail: See Summary Table Ukraine-Turkey FTA		FTA Central: All policies by Ukraine and Turkey	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
		1	2	3	4	5	6	7	8	9	10
Business Services	code										
Wholesale and Retail Trade	TRD	1.7	0.0	0.0	0.3	0.5	0.0	0.0	0.7	0.0	0.0
Land transport	LTR	-3.5	0.0	0.0	-0.1	-1.2	0.0	0.0	-2.0	-0.2	-0.1
Water transport	WTR	2.3	0.0	0.0	0.0	-0.6	0.0	0.0	-1.0	-0.1	4.2
Air transport,	ATR	2.4	-0.1	0.0	-0.3	-0.9	-0.9	0.1	-1.5	-0.1	6.2
Telecommunications,	TEL	-0.5	-0.1	0.0	0.1	-0.2	-0.1	0.0	-0.5	-0.1	0.4
Computer and information services	PRO	-12.9	-0.2	-0.1	-1.9	-3.6	0.0	0.0	-6.7	-0.6	-0.3
Insurance	INS	0.6	0.0	0.0	0.1	0.2	0.0	0.0	0.1	0.0	0.1
Banking and other financial services	BNK	0.4	0.0	0.0	0.1	0.2	0.0	0.0	0.1	0.0	0.0
Other professional services	LGL	-1.0	0.0	0.0	-0.1	-0.4	0.0	0.0	-0.5	0.0	0.0
Imperfectly Competitive Goods											
Fish products	FIS	0.9	-0.1	0.0	-1.0	-0.1	0.0	0.0	1.8	0.0	0.0
Fruits and vegetables	PRV	6.9	0.1	0.0	0.4	-3.2	0.0	0.0	8.9	0.2	-0.2
Fats and oils	OIL	7.5	0.9	0.1	1.4	8.8	0.0	-0.1	-2.9	-0.3	-0.3
Grain mill products	MIL	-0.2	-0.1	0.0	-0.4	-0.1	0.0	0.0	0.4	0.0	0.0
Other food products	OTF	9.8	-0.1	0.0	0.2	-0.3	0.0	0.0	9.6	0.0	0.0
Textiles	TEX	-7.0	0.7	0.2	-0.6	-2.8	0.0	0.0	-4.1	0.0	-0.3
Petroleum products and coke	COK	-0.9	0.0	0.0	-0.7	-0.3	0.0	0.0	0.0	0.1	0.1
Paper and prining products	PAP	-0.3	0.1	0.0	-0.2	0.0	0.0	0.0	-0.1	-0.1	-0.1
Pharmaceuticals	PHA	-3.8	0.0	0.0	-0.3	-0.9	0.0	0.0	-2.1	-0.2	-0.1
Consumer electronics and optical equip.	CON	-3.5	0.2	0.1	-0.5	-0.3	0.0	0.0	-2.4	0.0	-0.2
Electronic components	ELT	-28.3	-0.1	-0.1	25.6	-10.2	0.3	-0.2	-28.5	-2.7	-2.0
Transport Equipment	TRQ	-5.7	-0.2	0.0	-2.4	-0.9	0.0	0.0	-1.9	-0.1	-0.1
Electricity and gas	GAS	-0.1	0.0	0.0	-0.1	-0.4	0.0	0.0	0.4	0.1	-0.1
Perfectly Competitive Goods and Services											
Growing of crops	CRP	4.8	0.1	0.0	0.2	4.3	0.0	0.0	0.4	0.0	-0.1
Animal production and fishing	ANM	6.6	0.0	0.0	0.3	1.4	0.0	0.1	4.6	0.0	0.0
Forestry and logging	LOG	-7.9	0.0	0.0	-0.5	-3.0	0.0	-0.1	-4.7	0.5	-0.3
Coal, crude oil and gas	ENE	-3.0	0.0	0.0	-0.4	-1.2	0.0	0.0	-1.1	-0.1	-0.1
Mining of metal ores	ORE	-4.1	-0.1	-0.1	-0.6	-3.3	0.0	-0.1	-0.2	0.5	-0.3
Other mining	MIN	-2.9	-0.1	0.0	-0.4	-1.3	0.0	0.0	-1.1	0.1	-0.1
Meat products	PRM	7.2	-0.1	0.0	0.1	0.3	0.0	0.1	6.5	0.0	0.0
Dairy products	DAI	28.5	-0.1	0.0	0.2	0.6	0.0	0.1	26.3	0.0	0.0
Wearing apparel	WER	-10.8	-3.7	-0.2	-1.0	-1.5	0.0	0.0	-3.7	-0.3	-0.2
Leather goods	LET	-8.6	0.1	0.0	0.8	-2.9	0.1	0.0	-5.8	-0.5	-0.3
Wood products	WOD	-9.1	0.1	0.0	-0.5	-3.5	0.0	-0.1	-5.4	0.6	-0.4
Chemicals, fertilizers, rubber, plastics, pain	CHM	0.8	0.0	0.0	0.0	0.5	0.0	0.0	0.4	0.1	-0.2
Glass, clay, cement and stone	MNM	-1.1	-0.2	0.0	-0.5	-0.5	0.0	0.0	0.2	0.0	-0.1
Metals and metal products	MET	0.3	-0.1	0.0	-0.4	-2.9	0.0	-0.1	3.3	0.8	-0.3
Manufacture of Machinery	MAS	-10.0	0.2	0.0	-0.9	-3.2	0.1	-0.1	-5.7	-0.1	-0.5
Electric motors, equipment and batteries	ELC	-12.3	-0.1	-0.1	-0.7	-3.8	0.1	0.0	-6.7	-0.6	-0.5
Furniture and jewelry	FUR	-3.3	0.0	0.0	-0.8	-0.9	0.0	0.0	-1.4	-0.1	-0.1
Water, waste and steam activities	UTL	0.3	0.0	0.0	0.7	-0.6	-0.1	0.2	-0.4	-0.1	0.9
Construction	CNS	-0.7	-0.1	0.0	-0.2	-0.2	0.0	0.0	-0.1	0.0	0.0
Transportation support activities	TRA	1.2	0.1	0.0	0.1	0.4	0.0	0.0	0.5	0.0	0.1
Accomodation and food services	HOS	-0.5	-0.1	0.0	0.1	-0.3	0.0	0.0	-0.2	0.0	0.0
Other private services	OPS	0.1	0.0	0.0	0.0	-0.1	0.0	0.0	0.1	0.0	0.0
Government services	PUB	-0.4	0.0	0.0	-0.1	-0.2	0.0	0.0	-0.1	0.0	0.0

Source: Authors' estimates

Table 21: Change in Ukrainian household consumption by sector from a Deep Free Trade Agreement with Turkey, with decomposed effects

Results are percentage change from initial equilibrium.		Central Model (with imperfectly competitive sectors)									
			Ukrainian Policies Toward Turkey						Turkey's Policies Toward Ukraine		
Scenario definitions in detail: See Summary Table Ukraine-Turkey FTA		FTA Central: All policies by Ukraine and Turkey	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
		1	2	3	4	5	6	c	8	9	10
Business Services	code										
Wholesale and Retail Trade	TRD	2.7	0.0	0.0	0.7	0.5	0.0	0.1	1.2	0.1	0.0
Land transport	LTR	2.8	0.0	0.0	0.7	0.5	0.0	0.1	1.2	0.1	0.0
Water transport	WTR	3.0	0.0	0.0	0.6	0.8	0.0	0.0	1.2	0.1	0.1
Air transport,	ATR	8.5	0.0	0.0	0.6	0.7	0.7	4.4	1.1	0.1	0.6
Telecommunications,	TEL	2.3	-0.1	0.0	0.6	0.7	0.1	0.0	0.7	0.0	0.2
Computer and information services	PRO	2.5	0.0	0.0	0.5	0.8	0.0	0.0	1.1	0.1	0.0
Insurance	INS	2.0	0.0	0.0	0.5	0.7	0.0	0.0	0.7	0.0	0.0
Banking and other financial services	BNK	1.8	-0.1	0.0	0.4	0.6	0.0	0.0	0.7	0.0	0.0
Other professional services	LGL	1.7	0.0	0.0	0.4	0.5	0.0	0.1	0.6	0.0	0.0
Imperfectly Competitive Goods											
Fish products	FIS	2.8	0.0	0.0	0.8	0.6	0.0	0.1	1.0	0.1	0.0
Fruits and vegetables	PRV	3.4	0.1	0.1	1.0	0.3	0.0	0.1	1.4	0.1	0.0
Fats and oils	OIL	2.5	0.0	0.0	0.9	0.8	0.0	0.1	0.5	0.0	0.0
Grain mill products	MIL	1.9	0.0	0.0	0.7	0.3	0.0	0.1	0.7	0.1	0.0
Other food products	OTF	3.6	0.0	0.0	0.7	0.5	0.0	0.1	2.1	0.1	0.0
Textiles	TEX	3.6	0.5	0.2	0.9	0.7	0.0	0.1	1.1	0.1	0.0
Petroleum products and coke	COK	2.6	0.0	0.0	0.7	0.7	0.0	0.1	0.9	0.1	0.0
Paper and prining products	PAP	2.9	0.0	0.0	0.9	0.8	0.0	0.1	1.0	0.1	0.0
Pharmaceuticals	PHA	2.9	0.0	0.0	1.0	0.7	0.0	0.1	1.0	0.1	0.0
Consumer electronics and optical equip.	CON	2.9	0.0	0.0	0.9	0.7	0.0	0.1	1.0	0.1	0.0
Electronic components	ELT	3.4	0.0	0.0	1.4	0.8	0.0	0.1	1.1	0.1	0.0
Transport Equipment	TRQ	3.4	0.0	0.0	1.3	0.8	0.0	0.1	1.1	0.1	0.0
Electricity and gas	GAS	2.0	0.0	0.0	0.5	0.7	0.0	0.0	0.8	0.0	0.0
Perfectly Competitive Goods and Services											
Growing of crops	CRP	1.2	0.0	0.0	0.6	-0.3	0.0	0.1	0.7	0.1	0.0
Animal production and fishing	ANM	1.5	0.0	0.0	0.6	0.4	0.0	0.1	0.3	0.1	0.0
Forestry and logging	LOG	2.2	-0.1	0.0	0.4	0.7	0.0	0.1	0.9	0.0	0.0
Coal, crude oil and gas	ENE	2.5	0.0	0.0	0.5	0.8	0.0	0.0	1.0	0.1	0.0
Mining of metal ores*	ORE	2.4	0.0	0.0	0.6	0.5	0.0	0.1	1.0	0.0	0.0
Other mining*	MIN	5.4	0.0	0.0	0.6	0.6	0.0	0.1	3.9	0.0	0.0
Meat products	PRM	4.0	1.1	0.2	0.8	0.6	0.0	0.1	0.8	0.1	0.0
Dairy products	DAI	2.6	0.1	0.1	0.7	0.7	0.0	0.1	0.9	0.1	0.0
Wearing apparel	WER	1.7	0.0	0.0	0.5	0.4	0.0	0.1	0.5	0.1	0.0
Leather goods	LET	2.9	0.0	0.1	0.9	0.7	0.0	0.1	1.0	0.1	0.0
Wood products	WOD	2.5	0.0	0.0	0.7	0.7	0.0	0.1	0.8	0.1	0.0
Chemicals, fertilizers, rubber, plastics, pain	CHM	2.8	0.0	0.1	0.7	0.6	0.0	0.1	1.2	0.1	0.0
Glass, clay, cement and stone	MNM	2.8	0.0	0.1	0.8	0.7	0.0	0.1	1.0	0.1	0.0
Metals and metal products	MET	3.0	0.1	0.1	0.8	0.7	0.0	0.1	1.0	0.1	0.0
Manufacture of Machinery	MAS	2.5	0.0	0.0	0.8	0.6	0.0	0.1	0.8	0.1	0.0
Electric motors, equipment and batteries	ELC	2.0	0.0	0.0	0.5	0.6	0.0	0.0	0.8	0.1	0.0
Furniture and jewelry	FUR	2.2	0.0	0.0	0.6	0.6	0.0	0.0	0.8	0.1	0.0
Water, waste and steam activities	UTL	2.8	0.0	0.0	0.7	0.5	0.0	0.1	1.2	0.1	0.0
Construction	CNS	2.2	0.0	0.0	0.5	0.6	0.0	0.0	0.9	0.1	0.0
Transportation support activities	TRA	1.5	-0.1	0.0	0.4	0.5	0.0	0.0	0.6	0.0	0.0
Accomodation and food services	HOS	1.5	-0.1	0.0	0.4	0.5	0.0	0.0	0.6	0.0	0.0
Other private services	OPS	1.1	-0.1	0.0	0.3	0.5	0.0	0.0	0.3	0.0	0.0
Government services	PUB	1.1	-0.1	0.0	0.3	0.4	0.0	0.0	0.4	0.0	0.0

*Mining of metal ores and Other mining are not consumed directly by households.
Source: Authors' estimates

Table 22: Rents by Instrument in the Benchmark and their Percentage Change by Policy*

Results are the percentage change from benchmark value except for column 0, which is the benchmark percent of rents relative to real household income.

For scenario definitions see: Summary Table Ukraine-Turkey FTA	Benchmark — Rents as a percent of aggregate household income	Central Model with Monopolistically Competitive Sectors										
		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	Reduction by Ukraine of Non-Discriminatory Barriers Against Investment in Ukrainian Services	Zero tariffs against imports from Ukraine	Reduction of Non-tariff barriers on goods	Services: Reduction of Barriers against cross border
Rents impacted by policy	0	1	2	3	4	5	6	7	8	9	10	11
1. Ukrainian barriers												
Non-tariff barriers in Ukraine	0.12	0.02		0.02								
Time in Trade on Imports	6.75	0.35			0.35							
Time in Trade on Ukrainian Exports	5.91	0.30				0.30						
Services: Ukrainian barriers against FDI	0.06	0.03					0.03					
Services: Ukrainian cross-border barriers	0.14	0.07						0.07				
Services: Ukrainian non-discriminatory barriers against investment	3.19								0.80			
Total Rents from Ukrainian policies	16.18	0.78		0.02	0.35	0.30	0.03	0.07	0.80			
2. Turkish barriers												
Non-tariff barriers in Turkey	0.14	0.03									0.03	
Services: Turkish cross-border barriers	0.09	0.05										0.05
Total Rents from Turkish policies	0.23	0.07									0.03	0.05

*The percentage change in rents is the percent of Ukrainian capital and labor that is freed as a percent of consumption in the counterfactual equilibrium.

**The total may not equal the sum of the components due to rounding.

Source: Authors' estimates.

Table 23. Perfect Competition Assessment of a Ukraine-Turkey Deep Free Trade Agreement (FTA)

(results are percentage change from initial equilibrium)

	Model with all Perfectly Competitive Sectors									
	Ukrainian Policies Toward Turkey							Turkey's Policies Toward Ukraine		
Scenario definitions	FTA Central: All policies by Ukraine and Turkey	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
Ukraine's Policies Toward Turkey	1	2	3	4	5	6	7	8	9	11
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
Turkey's Policies Toward Ukraine										
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
Aggregate welfare and real GDP										
Welfare (EV as % of consumption)	1.7	0.0	0.0	0.5	0.3	0.0	0.1	0.6	0.0	0.0
Welfare (EV as % of GDP)	1.2	0.0	0.0	0.3	0.2	0.0	0.1	0.4	0.0	0.0
real GDP	1.3	0.0	0.0	0.3	0.2	0.0	0.1	0.5	0.0	0.0
Aggregate trade										
Real exchange rate	-0.5	0.0	0.0	0.1	-0.4	0.0	0.1	-0.3	0.0	0.0
Aggregate exports	2.2	0.2	0.0	0.4	0.2	0.0	0.1	1.0	0.1	0.0
Aggregate imports	1.6	0.1	0.0	0.3	0.1	0.0	0.1	0.9	0.1	0.0
Change in imports from Turkey	28.0	11.8	3.8	0.8	0.9	0.0	8.6	0.7	0.0	0.1
Change in imports from all other countries	0.7	-0.4	-0.1	0.3	0.1	0.0	-0.2	0.9	0.1	0.0
Government budget Benchmark percent of GDP										
Tariff revenue (% of GDP)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Tariff Revenue	1.4	-1.1	0.2	1.2	0.7	0.0	0.0	0.8	0.1	0.0
Value Added Taxes total	0.6	0.0	0.0	0.1	0.1	0.0	0.0	0.3	0.0	0.0
Value Added Taxes on imorts	2.2	0.2	0.0	0.2	0.5	0.0	0.0	1.2	0.1	0.0
Value Added Taxes domestic	1.6	0.1	0.0	0.2	0.3	0.0	0.0	0.8	0.1	0.0
Excise Taxes on domestic	2.2	0.0	0.0	0.2	0.0	0.0	0.0	1.8	0.0	0.0
Excise Taxes on imports	1.7	0.0	0.0	0.1	0.1	0.0	0.1	1.1	0.1	0.1
Excise Taxes total	2.0	0.0	0.0	0.2	0.1	0.0	0.1	1.5	0.1	0.0
Factor Earnings										
Skilled labor earnings	0.8	0.1	0.0	0.3	-0.1	0.0	0.1	0.3	0.0	0.0
Unskilled labor earnings	1.0	0.1	0.0	0.3	0.1	0.0	0.1	0.3	0.0	0.0
Capital earnings	0.9	0.1	0.0	0.2	-0.1	0.0	0.1	0.4	0.0	0.0
Specific Factors earnings in domestic firms	4.1	0.1	0.0	0.4	2.6	0.0	0.1	0.9	0.0	-0.1
Specific Factors earnings in multinational firms in Ukraine	4.1	0.1	0.1	0.6	0.7	0.0	0.2	2.2	0.1	0.0
Specific Factors earnings in multinational firms in Ukraine	1.8	0.2	0.0	0.4	0.1	0.3	0.2	0.6	0.0	0.0
Factor Adjustments*										
Total labor	1.1	0.0	0.0	0.1	0.5	0.0	0.0	0.6	0.0	0.1
Skilled labor	0.9	0.0	0.0	0.1	0.4	0.0	0.0	0.5	0.0	0.1
Unskilled labor	1.4	0.1	0.0	0.2	0.7	0.0	0.0	0.8	0.1	0.1
Capital	1.1	0.0	0.0	0.1	0.5	0.0	0.0	0.5	0.1	0.1

*Percentage of the factor that must change sectors

Source: Authors' estimates.

Table 24: Impact of Spillovers* or Deeper Liberalization or to all External Regions except Turkey

Results are percentage change from initial equilibrium.

Scenario definitions	FTA Central: All policies in Ukraine-Turkey FTA	Central Model with Monopolistically Competitive Sectors					
		Spillovers* with Respect to the Whole World					
			Only Spillover Effect and Limited to:				
		FTA Central Plus FDI Services	FDI Services Barriers Only	Cross-Border Services Barriers Only	Import Non-Tariff Barriers Only**	Import Time in Trade Barriers Only	Export Time in Trade Barriers Only
	1	**2**	**3**	**4**	**5**	**6**	**7**
All Policies of FTA Central	**Yes**	**Yes**	No	No	No	No	No
FDI in Services: 50% reduction of AVEs on Turkey; 25% from other regions.	No	Yes	Yes	No	No	No	No
Cross-Border services: 50% reduction of AVEs on Turkey, 25% from other regions.	No	No	No	Yes	No	No	No
Non-Tariff Barriers for goods: 20% reduction of AVEs for Turkey, 10% for other regions.**	No	No	No	No	Yes	No	No
Time in Trade Costs for Imports: 20% reduction of AVEs for Turkey, 5% for other regions.	No	No	No	No	No	Yes	No
Time in Trade Costs for Exports: 20% reduction of AVEs for Turkey, 5% for other regions.	No	No	No	No	No	No	Yes
Aggregate welfare and real GDP							
Welfare (EV as % of consumption)	2.72	2.99	0.29	0.61	0.48	0.68	0.54
Welfare (EV as % of GDP)	1.88	2.06	0.20	0.42	0.33	0.47	0.37
change in real GDP as % of GDP	2.12	2.37	0.28	0.56	0.33	0.48	0.38
Aggregate trade							
Real exchange rate	-0.1	0.1	0.2	0.4	0.1	0.1	-0.3
Aggregate exports	3.2	3.6	0.4	0.7	0.5	0.7	0.5
Aggregate imports	2.4	2.6	0.2	0.6	0.4	0.5	0.3
Government budget							
Tariff revenue (% of GDP)	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Tariff Revenue	2.4	2.5	0.1	0.2	1.0	1.9	0.8
Value Added Taxes total	1.0	1.1	0.1	0.2	0.1	0.2	0.2
Value Added Taxes on imorts	3.1	3.2	0.1	0.2	0.3	0.5	0.7
Value Added Taxes domestic	2.2	2.3	0.1	0.2	0.2	0.3	0.5
Excise Taxes on domestic	2.7	2.8	0.1	0.2	0.1	0.3	0.0
Excise Taxes on imports	2.9	3.2	0.2	0.4	0.5	0.4	0.3
Excise Taxes total	2.8	3.0	0.2	0.3	0.3	0.3	0.2
Factor Earnings							
Skilled labor earnings	1.5	1.8	0.3	0.5	0.3	0.4	0.1
Unskilled labor earnings	1.8	2.0	0.3	0.5	0.3	0.5	0.2
Capital earnings	1.6	1.9	0.3	0.5	0.3	0.4	0.1
Specific Factors earnings (land and natural resoures)	5.2	5.4	0.3	0.5	0.2	0.5	2.9
Specific Factors earnings (IRTS domestic firms)	5.3	5.3	0.0	0.9	0.6	0.8	0.8
Specific Factors earnings (multinationals)	3.0	4.1	1.6	0.6	0.5	0.7	0.3
Factor Adjustments*							
Total labor	1.2	1.2	0.0	0.1	0.1	0.2	0.5
Skilled labor	1.0	1.0	0.0	0.1	0.1	0.2	0.4
Unskilled labor	1.5	1.6	0.0	0.1	0.1	0.2	0.7
capital	1.2	1.2	0.0	0.1	0.1	0.2	0.5

*Spillovers do not include the reduction of non-discriminatory barriers against investment in business services.
**The EU is excluded from spillovers on non-tariff barriers due to harmonization under the DCFTA.
***Percentage of the factor that must change sectors.
Source: Authors' estimates.

Table 25: Estimates of the Adjustment Costs of the Trade Liberalization and Benefit-Cost Ratios

	FTA with Turkey	FTA plus reduction of non-discriminatory regulatory barriers in business services	FTA plus reduction of barriers against FDI in business services
1. Adjustment Costs as % of GDP	0.246	0.285	0.250
2. Equivalent Variation (EV) as % of consumption	2.72	4.76	2.99
3. Equivalent Variation (EV) as % of GDP	1.88	3.28	2.06
4. Present Value of EV as % of benchmark GDP*	28.7	50.1	31.5
5. Benefit-Cost Ratio (row 4 divided by row 1)	**116.9**	**175.9**	**126.0**

 Seven percent discount factor into the infinite future. Row 4 = Row 3[1.07/.07].
Source: Authors' estimates.

Table 26: Piecemeal Sensitivity: Impact on Ukraine-Turkey FTA with and without Reduction of Non-Discriminatory Services Barriers

Results are Percent Change in Real Household Consumption	Parameter Value			Ukraine-Turkey FTA Central			Plus Reduction of Non-Discriminatory Services		
Parameter	Lower	Central	Upper	Lower	Central	Upper	Lower	Central	Upper
$\sigma(q_i, q_j)$ – services sectors	(0.5)central*	see Sources	(1.5)central	4.00	2.72	2.42	5.81	4.76	4.00
$\sigma(q_i, q_j)$ – goods sectors	(0.5)central*	see Sources	(1.5)central	3.52	2.72	2.52	4.95	4.76	4.43
$\sigma(va, bs)$	0.625	1.25	1.875	2.60	2.72	2.86	4.37	4.76	5.21
$\sigma(D, M)$ for section i	(0.5)central	$\sigma(D, M)_i$	(1.5)central	2.61	2.72	2.82	4.64	4.76	4.87
$\sigma(M, M)$ for sector i	(0.5)central	$\sigma(M, M)_i$	(1.5)central	2.56	2.72	2.90	4.60	4.76	4.94
$\sigma(D, X)$ for sector i	3	4	5	2.47	2.72	3.09	4.49	4.76	5.14
$\sigma(L, K)$	0.5	1	1.5	2.73	2.72	2.72	4.77	4.76	4.75
$\sigma(A_1,\ldots A_n)$	0	0.5	1	2.65	2.72	2.79	4.67	4.76	4.85
$\varepsilon_{UKRAINE}, \varepsilon_{TURKEY}, \varepsilon_{RUSSIA}**, \varepsilon_{CHINA}$	1.5	3	4.5	2.23	2.72	3.02	3.82	4.76	5.31
$\varepsilon_{EU}, \varepsilon_{ROW}, \varepsilon_{USA}, \varepsilon_{FTR}$	(0.5)central	see Sources	(1.5)central						

Key:

$\sigma(q_i, q_j)$: Dixit-Stiglitz elasticity of substitution between firm varieties in imperfectly competitive sectors;

$\sigma(va, bs)$: Elasticity of substitution between value-added and business services.

$\sigma(D, M)$: Elasticity of substitution between domestic goods and imports in CRTS sectors.

$\sigma(M, M)$: Elasticity of substitution between imports from different regions in CRTS sectors. Values taken from GTAP.

$\sigma(D, X)$ for sector i: Elasticity of transformation between exports and domestic production in sector i.

$\sigma(L, K)$: Elasticity of substitution between primary factors of production in value added.

$\sigma(A_1,\ldots A_n)$: Elasticity of substitution in intermediate production between composite Armington aggregate goods.

$\varepsilon_{EU}, \varepsilon_{ROW}, \varepsilon_{USA}, \varepsilon_{FTR}$: Vectors of elasticities of imperfectly competitive firms' supply with respect to price of their outputs in Ukraine.

*For model stability, we impose the following parameter bounds.
In the FTA Central scenario: for σ(qi, qj) in IRTS business services and goods, a lower bound of 2;
In the FTA plus scenario, we impose: (i) for σ(qi, qj) in business services, a lower bound of 2.5, and those lower 2.5 are unchanged; and (ii) for for σ(qi, qj) in goods, a lower bound of 4, and those lower 4 are unchanged.
Sources: Elasticities of substitution from table 2 for goods and from Movchan *et al.* (2020b, appendix D) for services. Supply elasticities are from table 8. Authors' estimates for model results.

Appendices

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Appendix A: Estimates of the Ad Valorem Equivalents of Time in Trade Costs

Zoryana Olekseyuk, David G. Tarr and Veronika Movchan

Our estimates of the ad valorem equivalents (AVEs) of poor trade facilitation are based on the path-breaking work of David Hummels and his co-authors (Hummels, 2007; Hummels and Schaur, 2013; Hummels *et al.*, 2007). Using the estimates of Hummels and his co-authors, Peter Minor (2013) provided estimates for the regions and products in the GTAP database. We use estimates from Peter Minor, which we aggregate to the sectors and regions of our model. Documentation of the steps we have taken and a brief explanation of the methodology are explained below. (See Minor (2013) for a fuller explanation of the methodology.)

Although a central finding of the above studies is that the AVE of time in trade varies across products, most computable general equilibrium modeling of trade facilitation issues have used a single AVE across all products. By basing our estimates on the work of Hummels and Minor, we improve on the sector accuracy of the benefits of trade facilitation, and show that the results are dependent on these sector estimates. We summarize the steps in the estimation of Minor and our aggregation below.

1. Estimation of the value of one day saved in transit for over 600 HS4 products

("the per-day value of time savings" by product)

The crucial first step is the estimation of the value of one day saved in transit for each *product* ("the per-day value of time savings" by product). The key to the estimation is the premium in shipping costs that firms are willing to pay for air shipping to avoid an additional day of ocean shipping. The premium that firms are willing to pay for air shipping varies considerably across products. At one extreme, we have products like crude oil, coal and fertilizers with an AVE of zero for one day saved in transit. Evidently, no significant amounts of these products are shipped by air, which reflects no willingness to pay to save time. On the other hand, a significant share of fruits and vegetables are shipped by air, reflecting a willingness to pay to save time in shipping. Hummels *et al.*, (2007, p. 8) estimate that for an aggregate of all fruits and vegetables the AVE of one day saved is 0.9 percent; that is, one additional day in transit cost almost one percent of the value of the fruits and vegetables. Hummels has statistically significant estimates of the AVE of one day saved in transit for slightly more than 600 HS4 products. The AVE of one day of time saved in shipping is independent of the country.

The data for Hummels estimates come from the U.S. Merchandise Imports database 1991-2005, and a database on shipping times between ports. Hummels calculates average shipping times between ports around the world and U.S. ports. As such, the AVE estimates of one day saved in shipping are based solely on U.S. data and assumed to apply to all countries.

To obtain estimates of the AVE of one day saved in transit for the GTAP product categories, Peter Minor (2013) aggregated the HS4 categories for which Hummels has provided estimates, to the 57 product categories of the GTAP database. The 600 plus HS4 product categories for which Hummels has statistically significant estimates, however, is less than the number of HS4 categories underlying the GTAP database. Hummels and Schaur (2013, p.1) estimate that excluding Canada and Mexico, 36 percent of imports of the U.S. and 58 percent of the exports of the U.S. are shipped by air.[47]

Data on shipments are collected at a disaggregated level and then aggregated to the HS4 level for an estimate of the value of one day saved in shipping. Hummels and Schaur (2013) explain that the methodology should be thought off as regarding the HS4 category as the industry and products at the HS6 or HS10 level as varieties within the industry. This explains the following comment of Hummels, Minor et al. (2007) regarding potential biases in the HS4 category estimates. In their appendix they note that if a product is not shipped by air and sea, it is excluded from the estimation:

> "For approximately one-third of j-k-d-t observations both air and ocean transportation are employed. These represent roughly 70 percent of trade by value, and the estimation is based on these observations. For the remaining observations only one mode is observed. Since we do not see shipping prices for these goods they are dropped from the estimation. This could cause biased estimates if there is heterogeneity in the parameters across observations within a product. For example, suppose that some observations have systematically higher values of tau(k) than the average, resulting in them being shipped only by ocean. Omitting these observations would then bias tau(k) downward. Similarly, *suppose some observations have systematically lower values of tau(k) than the average, resulting in them being shipped only by ocean. Omitting these observations would then bias tau(k) upward.*"

Although Hummels, Minor et al. (2007) have only one estimate of a value of one day saved in transit for an HS4 category, Minor (2013) proposes three methodologies to address the lack of estimates for the missing HS4 categories. In the method he calls tau-1, the missing HS4 values are replaced with zeros. In the method he calls tau-2, the statistically insignificant estimates are included and the estimates are then based on slightly more than 1,000 HS4 products. In the method he calls tau-3, Minor replaces the missing values with the average for the same GTAP product category based on values that exist from Hummels, Minor *et al*. (2007). This provides three sets of estimates for the value of one day saved in shipping.

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[47] Minor (2013, p.5) estimates that the missing HS4 categories account for about 17 percent of the value of world trade, based on the MacMap 2007 database.

The trade weights in the MacMap dataset vary by country; so, despite the fact that there is a unique AVE for the value of one day saved in trade at the HS4 level for each of the 600 plus product categories from Hummels, due to differing trade weights across countries, the value of one day saved in transit varies across countries at the GTAP 57 product level. Minor's full dataset of results is available at http://mygtap.org/resources/.

We employ a combination of these three estimates. Since agriculture and food products are perishable products that decay and become valueless in time, we believe the estimates of tau-3 are the best estimates. That is, tau-3 appears unbiased for these products, and the results appear sensible. For manufacturing and mining products, however, we believe that the tau-3 estimates are significantly misleading. For example, there is a relatively high value of tau-3 for petroleum products. While the bulk of petroleum products are not shipped by air, we know that there are some expensive mineral products that are shipped by air. The high per day value of tau-3 is likely highly influenced by these exceptional products. Inspection of the estimates for manufacturing shows that a considerable number of the estimates in the manufacturing sector are biased upward in this manner. The estimate of tau-1, however, is not biased in this manner as it takes a zero value for tau-1(k) if there is a missing shipment value for product k, either water or air. As a result, we take tau-1 values in mining and manufacturing.

2. Calculating the AVE of Time in Importing and Exporting for the GTAP sectors and countries.

Following Hummels et al. (2007), Minor combines the above data set with the World Bank's *Doing Business* data set for 2012. The *Doing Business* dataset shows the number of days in transit in each country for importing and for exporting goods. In this project we update the number of days to export from or import to Ukraine by a bilateral value for each trade partner of Ukraine in 2020. The calculated number of days is based on the following datasets:

- World Bank's *Doing Business* 2020: trading across borders, time (hours) for border compliance;
- CEPII distance database: the geodesic distance between countries, km (see Mayer and Zignago (2011) for description);
- CERDI sea distance database: the distance between seaports plus the distance between the capital and the seaport (see Bertoli et al. (2016) for description).

Our calculations of the number of days in transit are based on the following assumptions:

- The average speed of a commercial vessel is 30 km/hour. It corresponds to 16 knots (generally the speed varies from 13 to 24 knot for different types of vessels;

- The average speed of the truck is 60 km/hour, but it cannot go more than 600 km per day. If the land distance is longer, we count 600 km as 24 hours plus the estimated number of hours for the last day;
- The average trip between Kyiv and Odesa port (a proxy for distance in case of sea shipment) is 490 km or approximately 8 hours;
- For transit countries, zero time for border compliance;
- Border compliance costs (following World Bank's *Doing Business*) are the same for land and port facilities;
- As World Bank's *Doing Business* does not contain information about Turkmenistan, Uzbekistan's border compliance is taken as a proxy;
- As CERDI dataset does not contain data for South Sudan and the Democratic Republic of Congo, sea distance for Sudan and the Republic of Congo are taken as a proxy;
- In the CEPII dataset, the distance between Ukraine and the former Yugoslavia is used as a proxy for the distance with Montenegro and Serbia.

Given the described data sources and assumptions, we are able to calculate the time in transit between Ukraine and its trade partners:

Time to export from Ukraine to partner country =

= Border compliance time to export from Ukraine (border compliance, hours, World Bank's *Doing Business*)

+ Border compliance time to enter the partner country (border compliance, hours, World Bank's *Doing Business*)

+ The transportation time en route. The latter is calculated as follows:
- if only the land route is reasonable, the time estimates are based on the geodesic distance between countries
- if only the sea route is reasonable, the time estimates are for sea route plus the time for land transportation between the seaports and capitals in the two countries
- if both the land and sea routes are reasonable, we take the minimum of the time of transport by land or by sea).

Time to import to Ukraine from partner country =

= Time to import into Ukraine (border compliance, hours, World Bank's *Doing Business*)

+ Border compliance time to export from the partner country (border compliance, hours, World Bank's *Doing Business*)

+ The transportation time en route. The latter is calculated as:

- if only the land route is reasonable, the time estimates are based on the geodesic distance between countries
- if only the sea route is reasonable, the time estimates are for sea route plus time for land transportation between the seaport and capital in two countries
- if both the land and sea routes are reasonable, we take the minimum time of transport by land or by sea).

This methodology provides estimates for 182 countries, including all countries that are the part of the model regions. We then map these 182 countries to the GTAP countries and regions. We directly receive the number of days in transit for 117 out of 140 GTAP countries and regions. For the remaining GTAP regions, we calculate a simple average over available estimates.[48]

Combining this updated dataset for the number of days in transit with the Minor's dataset mentioned in step 2 above, yields the AVE equivalents of the <u>total</u> cost of time to export or import[49] by product and country in the GTAP dataset for imports and exports, where the AVEs are bilateral depending on the partner country.

3. Aggregating the AVE of the time in trade to the products and regions of our model.

We start with the estimates of Minor (2013) described in step 2 of the bilateral AVEs of the cost of one day of time in trade for exports and imports. We then aggregate these estimates to the products and regions of our model.
The mapping of the GTAP sectors of our model is provided in table A.1. For coal (coa), gas and crude oil (cru) we use tau-1estimates from Minor (2013, table A1). These values are zero, and therefore

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[48] Some further assumptions include the following: For EFTA and Rest of South Africa the value is based on one available estimate; for Taiwan and Rest of East Asia we use an average over China and Hong Kong as a proxy, since underlying values are not available; for Rest of North America we use an average over USA and Canada since underlying countries are not included in the dataset; for Venezuela we use the value for Colombia as a proxy; for the Rest of the World we assume an average over all available estimates.

[49] We multiply the per day time in trade AVE by the total number of days to export of import.

independent of the trade weights. We take tau-1 to be equal to zero for these sectors, for all regions with which Ukraine trades and for both imports and exports. For some sectors of our model, there was no estimate according to the mapping based on the official correspondence tables. In these cases we employed the estimates of similar products. In particular, for dairy (mil) and gain mill products (pcr) there were no tau-3 values available, so we used the estimates for other food products (ofd) for DAIR and MILL. For coke, we use coal (coa) rather than petroleum products and coke aggregate (p_c), which is strongly influenced by outliers in the petroleum sector. Finally, for cement, we use coal (coa), rather than non-metallic mineral products (nmm), since cement is a product that is much closer to coal regarding its lack of air shipment than non-metallic minerals.

The region mapping is provided in table A.4. The weights we use for the aggregation are bilateral trade weights, taken from the World Integrated Trade Solution (WITS)[50] database for 2018. There are four steps in the aggregation, which we describe in both words and mathematics. We specify the mathematics for exporting; the importing aggregation is fully symmetric and is omitted.

(i) **Total time costs of exporting product k from region r to region s**. We calculate the value of the total time costs of exporting product k from region r to region s by multiplying the AVEs of time costs of exporting product k from region r to region s by the bilateral exports of product k from region r to region s.

Let X_{rs}^k define the value of exports of product k from region r to region s from the WITS database. Let $etau_{rs}^k$ be the bilateral trade weighted ad valorem equivalent of the time in trade in exporting product k from region r to region s (from step 3 above).

Define $CTIT_{rs}^k = X_{rs}^k * etau_{rs}^k$ = the total costs of time in exporting product k from GTAP region r to GTAP region s.

(ii) **Total time cost of exporting products within one of the model's sectors and regions.** Then for any sector and region of our model, we aggregate these total costs for all subsectors and subregions –simply summing up the values for GTAP sectors which belong to the one sector of our model and the same for the regions) – according to the mapping given in tables A.1 and A.4.

Let R be the set of all regions in the GTAP dataset. Our model contains eight regions, R_v, v= 1,…8. The GTAP regions that belong to R_v are defined in table A.4. The regions are non-overlapping subsets of R,

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the union of which is all the GTAP regions. That is, we have R = $(R_1 \cup R_2 \cup, \dots, \cup R_8)$, with $R_v \cap R_{v'} = \emptyset \; \forall \; v, v'$, where v' is an alternate index for the elements of R_v. Let the elements of R be indexed by both R_v and S_v. In this project we are interested in the barriers between Ukraine and its partners, so we calculate the AVEs only for bilateral trade of Ukraine with the other seven regions of the model (therefore, Ukraine is always either R_v as exporter or S_v as importer).

Similarly, let K be the set of all GTAP sectors. Our model contains 52 goods sectors, K_w, w= 1,…52, for which we are able to provide the AVEs based on Minor (2013). The GTAP sectors that belong to K_w are defined in Table A.1. Our sectors are non-overlapping subsets of K, the union of which is all the GTAP products. That is, we have K = $(K_1 \cup K_2 \cup, \dots, \cup K_{52})$,
with $K_w \cap K_{w'} = \emptyset \; \forall \; w, w'$, where $w \neq w'$ and w' is an alternate index for the elements of K_w.
For any product group K_w and any pair of regions R_v , $R_{v'}$ of our model, we aggregate the total cost of exporting across the sub-products of K_w from the sub-regions of R_v to the sub-regions of $R_{v'}$. That is, the aggregate or total time cost of exporting products within product group K_w from region R_v to region S_v is:

$$ACTIT_{R_v S_{v'}}^{K_w} = \sum_{k \in K_w} \sum_{s \in S_{v'}} \sum_{r \in R_v} CTIT_{rs}^k \; \forall w, v, v' \; v \neq v'.$$

(iii) **Total value of exports within one of the model's sectors from one of the model's regions to another.** In the same way we aggregate the value of all exports X_{rs}^k. The total value of all exports within product group K_w from one sub-region of R_v to another sub-region of region R_v is:

$$AX_{R_v S_{v'}}^{K_w} = \sum_{k \in K_w} \sum_{s \in S_{v'}} \sum_{r \in R_v} X_{rs}^k \; \forall w, v, v' \; v \neq v'.$$

(iv) **Model specific AVEs of the cost of time in exporting one of the model's products from one of the model's regions to another.** At the end, we calculate the model-specific AVEs of time in trade $etf_{R_v S_{v'}}^{K_w}$ to export the commodities within product group K_w from one to another region of our model. In particular, we divide the value of total costs of time to export (import) by the value of exports (imports) for each sector and country pair of our model (we use here already aggregated values from (ii) and (iii):

$$etf_{R_vS_{v\prime}}^{K_w} = \left.ACTIT_{R_vS_{v\prime}}^{K_w}\middle/AX_{R_vS_{v\prime}}^{K_w}\right. \quad \forall w, v, v' \; v \neq v'.$$

The resulting values are reported in the Tables A.2 and A.3.

4. Interpretation and Caveats

If using these estimates in a simulation exercise of policy changes to facilitate trade, we believe that it is prudent to simulate modest percentage cuts, rather than cuts of 50 to 100 percent. In our policy scenarios, we will employ maximum cuts in the time in trade costs that we implement of 25 percent. The reasons are as follows.

(i)   The time in trade can't be cut to zero. The world average for shipping a container for exporting or importing is about 23 days, down about two days compared with 2009.[51] However, the most efficient country in the world in the Doing Business data is Singapore. Based in the 2014 *Doing Business* data, it takes six days to export a shipment on average and four days to import a shipment in Singapore. This is likely a lower bound for most countries to achieve.

(ii)   Policies can't change infrastructure. Many of the changes responsible for the global decline in the time in trade to ship a container in the past few years are policies such as: improved customs administration; introduction or improvement in electronic submission and processing; introduction of the electronic single window; introduction or improvement in risk management procedures. But poor roads, ports, rail facilities, airports and pipelines also significantly contribute to delays. If polices are being simulated, they can't be expected to improve infrastructure.

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[51] In 2009 the world average to export a standard containerized cargo by sea transport was 23.5 days, and 25.9 days to import. In 2014 it took 21.8 days on average to export and 24.2 days to import (World Bank, 2014, p.107).

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Table A.1: Mapping of GTAP sectors to the model-specific sectors

No	Model sector		Aggre-gation code	GTAP sectors	Description of GTAP sectors
1	Growing of crops, mixed farming	CROP	CROP	c_b	Cane & Beet: sugar crops
				gro	Other Grains: maize (corn), sorghum, barley, rye, oats, millets, other cereals
				ocr	Other Crops: stimulant; spice and aromatic crops; forage products; plants and parts of plants used primarily in perfumery, pharmacy, or for insecticidal, fungicidal or similar purposes; beet seeds (excluding sugar beet seeds) and seeds of forage plants;
				osd	Oil Seeds: oil seeds and oleaginous fruit
				pdr	Rice: seed, paddy (not husked)
				pfb	Fibres crops
				v_f	Veg & Fruit: vegetables, fruit and nuts, edible roots and tubers, pulses
				wht	Wheat: seed, other
2	Animal production; hunting, trapping and related service activities	ANIM	ANIM	ctl	Cattle: bovine animals, live, other ruminants, horses and other equines, bovine semen
				oap	Other Animal Products: swine; poultry; other live animals; eggs of hens or other birds in shell, fresh; reproductive materials of animals; natural honey; snails, fresh, chilled, frozen, dried, salted or in brine, except sea snails
				rmk	Raw milk
				wol	Wool: wool, silk, and other raw animal materials used in textile
3	Forestry and logging	LOGG	LOGG	frs	Forestry: forestry, logging and related service activities
4	Fishing and aquaculture	FISH	FISH	fsh	Fishing: hunting, trapping and game propagation including related service activities, fishing, fish farms; service activities incidental to fishing
5	Mining of coal and lignite	COAL	coa_	coa	Coal: mining and agglomeration of hard coal, lignite and peat
6	Manufacture of coke	COKE			
7	Manufacture of cement, lime and plaster; articles of concrete, cement and plaster	CEMT			
8	Extraction of crude petroleum and natural gas	CGAS	CGAS	gas	Gas: extraction of natural gas, service activities incidental to oil and gas extraction excluding surveying (part)
				oil	Oil: extraction of crude petroleum, service activities incidental to oil and gas extraction excluding surveying (part)

No	Model sector		Aggre-gation code	GTAP sectors	Description of GTAP sectors
9	Mining of metal ores	ORES	oxt_	oxt	Other Mining Extraction (formerly omn): mining of metal ores; other mining and quarrying
10	Quarrying of stone, sand and clay	SAND			
11	Mining of chemical and fertiliser minerals	CHMN			
12	Other mining and quarrying n.e.c., mining support service activities	OTMN			
13	Processing and preserving of meat and production of meat products	PRMT	PRMT	cmt	Cattle Meat: fresh or chilled; meat of buffalo, fresh or chilled; meat of sheep, fresh or chilled; meat of goat, fresh or chilled; meat of camels and camelids, fresh or chilled; meat of horses and other equines, fresh or chilled; other meat of mammals, etc.
				omt	Other Meat: meat of pigs, fresh or chilled; meat of rabbits and hares, fresh or chilled; meat of poultry, fresh or chilled; meat of poultry, frozen; edible offal of poultry, fresh, chilled or frozen; other meat and edible offal, fresh, chilled or frozen;
14	Processing and preserving of fish, crustaceans and molluscs	PRFS	ofd_	ofd	Other Food: prepared and preserved fish, crustaceans, molluscs and other aquatic invertebrates; prepared and preserved vegetables, pulses and potatoes; prepared and preserved fruits and nuts; wheat and meslin flour; other cereal flours; groats, ect.
15	Processing and preserving of fruit and vegetables	PRFV			
16	Manufacture of prepared animal feeds	FEED			
17	Manufacture of dairy products	DAIR			
18	Manufacture of grain mill products, starches and starch products	MILL			
19	Manufacture of vegetable and animal oils and fats	OILS	OILS	vol	Vegetable Oils: margarine and similar preparations; cotton linters; oil-cake and other residues resulting from the extraction of vegetable fats or oils; flours and meals of oil seeds or oleaginous fruits, except those of mustard; vegetable waxes
20	Manufacture of other food products n.e.c.; beverages; tobacco products	OTFD	OTFD	b_t	Beverages and Tobacco products
				sgr	Sugar and molasses
21	Manufacture of textiles	TEXT	TEXT	tex	Manufacture of textiles
22	Manufacture of wearing apparel	WEAR	WEAR	wap	Manufacture of wearing apparel
23	Manufacture of leather and related products	LEAT	LEAT	lea	Manufacture of leather and related products

No	Model sector		Aggre-gation code	GTAP sectors	Description of GTAP sectors
24	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	WOOD	WOOD	lum	Lumber: manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
25	Manufacture of paper and paper products	PAPR	ppp_	ppp	Paper & Paper Products: includes printing and reproduction of recorded media
26	Printing and reproduction of recorded media	PRNT			
27	Manufacture of refined petroleum products	PETR	p_c_	p_c	Petroleum & Coke: manufacture of coke and refined petroleum products
28	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	BSCH	crp_	crp	chemical, rubber and plastic products
29	Manufacture of pesticides and other agrochemical products	AGCH			
30	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	PNTS			
31	Manufacture of man-made fibres	FIBR			
32	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations; other chemical products n.e.c.	SOAP			
33	Manufacture of rubber and plastic products	RUBB			
34	Manufacture of basic pharmaceutical products and pharmaceutical preparations	PHAR			
35	Manufacture of glass and glass products	GLAS	nmm_	nmm	Manufacture of other non-metallic mineral products
36	Manufacture of refractoryproducts; clay building materials; other porcelain and ceramic products	CLAY			
37	Cutting, shaping and finishing of stone; manufacture of abrasive products and non-metallic mineral products n.e.c.	STON			

No	Model sector		Aggre-gation code	GTAP sectors	Description of GTAP sectors
38	Manufacture of basic metals	BSME	BSME	i_s	Iron & Steel: basic production and casting
				nfm	Non-Ferrous Metals: production and casting of copper, aluminium, zinc, lead, gold, and silver
39	Manufacture of fabricated metal products, except machinery and equipment	MEPR	MEPR	fmp	Manufacture of fabricated metal products, except machinery and equipment
40	Manufacture of general — purpose machinery	GPMA	ome_	ome	Manufacture of machinery and equipment n.e.c.
41	Manufacture of other general-purpose machinery	OTMA			
42	Manufacture of agricultural and forestry machinery	AGMA			
43	Manufacture of metal forming machinery and machine tools	MEMA			
44	Manufacture of other special-purpose machinery	SPMA			
45	Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus; batteries and accumulators; wiring and wiring devices; electric lighting equipment; other electrical equipment	BATT			
46	Manufacture of domestic appliances	APPL			
47	Manufacture of computers and peripheral equipment	COMP	ele_	ele	Manufacture of computer, electronic and optical products
48	Manufacture of electronic components and boards, communication equipment	ELTR			
49	Manufacture of consumer electronics, instruments and appliances for measuring, testing and navigation; watches and clocks; irradiation, electromedical and electrotherapeutic equipment; optical instruments and	OPTC			

No	Model sector	Aggre-gation code	GTAP sectors	Description of GTAP sectors
	photographic equipment; etc.			
50	Manufacture of motor vehicles, trailers and semi-trailers	VEHL	VEHL	mvh	Manufacture of motor vehicles, trailers and semi-trailers
51	Manufacture of other transport equipment	TREQ	TREQ	otn	Manufacture of other transport equipment
52	Manufacture of furniture; jewelry, musical instruments, toys; repair and installation of machinery and equipment	FURN	FURN	omf	Other Manufacturing: includes furniture

Table A.2: AVEs of time to export from Ukraine to partner regions/countries, in percent

	Model sectors		AVEs in percent						
			CHN	USA	RUS	TUR	EUR	FTR	ROW
1	Growing of crops, mixed farming	CROP	39.31	36.21	4.48	5.78	9.37	6.63	42.57
2	Animal production; hunting, trapping and related service activities	ANIM	19.28	21.00	3.17	1.88	2.81	3.32	10.72
3	Forestry and logging	LOGG	26.84	22.70	3.03	2.01	1.96	4.85	11.63
4	Fishing and aquaculture	FISH	15.35	13.41	1.86	1.14	1.02	1.06	7.58
5	Mining of coal and lignite	COAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Extraction of crude petroleum and natural gas	CGAS	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Mining of metal ores	ORES	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	Quarrying of stone, sand and clay	SAND	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	Mining of chemical and fertiliser minerals	CHMN	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Other mining and quarrying n.e.c., mining support service activities	OTMN	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	Processing and preserving of meat and production of meat products	PRMT	44.07	0.00	4.97	3.24	4.83	6.87	22.51
12	Processing and preserving of fish, crustaceans and molluscs	PRFS	38.57	34.52	5.83	3.23	3.95	7.22	26.46
13	Processing and preserving of fruit and vegetables	PRFV	38.57	34.52	5.83	3.23	3.95	7.22	26.46
14	Manufacture of vegetable and animal oils and fats	OILS	49.65	35.06	4.67	3.10	5.83	5.82	24.16
15	Manufacture of dairy products	DAIR	38.57	34.52	5.83	3.23	3.95	7.22	26.46
16	Manufacture of grain mill products, starches and starch products	MILL	38.57	34.52	5.83	3.23	3.95	7.22	26.46
17	Manufacture of prepared animal feeds	FEED	38.57	34.52	5.83	3.23	3.95	7.22	26.46
18	Manufacture of other food products n.e.c.; beverages; tobacco products	OTFD	15.76	12.74	1.78	1.14	1.26	1.46	11.01
19	Manufacture of textiles	TEXT	3.81	9.21	1.37	0.36	1.55	1.66	7.52
20	Manufacture of wearing apparel	WEAR	18.20	16.04	2.10	1.22	1.95	4.86	10.40
21	Manufacture of leather and related products	LEAT	10.51	6.52	1.38	0.78	0.87	0.49	3.40
22	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	WOOD	1.91	1.69	0.49	0.02	0.36	0.35	2.60
23	Manufacture of paper and paper products	PAPR	17.03	13.71	5.62	5.28	4.02	6.70	15.82
24	Printing and reproduction of recorded media	PRNT	17.03	13.71	5.62	5.28	4.02	6.70	15.82
25	Manufacture of coke	COKE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	Manufacture of refined petroleum products	PETR	53.33	38.65	5.52	3.36	4.01	10.46	17.68
27	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	BSCH	28.17	8.70	4.42	0.83	1.85	4.28	3.42
28	Manufacture of pesticides and other agrochemical products	AGCH	28.17	8.70	4.42	0.83	1.85	4.28	3.42

	Model sectors		AVEs in percent						
			CHN	USA	RUS	TUR	EUR	FTR	ROW
29	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	PNTS	28.17	8.70	4.42	0.83	1.85	4.28	3.42
30	Manufacture of man-made fibres	FIBR	28.17	8.70	4.42	0.83	1.85	4.28	3.42
31	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations; other chemical products n.e.c.	SOAP	28.17	8.70	4.42	0.83	1.85	4.28	3.42
32	Manufacture of basic pharmaceutical products and pharmaceutical preparations	PHAR	28.17	8.70	4.42	0.83	1.85	4.28	3.42
33	Manufacture of rubber and plastic products	RUBB	28.17	8.70	4.42	0.83	1.85	4.28	3.42
34	Manufacture of glass and glass products	GLAS	33.33	32.33	3.67	3.19	3.18	5.83	15.17
35	Manufacture of refractory products; clay building materials; other porcelain and ceramic products	CLAY	33.33	32.33	3.67	3.19	3.18	5.83	15.17
36	Manufacture of cement, lime and plaster; articles of concrete, cement and plaster	CEMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37	Cutting, shaping and finishing of stone; manufacture of abrasive products and non-metallic mineral products n.e.c.	STON	33.33	32.33	3.67	3.19	3.18	5.83	15.17
38	Manufacture of basic metals	BSME	4.60	1.47	2.92	0.04	0.35	0.80	1.07
39	Manufacture of fabricated metal products, except machinery and equipment	MEPR	1.23	21.24	2.88	1.63	2.05	2.79	14.98
40	Manufacture of general — purpose machinery	GPMA	11.69	14.63	1.88	0.84	1.19	2.27	8.36
41	Manufacture of other general-purpose machinery	OTMA	11.69	14.63	1.88	0.84	1.19	2.27	8.36
42	Manufacture of agricultural and forestry machinery	AGMA	11.69	14.63	1.88	0.84	1.19	2.27	8.36
43	Manufacture of metal forming machinery and machine tools	MEMA	11.69	14.63	1.88	0.84	1.19	2.27	8.36
44	Manufacture of other special-purpose machinery	SPMA	11.69	14.63	1.88	0.84	1.19	2.27	8.36
45	Manufacture of computers and peripheral equipment	COMP	12.28	15.81	2.16	0.97	1.02	2.13	10.17
46	Manufacture of electronic components and boards, communication equipment	ELTR	12.28	15.81	2.16	0.97	1.02	2.13	10.17
47	Manufacture of consumer electronics, instruments and appliances for measuring, testing and navigation; watches and clocks; irradiation, electromedical and electrotherapeutic equipment; optical instruments and photographic equipment;	OPTC	12.28	15.81	2.16	0.97	1.02	2.13	10.17

	Model sectors		AVEs in percent						
			CHN	USA	RUS	TUR	EUR	FTR	ROW
48	Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus; batteries and accumulators; wiring and wiring devices; electric lighting equipment; other electrical equipment	BATT	11.69	14.63	1.88	0.84	1.19	2.27	8.36
49	Manufacture of domestic appliances	APPL	11.69	14.63	1.88	0.84	1.19	2.27	8.36
50	Manufacture of motor vehicles, trailers and semi-trailers	VEHL	29.15	6.27	5.03	2.24	1.87	3.53	6.55
51	Manufacture of other transport equipment	TREQ	4.82	4.85	0.12	0.08	1.18	0.68	9.47
52	Manufacture of furniture; jewelry, musical instruments, toys; repair and installation of machinery and equipment	FURN	25.87	7.77	2.56	1.56	2.24	2.86	8.47

Table A.3: AVEs of time to import to Ukraine from partner regions/countries, in percent

	Model sectors		AVEs in percent						
			CHN	USA	RUS	TUR	EUR	FTR	ROW
1	Growing of crops, mixed farming	CROP	60.27	63.02	10.00	8.82	12.07	14.86	48.08
2	Animal production; hunting, trapping and related service activities	ANIM	30.63	17.91	3.40	2.33	4.03	4.93	15.44
3	Forestry and logging	LOGG	27.30	23.79	5.62	3.22	5.23	2.74	16.04
4	Fishing and aquaculture	FISH	37.52	13.66	0.00	2.01	3.27	2.59	10.66
5	Mining of coal and lignite	COAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Extraction of crude petroleum and natural gas	CGAS	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Mining of metal ores	ORES	0.01	0.02	0.01	0.00	0.01	0.02	0.17
8	Quarrying of stone, sand and clay	SAND	0.01	0.02	0.01	0.00	0.01	0.02	0.17
9	Mining of chemical and fertiliser minerals	CHMN	0.01	0.02	0.01	0.00	0.01	0.02	0.17
10	Other mining and quarrying n.e.c., mining support service activities	OTMN	0.01	0.02	0.01	0.00	0.01	0.02	0.17
11	Processing and preserving of meat and production of meat products	PRMT	0.00	39.07	0.00	0.00	6.93	19.18	35.29
12	Processing and preserving of fish, crustaceans and molluscs	PRFS	40.68	34.85	9.95	3.39	8.10	12.26	30.45
13	Processing and preserving of fruit and vegetables	PRFV	40.68	34.85	9.95	3.39	8.10	12.26	30.45
14	Manufacture of vegetable and animal oils and fats	OILS	37.94	36.89	8.68	4.94	7.08	8.78	30.61
15	Manufacture of dairy products	DAIR	40.68	34.85	9.95	3.39	8.10	12.26	30.45
16	Manufacture of grain mill products, starches and starch products	MILL	40.68	34.85	9.95	3.39	8.10	12.26	30.45
17	Manufacture of prepared animal feeds	FEED	40.68	34.85	9.95	3.39	8.10	12.26	30.45
18	Manufacture of other food products n.e.c.; beverages; tobacco products	OTFD	15.72	13.75	3.17	1.81	2.98	3.33	12.83
19	Manufacture of textiles	TEXT	19.19	8.18	3.57	1.78	3.18	3.23	12.32
20	Manufacture of wearing apparel	WEAR	20.44	16.80	4.02	2.24	3.31	2.65	15.59
21	Manufacture of leather and related products	LEAT	8.08	9.40	2.21	0.95	1.05	1.67	6.18
22	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	WOOD	4.99	9.49	1.67	0.81	1.27	1.01	3.01
23	Manufacture of paper and paper products	PAPR	55.63	40.05	7.50	7.94	7.81	7.08	30.24
24	Printing and reproduction of recorded media	PRNT	55.63	40.05	7.50	7.94	7.81	7.08	30.24
25	Manufacture of coke	COKE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	Manufacture of refined petroleum products	PETR	7.15	46.49	10.07	6.39	5.74	5.23	19.37
27	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	BSCH	37.23	27.56	5.57	4.39	5.54	7.24	23.40
28	Manufacture of pesticides and other agrochemical products	AGCH	37.23	27.56	5.57	4.39	5.54	7.24	23.40
29	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	PNTS	37.23	27.56	5.57	4.39	5.54	7.24	23.40

	Model sectors		AVEs in percent						
			CHN	USA	RUS	TUR	EUR	FTR	ROW
30	Manufacture of man-made fibres	FIBR	37.23	27.56	5.57	4.39	5.54	7.24	23.40
31	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations; other chemical products n.e.c.	SOAP	37.23	27.56	5.57	4.39	5.54	7.24	23.40
32	Manufacture of basic pharmaceutical products and pharmaceutical preparations	PHAR	37.23	27.56	5.57	4.39	5.54	7.24	23.40
33	Manufacture of rubber and plastic products	RUBB	37.23	27.56	5.57	4.39	5.54	7.24	23.40
34	Manufacture of glass and glass products	GLAS	46.26	32.33	7.77	3.25	5.32	2.70	20.81
35	Manufacture of refractory products; clay building materials; other porcelain and ceramic products	CLAY	46.26	32.33	7.77	3.25	5.32	2.70	20.81
36	Manufacture of cement, lime and plaster; articles of concrete, cement and plaster	CEMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37	Cutting, shaping and finishing of stone; manufacture of abrasive products and non-metallic mineral products n.e.c.	STON	46.26	32.33	7.77	3.25	5.32	2.70	20.81
38	Manufacture of basic metals	BSME	9.91	12.25	1.97	1.97	1.89	0.68	3.20
39	Manufacture of fabricated metal products, except machinery and equipment	MEPR	22.51	19.80	4.55	3.20	3.55	3.39	14.87
40	Manufacture of general — purpose machinery	GPMA	18.23	23.35	3.37	1.71	3.20	4.61	11.72
41	Manufacture of other general-purpose machinery	OTMA	18.23	23.35	3.37	1.71	3.20	4.61	11.72
42	Manufacture of agricultural and forestry machinery	AGMA	18.23	23.35	3.37	1.71	3.20	4.61	11.72
43	Manufacture of metal forming machinery and machine tools	MEMA	18.23	23.35	3.37	1.71	3.20	4.61	11.72
44	Manufacture of other special-purpose machinery	SPMA	18.23	23.35	3.37	1.71	3.20	4.61	11.72
45	Manufacture of computers and peripheral equipment	COMP	23.40	14.63	2.87	2.07	2.92	5.06	19.51
46	Manufacture of electronic components and boards, communication equipment	ELTR	23.40	14.63	2.87	2.07	2.92	5.06	19.51
47	Manufacture of consumer electronics, instruments and appliances for measuring, testing and navigation; watches and clocks; irradiation, electromedical and electrotherapeutic equipment; optical instruments and photographic equipment;	OPTC	23.40	14.63	2.87	2.07	2.92	5.06	19.51
48	Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus; batteries and accumulators; wiring and wiring devices; electric lighting equipment; other electrical equipment	BATT	18.23	23.35	3.37	1.71	3.20	4.61	11.72
49	Manufacture of domestic appliances	APPL	18.23	23.35	3.37	1.71	3.20	4.61	11.72
50	Manufacture of motor vehicles, trailers and semi-trailers	VEHL	20.23	52.28	5.58	4.56	6.33	9.46	47.48

	Model sectors		AVEs in percent						
			CHN	USA	RUS	TUR	EUR	FTR	ROW
51	Manufacture of other transport equipment	TREQ	36.83	8.83	0.38	0.09	1.19	6.10	37.70
52	Manufacture of furniture; jewelry, musical instruments, toys; repair and installation of machinery and equipment	FURN	26.41	20.18	3.23	3.20	4.71	2.29	17.73

Table A.4 Mapping from the GTAP Regions to WITS Regions to the Regions of our Model

GTAP code	GTAPregion	Partner ISO3 WITS	ISO Number	Partner Name WITS	Model regions	Model regions with relocated 2 Balkan states	Model regions with relocated 2 Balkan states PLUS split ROW into GTAP regions	Description 3
XSA	Rest of South Asia	AFG	26	Afghanistan	row	row	XSA	Rest of South Asia
ALB	Albania	ALB	82	Albania	row	row	ALB	Albania
XNF	Rest of North Africa	DZA	111	Algeria	row	row	XNF	Rest of North Africa
XOC	Rest of Oceania	ASM	3	American Samoa	row	row	XOC	Rest of Oceania
XER	Rest of Europe	AND	90	Andorra	row	row	XER	Rest of Europe
XAC	South Central Africa	AGO	123	Angola	row	row	XAC	South Central Africa
XCB	Rest of Caribbean	AIA	53	Anguila	row	row	XCB	Rest of Caribbean
XTW	Rest of the World	ATA	140	Antarctica	row	row	XTW	Rest of the World
XCB	Rest of Caribbean	ATG	53	Antigua and Barbuda	row	row	XCB	Rest of Caribbean
ARG	Argentina	ARG	31	Argentina	row	row	ARG	Argentina
ARM	Armenia	ARM	94	Armenia	fta	fta	fta	FTA without Balkans
XCB	Rest of Caribbean	ABW	53	Aruba	row	row	XCB	Rest of Caribbean
AUS	Australia	AUS	1	Australia	row	row	AUS	Australia
AUT	Austria	AUT	54	Austria	eu	eu	eu	EU27
AZE	Azerbaijan	AZE	95	Azerbaijan	fta	fta	fta	FTA without Balkans
XCB	Rest of Caribbean	BHS	53	Bahamas, The	row	row	XCB	Rest of Caribbean
BHR	Bahrain	BHR	97	Bahrain	row	row	BHR	Bahrain
BGD	Bangladesh	BGD	21	Bangladesh	row	row	BGD	Bangladesh
XCB	Rest of Caribbean	BRB	53	Barbados	row	row	XCB	Rest of Caribbean
BLR	Belarus	BLR	84	Belarus	fta	fta	fta	FTA without Balkans
BEL	Belgium	BEL	55	Belgium	eu	eu	eu	EU27
XCA	Rest of Central America	BLZ	48	Belize	row	row	XCA	Rest of Central America
BEN	Benin	BEN	112	Benin	row	row	BEN	Benin
XNA	Rest of North America	BMU	30	Bermuda	row	row	XNA	Rest of North America
XSA	Rest of South Asia	BTN	26	Bhutan	row	row	XSA	Rest of South Asia
BOL	Bolivia	BOL	32	Bolivia	row	row	BOL	Bolivia
XER	Rest of Europe	BIH	90	Bosnia and Herzegovina	row	row	XER	Rest of Europe
BWA	Botswana	BWA	136	Botswana	row	row	BWA	Botswana
XTW	Rest of the World	BVT	140	Bouvet Island	row	row	XTW	Rest of the World
BRA	Brazil	BRA	33	Brazil	row	row	BRA	Brazil
XTW	Rest of the World	IOT	140	British Indian Ocean Ter.	row	row	XTW	Rest of the World
XCB	Rest of Caribbean	VGB	53	British Virgin Islands	row	row	XCB	Rest of Caribbean
BRN	Brunei Darussalam	BRN	11	Brunei	row	row	BRN	Brunei Darussalam
BGR	Bulgaria	BGR	83	Bulgaria	eu	eu	eu	EU27
BFA	Burkina Faso	BFA	113	Burkina Faso	row	row	BFA	Burkina Faso
XEC	Rest of Eastern Africa	BDI	135	Burundi	row	row	XEC	Rest of Eastern Africa
KHM	Cambodia	KHM	12	Cambodia	row	row	KHM	Cambodia
CMR	Cameroon	CMR	114	Cameroon	row	row	CMR	Cameroon
CAN	Canada	CAN	27	Canada	fta	fta	fta	FTA without Balkans
XWF	Rest of Western Africa	CPV	121	Cape Verde	row	row	XWF	Rest of Western Africa
XCB	Rest of Caribbean	CYM	53	Cayman Islands	row	row	XCB	Rest of Caribbean
XCF	Rest of Central Africa	CAF	122	Central African Republic	row	row	XCF	Rest of Central Africa
XCF	Rest of Central Africa	TCD	122	Chad	row	row	XCF	Rest of Central Africa
CHL	Chile	CHL	34	Chile	row	row	CHL	Chile
CHN	China	CHN	4	China	chi	chi	chi	China
AUS	Australia	CXR	1	Christmas Island	row	row	AUS	Australia
AUS	Australia	CCK	1	Cocos (Keeling) Islands	row	row	AUS	Australia
COL	Colombia	COL	35	Colombia	row	row	COL	Colombia
XEC	Rest of Eastern Africa	COM	135	Comoros	row	row	XEC	Rest of Eastern Africa
XAC	South Central Africa	ZAR	123	Congo, Dem. Rep.	row	row	XAC	South Central Africa
XCF	Rest of Central Africa	COG	122	Congo, Rep.	row	row	XCF	Rest of Central Africa
XOC	Rest of Oceania	COK	3	Cook Islands	row	row	XOC	Rest of Oceania
CRI	Costa Rica	CRI	42	Costa Rica	row	row	CRI	Costa Rica
CIV	Côte d'Ivoire	CIV	115	Cote d'Ivoire	row	row	CIV	Côte d'Ivoire

Table A.4 (continued)

HRV	Croatia	HRV	85	Croatia	eu	eu	eu	EU27	Rest of Caribbean
XCB	Rest of Caribbean	CUB	53	Cuba	row	row	XCB	Rest of Caribbean
CYP	Cyprus	CYP	56	Cyprus	eu	eu	eu	EU27
CZE	Czech Republic	CZE	57	Czech Republic	eu	eu	eu	EU27
DNK	Denmark	DNK	58	Denmark	eu	eu	eu	EU27
XEC	Rest of Eastern Africa	DJI	135	Djibouti	row	row	XEC	Rest of Eastern Africa
XCB	Rest of Caribbean	DMA	53	Dominica	row	row	XCB	Rest of Caribbean
DOM	Dominican Republic P	DOM	49	Dominican Republic	row	row	DOM	Dominican Republic P
XSE	Rest of Southeast Asia	TMP	20	East Timor	row	row	XSE	Rest of Southeast Asia
ECU	Ecuador	ECU	36	Ecuador	row	row	ECU	Ecuador
EGY	Egypt	EGY	108	Egypt, Arab Rep.	row	row	EGY	Egypt
SLV	El Salvador	SLV	47	El Salvador	row	row	SLV	El Salvador
XCF	Rest of Central Africa	GNQ	122	Equatorial Guinea	row	row	XCF	Rest of Central Africa
XEC	Rest of Eastern Africa	ERI	135	Eritrea	row	row	XEC	Rest of Eastern Africa
EST	Estonia	EST	59	Estonia	eu	eu	eu	EU27
ETH	Ethiopia	ETH	124	Ethiopia(excludes Eritrea)	row	row	ETH	Ethiopia
XER	Rest of Europe	FRO	90	Faeroe Islands	row	row	XER	Rest of Europe
XSM	Rest of South America	FLK	41	Falkland Island	row	row	XSM	Rest of South America
XOC	Rest of Oceania	FJI	3	Fiji	row	row	XOC	Rest of Oceania
FIN	Finland	FIN	60	Finland	eu	eu	eu	EU27
XTW	Rest of the World	ATF	140	Fr. So. Ant. Tr	row	row	XTW	Rest of the World
FRA	France	FRA	61	France	eu	eu	eu	EU27
XOC	Rest of Oceania	PYF	3	French Polynesia	row	row	XOC	Rest of Oceania
XCF	Rest of Central Africa	GAB	122	Gabon	row	row	XCF	Rest of Central Africa
XWF	Rest of Western Africa	GMB	121	Gambia, The	row	row	XWF	Rest of Western Africa
GEO	Georgia	GEO	96	Georgia	fta	fta	fta	FTA without Balkans
DEU	Germany	DEU	62	Germany	eu	eu	eu	EU27
GHA	Ghana	GHA	116	Ghana	row	row	GHA	Ghana
XER	Rest of Europe	GIB	90	Gibraltar	row	row	XER	Rest of Europe
GRC	Greece	GRC	63	Greece	eu	eu	eu	EU27
XNA	Rest of North America	GRL	30	Greenland	row	row	XNA	Rest of North America
XCB	Rest of Caribbean	GRD	53	Grenada	row	row	XCB	Rest of Caribbean
XOC	Rest of Oceania	GUM	3	Guam	row	row	XOC	Rest of Oceania
GTM	Guatemala	GTM	43	Guatemala	row	row	GTM	Guatemala
GIN	Guinea	GIN	117	Guinea	row	row	GIN	Guinea
XWF	Rest of Western Africa	GNB	121	Guinea-Bissau	row	row	XWF	Rest of Western Africa
XSM	Rest of South America	GUY	41	Guyana	row	row	XSM	Rest of South America
XCB	Rest of Caribbean	HTI	53	Haiti	row	row	XCB	Rest of Caribbean
AUS	Australia	HMD	1	Heard Island and McDonald Isl	row	row	AUS	Australia
XER	Rest of Europe	VAT	90	Holy See	row	row	XER	Rest of Europe
HND	Honduras	HND	44	Honduras	row	row	HND	Honduras
HKG	Hong Kong, Special Adr	HKG	5	Hong Kong, China	row	row	HKG	Hong Kong, Special Administra
HUN	Hungary	HUN	64	Hungary	eu	eu	eu	EU27
XEF	Rest of European Free	IL	81	Iceland	fta	fta	fta	FTA without Balkans
IND	India	IND	22	India	row	row	IND	India
IDN	Indonesia	IDN	13	Indonesia	row	row	IDN	Indonesia
IRN	Iran, Islamic Republic o	IRN	98	Iran, Islamic Rep.	row	row	IRN	Iran, Islamic Republic of
XWS	Rest of Western Asia	IRQ	107	Iraq	row	row	XWS	Rest of Western Asia
IRL	Ireland	IRL	65	Ireland	eu	eu	eu	EU27
ISR	Israel	ISR	99	Israel	fta	fta	fta	FTA without Balkans
ITA	Italy	ITA	66	Italy	eu	eu	eu	EU27
JAM	Jamaica	JAM	50	Jamaica	row	row	JAM	Jamaica
JPN	Japan	JPN	6	Japan	row	row	JPN	Japan
JOR	Jordan	JOR	100	Jordan	row	row	JOR	Jordan
KAZ	Kazakhstan	KAZ	91	Kazakhstan	fta	fta	fta	FTA without Balkans
KEN	Kenya	KEN	125	Kenya	row	row	KEN	Kenya
XOC	Rest of Oceania	KIR	3	Kiribati	row	row	XOC	Rest of Oceania
XEA	Rest of East Asia	PRK	10	Korea, Dem. Rep.	row	row	XEA	Rest of East Asia
KOR	Korea, Republic of	KOR	7	Korea, Rep.	row	row	KOR	Korea, Republic of

Table A.4 (continued)

KWT	Kuwait	KWT	101	Kuwait	row	row	KWT	Kuwait
KGZ	Kyrgyztan	KGZ	92	Kyrgyz Republic	fta	fta	fta	FTA without Balkans
LAO	Lao PDR	LAO	14	Lao PDR	row	row	LAO	Lao PDR
LVA	Latvia	LVA	67	Latvia	eu	eu	eu	EU27
XWS	Rest of Western Asia	LBN	107	Lebanon	row	row	XWS	Rest of Western Asia
XSC	Rest of South African C	LSO	139	Lesotho	row	row	XSC	Rest of South African Customs
XWF	Rest of Western Africa	LBR	121	Liberia	row	row	XWF	Rest of Western Africa
XNF	Rest of North Africa	LBY	111	Libya	row	row	XNF	Rest of North Africa
LTU	Lithuania	LTU	68	Lithuania	eu	eu	eu	EU27
LUX	Luxembourg	LUX	69	Luxembourg	eu	eu	eu	EU27
XEA	Rest of East Asia	MAC	10	Macao	row	row	XEA	Rest of East Asia
XER	Rest of Europe	MKD	90	Macedonia, FYR	fta	ftab	XER	Rest of Europe
MDG	Madagascar	MDG	126	Madagascar	row	row	MDG	Madagascar
MWI	Malawi	MWI	127	Malawi	row	row	MWI	Malawi
MYS	Malaysia	MYS	15	Malaysia	row	row	MYS	Malaysia
XSA	Rest of South Asia	MDV	26	Maldives	row	row	XSA	Rest of South Asia
XWF	Rest of Western Africa	MLI	121	Mali	row	row	XWF	Rest of Western Africa
MLT	Malta	MLT	70	Malta	eu	eu	eu	EU27
XOC	Rest of Oceania	MHL	3	Marshall Islands	row	row	XOC	Rest of Oceania
XWF	Rest of Western Africa	MRT	121	Mauritania	row	row	XWF	Rest of Western Africa
MUS	Mauritius	MUS	128	Mauritius	row	row	MUS	Mauritius
MEX	Mexico	MEX	29	Mexico	row	row	MEX	Mexico
XOC	Rest of Oceania	FSM	3	Micronesia, Fed. Sts.	row	row	XOC	Rest of Oceania
XEE	Rest of Eastern Europe	MDA	89	Moldova	fta	fta	fta	FTA without Balkans
MNG	Mongolia	MNG	8	Mongolia	row	row	MNG	Mongolia
XER	Rest of Europe	MNT	90	Montenegro	fta	ftab	XER	Rest of Europe
XCB	Rest of Caribbean	MSR	53	Montserrat	row	row	XCB	Rest of Caribbean
MAR	Morocco	MAR	109	Morocco	row	row	MAR	Morocco
MOZ	Mozambique	MOZ	129	Mozambique	row	row	MOZ	Mozambique
XSE	Rest of Southeast Asia	MMR	20	Myanmar	row	row	XSE	Rest of Southeast Asia
NAM	Namibia	NAM	137	Namibia	row	row	NAM	Namibia
XOC	Rest of Oceania	NRU	3	Nauru	row	row	XOC	Rest of Oceania
NPL	Nepal	NPL	23	Nepal	row	row	NPL	Nepal
NLD	Netherlands	NLD	71	Netherlands	eu	eu	eu	EU27
XOC	Rest of Oceania	NCL	3	New Caledonia	row	row	XOC	Rest of Oceania
NZL	New Zealand	NZL	2	New Zealand	row	row	NZL	New Zealand
NIC	Nicaragua	NIC	45	Nicaragua	row	row	NIC	Nicaragua
XWF	Rest of Western Africa	NER	121	Niger	row	row	XWF	Rest of Western Africa
NGA	Nigeria	NGA	118	Nigeria	row	row	NGA	Nigeria
XOC	Rest of Oceania	NIU	3	Niue	row	row	XOC	Rest of Oceania
AUS	Australia	NFK	1	Norfolk Island	row	row	AUS	Australia
XOC	Rest of Oceania	MNP	3	Northern Mariana Islands	row	row	XOC	Rest of Oceania
NOR	Norway	NOR	80	Norway	fta	fta	fta	FTA without Balkans
XWS	Rest of Western Asia	PSE	107	Occ.Pal.Terr	row	row	XWS	Rest of Western Asia
OMN	Oman	OMN	102	Oman	row	row	OMN	Oman
PAK	Pakistan	PAK	24	Pakistan	row	row	PAK	Pakistan
XOC	Rest of Oceania	PLW	3	Palau	row	row	XOC	Rest of Oceania
PAN	Panama	PAN	46	Panama	row	row	PAN	Panama
XOC	Rest of Oceania	PNG	3	Papua New Guinea	row	row	XOC	Rest of Oceania
PRY	Paraguay	PRY	37	Paraguay	row	row	PRY	Paraguay
PER	Peru	PER	38	Peru	row	row	PER	Peru
PHL	Philippines	PHL	16	Philippines	row	row	PHL	Philippines
XOC	Rest of Oceania	PCN	3	Pitcairn	row	row	XOC	Rest of Oceania
POL	Poland	POL	72	Poland	eu	eu	eu	EU27
PRT	Portugal	PRT	73	Portugal	eu	eu	eu	EU27
QAT	Qatar	QAT	103	Qatar	row	row	QAT	Qatar
ROU	Romania	ROM	86	Romania	eu	eu	eu	EU27
RUS	Russian Federation	RUS	87	Russian Federation	rus	rus	rus	Russia
RWA	Rwanda	RWA	130	Rwanda	row	row	RWA	Rwanda
XWF	Rest of Western Africa	SHN	121	Saint Helena	row	row	XWF	Rest of Western Africa

XNA	Rest of North America	SPM	30	Saint Pierre and Miquelon	row	row	XNA	Rest of North America
XOC	Rest of Oceania	WSM	3	Samoa	row	row	XOC	Rest of Oceania
XER	Rest of Europe	SMR	90	San Marino	row	row	XER	Rest of Europe
XCF	Rest of Central Africa	STP	122	Sao Tome and Principe	row	row	XCF	Rest of Central Africa
SAU	Saudi Arabia	SAU	104	Saudi Arabia	row	row	SAU	Saudi Arabia
SEN	Senegal	SEN	119	Senegal	row	row	SEN	Senegal
XER	Rest of Europe	SER	90	Serbia, FR(Serbia/Montenegro)	row	row	XER	Rest of Europe
XEC	Rest of Eastern Africa	SYC	135	Seychelles	row	row	XEC	Rest of Eastern Africa
XWF	Rest of Western Africa	SLE	121	Sierra Leone	row	row	XWF	Rest of Western Africa
SGP	Singapore	SGP	17	Singapore	row	row	SGP	Singapore
SVK	Slovakia	SVK	74	Slovak Republic	eu	eu	eu	EU27
SVN	Slovenia	SVN	75	Slovenia	eu	eu	eu	EU27
XOC	Rest of Oceania	SLB	3	Solomon Islands	row	row	XOC	Rest of Oceania
XEC	Rest of Eastern Africa	SOM	135	Somalia	row	row	XEC	Rest of Eastern Africa
ZAF	South Africa	ZAF	138	South Africa	row	row	ZAF	South Africa
XSM	Rest of South America	SGS	41	South Georgia and the South S	row	row	XSM	Rest of South America
ESP	Spain	ESP	76	Spain	eu	eu	eu	EU27
LKA	Sri Lanka	LKA	25	Sri Lanka	row	row	LKA	Sri Lanka
XCB	Rest of Caribbean	KNA	53	St. Kitts and Nevis	row	row	XCB	Rest of Caribbean
XCB	Rest of Caribbean	LCA	53	St. Lucia	row	row	XCB	Rest of Caribbean
XCB	Rest of Caribbean	VCT	53	St. Vincent and the Grenadines	row	row	XCB	Rest of Caribbean
XEC	Rest of Eastern Africa	SUD	135	Sudan	row	row	XEC	Rest of Eastern Africa
XSM	Rest of South America	SUR	41	Suriname	row	row	XSM	Rest of South America
XSC	Rest of South African C	SWZ	139	Swaziland	row	row	XSC	Rest of South African Customs
SWE	Sweden	SWE	77	Sweden	eu	eu	eu	EU27
CHE	Switzerland	CHE	79	Switzerland	fta	fta	fta	FTA without Balkans
XWS	Rest of Western Asia	SYR	107	Syrian Arab Republic	row	row	XWS	Rest of Western Asia
XSU	Rest of Former Soviet U	TJK	93	Tajikistan	fta	fta	fta	FTA without Balkans
TZA	Tanzania, United Repul	TZA	131	Tanzania	row	row	TZA	Tanzania, United Republic of
THA	Thailand	THA	18	Thailand	row	row	THA	Thailand
TGO	Togo	TGO	120	Togo	row	row	TGO	Togo
XOC	Rest of Oceania	TKL	3	Tokelau	row	row	XOC	Rest of Oceania
XOC	Rest of Oceania	TON	3	Tonga	row	row	XOC	Rest of Oceania
TTO	Trinidad and Tobago P	TTO	52	Trinidad and Tobago	row	row	TTO	Trinidad and Tobago P
TUN	Tunisia	TUN	110	Tunisia	row	row	TUN	Tunisia
TUR	Turkey	TUR	105	Turkey	tur	tur	tur	Turkey
XSU	Rest of Former Soviet U	TKM	93	Turkmenistan	fta	fta	fta	FTA without Balkans
XCB	Rest of Caribbean	TCA	53	Turks and Caicos Isl.	row	row	XCB	Rest of Caribbean
XOC	Rest of Oceania	TUV	3	Tuvalu	row	row	XOC	Rest of Oceania
UGA	Uganda	UGA	132	Uganda	row	row	UGA	Uganda
UKR	Ukraine	UKR	88	Ukraine	ukr	ukr	ukr	Ukraine
ARE	United Arab Emirates	ARE	106	United Arab Emirates	row	row	ARE	United Arab Emirates
GBR	United Kingdom	GBR	78	United Kingdom	fta	fta	fta	FTA without Balkans
USA	United States of Americ	USA	28	United States	usa	usa	usa	USA
XOC	Rest of Oceania	UMI	3	United States Minor Outlying I	row	row	XOC	Rest of Oceania
URY	Uruguay	URY	39	Uruguay	row	row	URY	Uruguay
XSU	Rest of Former Soviet U	UZB	93	Uzbekistan	fta	fta	fta	FTA without Balkans
XOC	Rest of Oceania	VUT	3	Vanuatu	row	row	XOC	Rest of Oceania
VEN	Venezuela (Bolivarian F	VEN	40	Venezuela	row	row	VEN	Venezuela (Bolivarian Republi
VNM	Viet Nam	VNM	19	Vietnam	row	row	VNM	Viet Nam
XNF	Rest of North Africa	ESH	111	Western Sahara	row	row	XNF	Rest of North Africa
XWS	Rest of Western Asia	YEM	107	Yemen	row	row	XWS	Rest of Western Asia
ZMB	Zambia	ZMB	133	Zambia	row	row	ZMB	Zambia
ZWE	Zimbabwe	ZWE	134	Zimbabwe	row	row	ZWE	Zimbabwe

Source: Authors' estimates.

Appendix B. Estimates of the Ad Valorem Equivalents of Non-Tariff Measures (NTMs) for Imports of Ukrainian Goods

Veronika Movchan, Research Director, Institute for Economic Research and Policy Consulting (IER), Kyiv, Ukraine; and

David G. Tarr, Consultant with IER and the World Bank*

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Abstract: We calculate Frequency and Prevalence Indices of Sanitary and Phyto-Sanitary (SPS) measures and Technical Barriers to Trade (TBTs) for the 10,000 plus ten-digit tariff lines of the Ukrainian custom code of 2019; and we aggregate these indices to 55 goods sectors. We describe the progressive liberalization of the non-tariff barriers in Ukraine since its independence from the Soviet Union with its stifling GOST system of the post-Soviet era, to harmonization with European Union under the DCFTA, and how Ukraine eventually overcame the costly and substantial regulatory burden imposed by the State Standards authority. We estimate the ad valorem equivalents of NTMs in Ukraine for 55 sectors in two steps: (i) We calculate Frequency indices of Ukrainian SPS measures in 2005 and compare the total number of SPS measures in 2019 with those in 2005; we use those data to update the estimate of Kee, Nicita and Olarreaga (2009) for the aggregate AVE for mining and manufacturing; and (ii) we use our Prevalence indices by sector to generate the disperse AVEs across the sectors of Ukraine.

Key words: Non-tariff measures; ad valorem equivalents; Ukraine; regulation; frequency index; prevalence index.

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1. Introduction

In this paper, we estimate the ad valorem equivalents (AVEs) of non-tariff measures in Ukraine in 2019. Cadot and Gourdon (2014) have shown that the old command and control non-tariff measures, like quotas, bans, licenses and foreign exchange rationing have significantly declined in importance; but sanitary and phyto-sanitary (SPS) regulations and technical barriers to trade (TBTs) have become the new non-tariff measures (NTMs) that restrict trade.[52] We calculate Frequency and Prevalence indices of Sanitary and Phyto-Sanitary (SPS) measures and Technical Barriers to Trade (TBTs) for the 10,000 plus ten-digit tariff lines of the Ukrainian custom code of 2019; and we aggregate and present these indices for 55 goods sectors.

We describe the progressive liberalization of the non-tariff barriers in Ukraine, from the time of Ukraine's independence from the Soviet Union to the present. This includes a discussion of the stifling GOST system of the post-Soviet era, to the changes implemented with WTO accession in 2008, to harmonization with the European Union under the Deep and Comprehensive Free Trade Area (DCFTA). This historical discussion is directly relevant to the estimation methodology as we quantify the changes. At least as important, this historical discussion elaborates how the Standards authorities of Ukraine imposed substantial costs on the Ukrainian economy. This is an important story for the design of regulation and regulatory reform.

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[52] SPS regulations and standards on industrial goods, however, have legitimate regulatory functions. For example, in the case of SPS, countries have the right and obligation to protect human, animal and plant life. The World Trade Organization SPS and TBT agreements recognize these legitimate regulatory functions, but stipulate that any measures applied should not discriminate against imports and member countries are encouraged to apply international standards. The SPS agreement also calls on regulations to be applied in a manner that is science based and only applied to the extent necessary to protect human, animal or plant life or health. In the case of the TBT agreement, it encourages regulations, standards, testing and certification procedures that do not create unnecessary obstacles to trade. It stipulates that measures should not give domestic producers an unfair advantage and encourages mutual recognition of conformity assessment. For this reason, when referring to SPS or TBT measures, e use the term non-tariff measures, as opposed to non-tariff barriers. Where the non-tariff measure has a regulatory function, we assume that our measure is the discriminatory component of the regulation. Given these nuances, when referring to SPS or TBT measures, we use the term non-tariff measures, as opposed to non-tariff barriers. For further details of the WTO SPS and TBT agreements see:
https://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm4_e.htm#TRS

We estimate the ad valorem equivalents of NTMs in Ukraine for 55 goods sectors in two steps: (i) we update the estimate of Kee, Nicita and Olarreaga (2009) for the aggregate AVE for mining and manufacturing. We do this based on our calculation of Frequency indices of Ukrainian SPS measures in 2005 compared to the total number of SPS measures in 2019; and (ii) we use our Prevalence indices by sector to generate the disperse AVEs across the sectors of Ukraine.

2. The Evolution of the System of Regulating Product Standards in Ukraine: from the inherited Soviet regime to harmonization with the European Union.

2.1. Qualitative Changes. From the time of Ukrainian independence from the former Soviet Union, there have been dramatic *qualitative* changes in regulations that impact its Technical Barriers to Trade (TBTs). By 2019, we assess that they are dramatically more market oriented and importantly, considerably less costly to Ukrainian firms, importers and consumers. We summarize this evolution in this section, in part, because it directly impacts our estimation procedure. But we have not seen the story told and, due to the substantial burden imposed by the regulatory authority, it is an important record for issues in the design of regulation and regulatory reform.

As a part of the former Soviet Union, Ukraine inherited the Soviet system of product regulation known as "GOST" standards. In the absence of a market mechanism to regulate product quality, GOST standards regulated product "quality" not just health, safety or security. To regulate quality, they also regulated the production process in ways that did not impact health, safety or security. These regulations limited product innovation to better meet market demand or improve product quality, and limited production process innovation to reduce costs. As such, GOST standards have been widely criticized internationally as being non-tariff barriers on imports, and for their adverse role on innovation and growth in the economies that applied them.[53]

To be specific, in 1993, the Cabinet of Ministers adopted Decree 46-93[54] concerning the system of standards and mandatory certification. The Decree stipulated that unless cancelled explicitly or replaced by another standard, all Soviet standards (GOSTs in effect during the Soviet era) remained in force. According to this Decree, standards contained a mandatory component that had to be adhered to by all economic entities. (This mandatory component made these product specifications technical regulations, not voluntary standards.) The Decree also stipulated that there would be mandatory certification, a control

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[53] For example, the Asian Development Bank (2013, p.11) states a major obstacle to implementing an effective functioning SPS system in CAREC is the continued use of State Standards (GOST) inherited from the Soviet Union in seven of the ten CAREC countries. "*The most significant technical barriers to adherence to SPS principles, apart from being trade barriers itself, is the GOST system.*"

[54] See https://zakon.rada.gov.ua/laws/show/46-93/ed19930510.

procedure for compliance with the product regulations. The State Committee on Standardization, Metrology and Certification (Derzhstandart), or in some instances another ministry, was given the authority to enforce or modify the system of technical regulations. The State Committee on Standardization, Metrology and Certification was also given sole authority to organize issuance of certificates of compliance with the regulations, at a fee, and, importantly, to define the list of products for which it was necessary to have certificates of compliance.[55] In late 1990s, "mandatory certification" applied to approximately 32% of all tariff lines. So, though all products had to be produced under mandatory *standards* (at least, until 2001), only selected products that were defined by Derzstandart, faced additional costs of the state verification of compliance with the standards. Importantly for our purposes, the certification requirement applied to both domestic and imported products.

Ukraine gradually developed its own standards, some of which were international (ISO/EU), some were adopted from its participation in the CIS (Russian and other GOST standards) and a large number of the old GOST standards remained. In 2001, the Ukrainian Parliament passed the Law on Standardization 2408,[56] which converted all product standards to voluntary standards, unless legal acts specify otherwise. This law, however, did not have the effect that was hoped, since mandatory certification remained in effect and Derzstandart retained the legal right to define the list of products subject to mandatory certification. Mandatory certification was the mechanism that enforced compliance with rigid and

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[55] Article 14 of the 1993 Decree 46-93 states:

The state certification system is created by the State Committee of Ukraine on Standardization, Metrology and Certification - national certification body of Ukraine, which conducts and coordinates the work to ensure its functioning, namely:

- defines the basic principles, structure and rules of the system of certification in Ukraine;
- approves the lists of products subject to mandatory certification, and determines the timing of its implementation;
- appoints product certification bodies;
- accredits certification bodies and testing laboratories (centers), certifies expert auditors;
- establishes rules for the recognition of certificates of other countries;
- considers controversial issues of testing and compliance with product certification;
- maintains the Register of the state certification system; and
- organizes information support on certification issues.

The State Committee of Ukraine for Standardization, Metrology and Certification within its competence is responsible for compliance with the rules and procedures for product certification.

[56] See: https://zakon.rada.gov.ua/laws/show/2408-14.

frequently outdated standards even after the standards were officially announced as voluntary. In 2002, the State Committee on Standardization, Metrology and Certification updated the list of products subject to mandatory certification. Still, most of the listed standards were GOSTs, many of them adopted before 1992.[57] In a substantially unsuccessful effort at reform, the State Committee on Standardization, Metrology and Certification was replaced by the State Committee of Technical Regulation and Consumer Policy.[58] In 2005, the new Committee published an updated list of products subject to mandatory certification, which still contained many of the old GOST standards along with Ukrainian national standards.

In 2008, Ukraine acceded to the World Trade Organization. According to the WTO Working Party Report (Art.299), "from the date of accession, all existing national and regional standards would be voluntary, except those referred to or set out in technical regulations intended inter alia to protect national security interests, prevent deceptive practices, protect the life and health of people, animals or plants, as well as protect the environment." With this commitment to adhere to the WTO SPS and TBT agreement, Ukraine declared what had been passed into law in 2001: the standards were voluntary unless health or life, safety, security or environmental considerations required otherwise. The United States Trade Representative concluded that these commitments and changes by Ukraine represented substantial progress toward WTO compliance.[59]

Nonetheless, "mandatory certification" remained in place. True structural change began with implementation of the Deep and Comprehensive Free Trade Area (DCFTA) with the European Union. The DCFTA led to substantial reform of the product regulation regime, in particular, to harmonization of Ukrainian technical regulations and standards with the European Union. Finally, in 2018, the 1993 Decree on standards and mandatory certification was abolished.[60]

By 2019-2020, Ukraine applies a system of standards aligned with EU norms and practices. Importantly, the standards are voluntary; and the production process is not prescribed, i.e., different

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[57] See: https://zakon.rada.gov.ua/laws/show/z0782-02.

[58] See https://zakon.rada.gov.ua/laws/show/z0466-05.

[59] Bringing Ukraine's restrictive sanitary and phytosanitary regime and its import certification system into conformity with WTO rules was a priority objective for the United States in the negotiations…. U.S. efforts were also focused on ensuring that Ukraine would enforce intellectual property rights protection consistent with the TRIPS Agreement, including protection of undisclosed information for pharmaceuticals and agricultural chemicals. The United States Trade Representative (2008) indicated that Ukraine's commitments and legislative changes dealt with both issues. See.

[60] See: https://zakon.rada.gov.ua/laws/show/z0194-18#n13.

production processes that lead to the same safety level for a product are accepted. In some cases, there are mandatory safety requirements; in these cases, conformity with technical regulations is required, but again different production processes are allowed. For the majority of products subject to technical regulations, the conformity assessment can be done by the producer itself without any external assessment. If external conformity assessment is required (due to the high-risk profile of the product), it can be done by the state authority or a private organization.

Regarding the assessment of the AVE of NTMs on imports, a crucial difference between the import regime of 2019-2020 and the one of 2000-2005, is that the 2020 regime does not, in general, require a certificate of conformity. The declaration of conformity with the technical regulation is not on the list of the mandatory documents for imports; the only exemption is imports of medical devices. The declaration of conformity might be checked (i) if the product is in the annual plan for market surveillance. The plan, which is published annually, usually includes one specific technical regulation for each product group, e.g. gloves in the case of personal protective equipment; or (ii) if there is a registered complaint against the certain company (brand) or a risk warning regarding a specific product.

2.2 A Partial Quantitative Measure of the Changes. Quantitative measures of TBTs in Ukraine in the early part of this century are not comparable with the measures of 2019-2020. As we show in our data set, in 2019, there are 59 different mandatory technical regulations (TBTs), most of which differ from the TBTs of 2005. We have, however, calculated Frequency indices of SPS measures at the ten-digit level in 2005 and 2019. Since the GOST system was still in effect in 2005, we regard it as a reasonable proxy for the year of the data of Kee *et al*. The results, which are presented in table 2, show a substantial decline in the number of measures that are applied. The Frequency index in 2019 is only 41% of the Frequency Index in 2005.

2.3 Summary. The costs of compliance with technical regulations for both Ukrainian producers and importers have been significantly reduced as follows:

(i) Only essential safety requirements are controlled. Product quality and production processes are no longer controlled.

(ii) The mandatory check of most products by the Ukrainian state authority has been eliminated and replaced by a voluntary regime. Where technical regulations remain, the conformity assessment can be done by the producer itself for the majority of products. If an external assessment is required, it can be done by the state authority or a private organization. So, there is a competition among providers of this service.

(iii) Importantly for the ad valorem equivalents of import barriers, the declaration of conformity assessment has been removed from the list of documents that are mandatory for imports.

(iv) Prevalence indices of SPS measures in Ukraine in 2005 and 2019 show a 59 percent decline in the number of measures in 2019.

3. Literature Estimates of Non-tariff Measures of Ukraine

Several studies have examined the non-tariff barriers of Ukraine. Among these, Taran (2008), and Movchan and Eremenko (2003) focus on "frequency indices." We discuss frequency indices below and use them to adjust more aggregate ad valorem equivalents of non-tariff measures, but we need estimates of central ad valorem equivalents (AVEs) of the non-tariff measures to ground the analysis. Three studies have provided estimates of AVEs of the non-tariff measures related to Ukraine. Jakubiak *et al.* (2006) estimate the ad valorem equivalents of the barriers that Ukrainian exporters face on their exports to the European Union. While this is interesting, it does not provide us information on barriers on Ukrainian imports.

Movchan and Shportyuk (2008) build on the methodology of Kee *et al*. (2009) to estimate the trade impacts of standard as NTMs in eight aggregate manufacturing sectors in Ukraine. They calculate frequency indices of SPS and TBT measures in these eight sectors and estimate the impact of these indices on imports into these eight Ukrainian sectors. They do not, however, estimate AVEs.

Hartwell (2015) attempts to estimate the AVEs of non-tariff barriers in Ukraine based on the methodology of Novy (2013). As Novy (2013) explains, however, his measure of trade costs is indirect and a catch-all for anything that impacts trade flows. As a result, his measure of trade costs captures a wide variety of impacts of trade flows that include, but not limited to, core NTMs, transportation costs, tariffs, language barriers, bureaucratic red tape, information costs and poor security. Novy acknowledges that his estimates will typically exceed typical gravity estimates. since typical gravity estimates exclude some aspects of trade costs due to the difficulty in collecting data on barriers, such as core NTMs. A problem with the Novy approach, however, is that we do not know what instrument or policy is impacting the AVE, or the decomposition of the high AVEs into the impact of their components. This is not very helpful to reform minded policymakers who would like to identify the most important barriers to trade. For that reason, for the impact of NTMs, we calculate measures of the Frequency and Prevalence indices of NTMs in Ukraine in 2019, at the ten-digit tariff line level and aggregate to 55 goods sectors. We also, in an independent exercise, Olekseyuk and Tarr (forthcoming), estimate the impact of time in trade costs for Ukraine based on the data Hummels and Schaur (2013) and Minor (2014).

 Returning to Hartwell (2015), he estimates AVEs of what he refers to as non-tariff barriers on imports into Ukraine for 22 goods sectors and from six regions: the European Union, EFTA, Turkey, Russia, the Eurasian Economic Union and the Rest of the World. Hartwell (2015) adjusts for tariffs, but, like Novy, estimates the impact of trade costs indirectly from trade flows, so does not employ any

measure, like frequency indices of NTMs in Ukraine in his econometrics. So as with the Novy methodology, his estimates include all other impacts on trade flows, not only core non-tariff measures. The AVEs average more than 100 percent in Hartwell. To assess the realism of these results, consider domestic appliances. We show below that this is the sector in Ukraine with the most combined SPS and TBT measures. Then this sector might be expected to have the largest AVE of NTMs. In table 1, we exhibit data of a price comparison study between domestic appliances (with identical firm and product numbers) in Poland and Ukraine. Since Poland is in the European Union, with rather low internal trade barriers among the EU members, producers of domestic appliances in Poland face significant competition with relatively low core non-tariff barriers. Polish prices should provide a reasonable benchmark for comparison against world prices of domestic appliances delivered to Ukraine. Based on publicly available survey data, we see that domestic appliances in Ukraine are on average six percent higher in price than in Poland. These data reflect the fact that the non-tariff measures against imports have been dramatically liberalized in Ukraine in the past 20 years (see section 3). In Hartwell's closest product categories, however, he estimates the AVEs of electronic machinery and equipment at 105%, and for manufactures not classified elsewhere at 107%. Consistent with the argument of Novy, it is possible that Hartwell's AVE measure is a reasonable estimate of all the factors impacting trade costs in Ukraine. But this indicates to us that estimates by Hartwell of the AVEs of about 100% are unrealistically high as an estimate of what we seek: the AVEs of Ukrainian core NTMs on imports.

Kee, Nicita and Olarreaga (2009) employ a measure of core NTMs on goods to estimate the AVEs of NTMs on goods at the six-digit level in 167 countries. In section 4, we discuss their methodology, estimates for Ukraine and how we update their AVE estimates.

4. Central Estimates of the Ad Valorem Equivalents of Non-Tariff Measures

4.1. The estimates of Kee et al. (2009) for Ukraine. For many years since its publication, the gold standard for the estimates of the AVEs of core non-tariff measures in goods is the work of Kee, Nicita and Olarreaga (2009). In the case of Ukraine, we begin with the estimates of Kee *et al*., (2009), but adapt them based on: (i) our data on current SPS and TBT measures in Ukraine; and (ii) on our discussion in section 3 of how the regulatory regime in Ukraine has dramatically evolved toward a more market-oriented liberal SPS and TBT regime. Kee *et al*., (2009) estimate the AVEs of NTMs for 105 countries at the 6-digit level as well as aggregated estimates for manufacturing and agriculture.[61] The measure we start with is from Kee *et al*. It is the uniform tariff equivalent that generates the same level of import value for

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[61] The dataset is available at:

http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:22574446 ~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html.

the country in a given year, based on applied tariffs, which take into account bilateral trade preferences.[62] At the six-digit level, the estimates of Kee *et al.* are sometimes subject to a substantial margin of error that may lead to misleading results in a CGE model policy analysis.[63] Consequently, we start with the aggregated estimates of Kee *et al.* That is, 19.4 percent is the estimate from Kee *et al.* of the AVE for the aggregate manufacturing group of Ukraine; and 3.3 percent is the estimate from Kee *et al.* of the AVE for the agricultural group.

Equation (1) of Kee *et al.* (2009) is the following:

$$\ln(m_{i,c}) = \alpha_i + \sum_k \alpha_{i,k} C_c^k + \beta_{i,c}^{NTM} NTM_{i,c} + \beta_{i,c}^{DS} \ln(DS_{i,c}) + \varepsilon_{i,c} \ln(1+t_{i,c}) + \mu_{i,c} \quad (4)$$

where $m_{i,c}$ is the import value of good i in country c at world prices, α_i are tariff line fixed effect dummies, C_c^k are country characteristic variables, $NTM_{i,c}$ is the measure of Core NTMs[64] of product i in country c, $DS_{i,c}$ is a measure of domestic support for agricultural product i in country c, $t_{i,c}$ is the ad valorem tariff, $\varepsilon_{i,c}$ is the import demand elasticity, and $\mu_{i,c}$ are error terms. Then $\beta_{i,c}^{NTM} \leq 0$ [65] is the coefficient they estimate to determine the impact of their measure of NTMs on imports.

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[62] Specifically, we take the difference between the Overall Trade Restrictiveness Index (OTRI) and for the Tariff-only OTRI (OTRI_T), which gives us the AVE of the NTMs.

[63] Whether to aggregate elasticities or not is a complex question that depends on the sector focus of the research and the confidence in the reliability of sector estimates. In addition to the estimates of Kee *et al.* (2009) that differ by sector, there are other estimates of NTMs that differ by sector, such as in Cadot and Gourdon (2014) and de Melo and Vijil (2016). The problem is, as expressed by Costinot and Rodriguez-Clare (2014) "as the number of elasticities [and AVEs] that needs to be estimated increases, the precision with which each of these elasticities is estimated tends to decrease. Accordingly, results become much more sensitive to the presence of outliers." They note that estimates by Caliendo and Parro (2015) at the sector level would imply infinite gains from trade in autos. In an earlier application of the CGE model of Balistreri, Tarr and Yonezawa (2015), the authors found that results were also driven by outliers when they employed sector estimates of AVEs. Since they did not find evidence to support the wide variation in sector AVE estimates, they reverted to the more aggregate approach.

[64] We use the notation NTM in place of "Core" in Kee *et al.* (2009), but otherwise use their notation.

[65] Without a transformation, Kee *et al.* (2009) found that some of the estimates of $\beta_{i,c}^{NTM}$ are positive; they note that these estimates are "economically meaningless." Consequently, they employ the

The strength of the approach of Kee *et al.*, (2009) for estimating the AVEs is that they employ a measure of what they call "core" non-tariff barriers in their econometrics. (For reasons explained in footnote 1, we use the term non-tariff measures in this paper.) They define their measure of core non-tariff barriers as: price control measures; quantity restrictions; monopolistic measures; and technical regulations. They use a measure of this variable and its estimated coefficient to convert the measure of what they call core non-tariff barriers into an AVE of the barriers.

To obtain the AVEs of the NTMs, Kee *et al.* (2009) note that the elasticity of demand is equal to

$$\frac{\partial \ln(m_{i,c})}{\partial \ln(p_{i,c}^d)} = \varepsilon_{i,c},$$ where $p_{i,c}^d$ is the domestic price; they obtain the elasticity values from their

estimates in Kee *et al.* (2008). They define the ad valorem equivalents of the NTMs as:

$$AVE_{i,c} = \frac{\partial \ln(p_{i,c}^d)}{\partial NTM_{i,c}} \ . \tag{5}$$

Using these definitions, they note that the chain rule applied to differentiation of equation (4) with respect to the NTMs implies:

$$\frac{\partial \ln(m_{i,c})}{\partial NTM_{i,c}} = \frac{\partial \ln(m_{i,c})}{\partial \ln(p_{i,c}^d)} \frac{\partial \ln(p_{i,c}^d)}{\partial NTM_{i,c}} = \varepsilon_{i,c} AVE_{i,c} \tag{6}$$

Differentiation of equation (4) directly with respect to the NTM yields $\dfrac{\partial \ln(m_{i,c})}{\partial NTM_{i,c}} = \beta_{i,c}$; and

rearranging equation (6) yields:

$$AVE_{i,c} = \frac{\beta_{i,c}}{\varepsilon_{i,c}} \ {}^{66} . \tag{7}$$

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transformation: $\beta_{i,c}^{NTM} = -e^{\gamma_i + \sum_k \gamma_{i,k} C_c^k} \leq 0$ and estimate the gamma coefficients, which yields estimates

of $\beta_{i,c}^{NTM}$. For clarity, we substitute the gamma coefficients for beta coefficients in Kee *et al.* (2009).

[66] Kee *et al.* (2009) use a transformed value of $\beta_{i,c}$ in which case they obtain $AVE_{i,c} = -\dfrac{e^{\beta_{i,c}^{NTM}} - 1}{\varepsilon_{i,c}}$;

but in either case, the result is an estimated value that is known.

Using equation (7), Kee *et al.* (2009) solve for and calculate the estimated $AVE_{i,c}$. In the case of Ukrainian manufactured goods, this value is 19.4 percent.

4.2 Adaption of the Central Estimate in Ukrainian Manufacturing for the Quantitative Liberalization of the Product Regulatory Regime. Unfortunately, the measure of NTMs that Kee *et al.* (2009) employed is outdated for Ukraine. In the case of Ukraine, the measure of NTMs used by Kee *et al.* is from 1997. Given the dramatic liberalization of the regime on technical regulations in Ukraine, especially toward imports, the rather high estimate of an AVE of NTMs of 19.4 percent in Manufacturing appears high and in need of an update. In this section, we adapt the estimate of the AVEs of NTMs of Kee *et al.* (2009) for the liberalization of the regulatory regime of NTMs.

We use the estimate of Kee *et al.* (2009) of 19.4 percent AVE for Ukrainian manufactured goods and our data on our updated NTM measure to update the aggregate AVE measure in Ukrainian manufacturing. Since the AVE must be a function of the NTM, we need to introduce the NTM explicitly into our measure of the AVE. Since we measure a discrete change in the NTMs between 2005 and 2019, we convert equation (5) to a discrete version:

$$\frac{\Delta p_{i,c}^d / p_{i,c}^d}{\Delta NTM_{i,c}} = \frac{(p_{i,c}^d - p_{i,c}^w)/ p_{i,c}^d}{\Delta NTM_{i,c}} = 19.4\% \qquad (8)$$

where $p_{i,c}^w$ is the world price, i is Manufacturing and c is Ukraine in what follows. Rearranging, we have:

$$AVE_{i,c} = \frac{(p_{i,c}^d - p_{i,c}^w)}{p_{i,c}^d} = 19.4\% * \Delta NTM_{i,c} \qquad (9)$$

Note that for the discrete case, we are defining the AVE using the conventional definition as defined by, for example, Gourdon, Cadot and van Tongeren (2018): "the ad valorem equivalent of an NTM is the proportional rise in the domestic price of the goods to which it is applied, relative to a counterfactual where it is not applied." In the classic definition of the AVE, we assume that the NTM is zero in the counterfactual, in which case $\Delta NTM = NTM$. In our case, we will compare two equilibria, both of which have NTMs.

We show in table 2, that at the level of 10-digit tariff lines, there were 8195 mandatory SPS measures in place in 2005, but the number of these measures declined to 3341 in 2019.[67] That is, this measure of NTMs shows that NTMs in 2019 were only 41 percent of the number of NTMs in 2005. In addition, as a further indication of the reduction in NTMs in Ukraine, between 1997 and April 2000,

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[67] Comparable data over time of TBTs is not available.

Ukraine employed a regime of "minimum customs value," which is more commonly referred to as "reference prices" for the purpose of customs valuation. At its peak, this regime applied to 22 percent of food processing tariff lines and 16 percent of the textile and leather tariff lines and would, in part, have been included in the Core measure of NTBs used by Kee *et al.* (2009).

Define $NTM_{i,c}(2005)$ to be our measure of NTMs in the product group manufacturing in Ukraine in 2005, and similarly for 2009. From the results in table 2, these values are:

$$NTM_{i,c}(2005) = 8195 \text{ and } NTM_{i,c}(2019) = 3341 \tag{10}$$

We index $NTM_{i,c}(2005) = 1$. Then $NTM_{i,c}(2019) = 0.41$ and the change in the NTM measure between the two periods is a decline of 59% of its value in 2005. To implement a 59% decline in the NTM, we take $\Delta NTM_{i,c} = 0.41$. Then our quantitative based adjustment of the AVE of the NTMs in an aggregate of Ukrainian Manufacturing is:

$$AVE_{i,c}(2019) = 0.41 * AVE_{i,c}(2005) = 0.41 * 19.4\% = 7.9\% \tag{11}$$

4.3 Adaption of the Central Estimate in Ukrainian Manufacturing for the Qualitative Liberalization of the Product Regulatory Regime.

Given that Ukraine has moved from the stifling Soviet Union style system of standards regulation in 1997 to a system harmonized with the European Union in 2020, we should also adjust for the qualitative way NTMs are implemented in Ukraine in 2020 compared with the earlier years when the survey for work of Kee *et al.* was done. That is, we believe a simple quantitative adjustment would still exaggerate the AVE in mining and manufacturing. As table 1 shows, a price comparison study of domestic appliances, which is the Ukrainian sector *most* impacted by TBTs in 2019, shows only a six percent increase in prices over Polish prices. This suggests a smaller average AVE than 7.9 percent. We take an average AVE of 5.5 percent as our central value for mining and manufacturing.

4.4 Agricultural AVEs. In agriculture, we use the estimate of the AVE of Kee *et al.*, which is 3.3 percent. The reason is that domestic support, which is most relevant to agriculture, is included as a separate explanatory variable for the quantity impact in the estimates of Kee *et al.*; and, by international standards, the AVE of 3.3 is quite low. Thus, we do not judge it appropriate to reduce it further, but acknowledge that in the case of agriculture, we are capturing the impact of both NTMs and domestic support.

Summary. We have two central AVEs of NTMs: 5.5 percent in mining and manufacturing, and 3.3 percent in agriculture. We now turn to providing diverse estimates for our 55 aggregated goods sectors,

by using Frequency indices, or more precisely in our case, Prevalence indices at the sector level. But we shall preserve the unweighted AVE averages for all of agriculture of 3.3 percent and 5.5 percent for an aggregate of mining and manufacturing.

5. Frequency and Prevalence Indices--Definitions

Although Frequency indices in themselves do not provide an indication of the ad valorem equivalents of non-tariff barriers, economists have employed them as an indicator of trade protection. An important contribution of Kee et al. (2009) was that they used them as the key independent variables in their econometric estimates of the ad valorem equivalents of non-tariff measures. The frequency index summarizes the percentage of products to which one or more NTMs are applied. It may apply at the economy-wide level or an aggregate sector level. In more formal terms, the aggregate frequency index of NTMs for a country or region r imposed by region r is calculated as:

$$F_r = \frac{\sum_j D_j M_j}{\sum_j M_j} \text{ if } M_j = 1, \tag{12}$$

where D_j is a dummy variable which takes the value one if there is one or more NTM (a SPS or TBT measure only in our case) at tariff line j, M_j is also a dummy variable taking the value one if there are positive imports at tariff line j. We calculate Frequency indices at the level of an aggregate sector. That is, there are more than 10,000 tariff lines at the 10-digit level in the Ukrainian tariff schedule. We aggregate these to the 55 goods sectors in our model. For each tariff line j, we define a mapping to a set $I(i)$ which is the set of ten-digit tariff lines that we map to sector i. Formally,

$$I(i) = \left(j \middle| j \text{ is a ten-digit tariff line that is mapped to the sector } i \right), \; i = 1,...,55 \,.$$

Here $i = 1,...,55$ correspond to the sectors in our model that are not services sectors. These 55 sets are non-intersecting and their union constitutes the entire set of Ukrainian tariff lines at the ten-digit level, i.e.,

$$\bigcup_{i=1}^{55} I(i) = I \text{ and}$$

$$I(\mathrm{i}) \cap I(k) = \varnothing \quad \forall i, k \in (1,...,55) \; i \neq k \,,$$

where I is the set of all tariff lines of goods at the ten-digit level. For each of the sectors of our model, we calculate two indices: one for SPS measures and one for TBT measures.

$$F^v(i) = \frac{\sum\limits_{j \in I(i)} D_j M_j}{\sum\limits_{j \in I(i)} M_j} \quad i = 1,...,55 \, ; v = \text{SPS, TBT.} \tag{13}$$

Here D_j is a dummy variable which takes the value one if there is one or more NTMs at tariff line of the type we are measuring (either SPS or TBT) $j \in I(i)$, M_j is also a dummy variable taking the value one if there are positive imports at tariff line $j \in I(i)$.

In some cases, there are multiple types of NTMs (SPS or TBT measures in our case) applied on a single tariff line. It would seem useful to have a measure that incorporates the information that there are multiple types of NTM measures, rather than ignoring them in the calculations. As a result, CEPII (Centre d'Etudes Prospectives et d'Informations Internationales) also employ an index called the Prevalence index, see Gourdon (2014). The Prevalence index replaces the dummy variable D_j with a variable N_j, where the latter is a count of the number of types of NTMs that apply (again only SPS and TBTs in our case).

$$P^v(i) = \frac{\sum\limits_{j \in I(i)} N_j M_j}{\sum\limits_{j \in I(i)} M_j} \quad i = 1,...,55 \, ; v = \text{SPS, TBT} \tag{14}$$

We define the overall Prevalence index for a sector as the sum of Prevalence indices for both TBT and SPS measures:

$$P(i) = P^{SPS}(i) + P^{TBT}(i). \tag{15}$$

6. Frequency and Prevalence Indices in Ukrainian Data for 2018

6.1 SPS Measures. We present the results of our calculations of our SPS measures in table A.1. As an example, take the first sector of our model, "Growing of Crops, mixed farming." This sector has the code in our model "CROP," as shown in the table. Although not shown in the table, there are 353 tariff lines (at the 10-digit level) that are mapped into our sector CROP. Of these, there are 318 tariff lines with positive Ukrainian imports from somewhere in the world. SPS regulations are measured in three categories: (i) Food Safety, with results reported in column 1; (ii) phytosanitary measures, results reported in column 2; and (iii) veterinary measures, with results reported in column 3.

 Take Food Safety as an example. For any ten-digit tariff line, we use a scoring measure of one or zero. If there are zero food safety regulations that apply to this tariff line, we score the component of the

frequency and prevalence indices for Food Safety for this tariff line at zero.[68] If a particular ten-digit tariff line has one or more Food Safety regulations that apply, and there are positive imports on this tariff line, we score the component of the Frequency and Prevalence indices of the Food Safety measure at one. Note that, consistent with the standard methodology (see Bora *et al*., (2002); Nicita *et al*., (2013); and Gourdon, 2014), we ignore multiple Food Safety regulations applying on a ten-digit tariff line. i.e., if there is one Food Safety regulation or more than one Food Safety regulation on a particular ten-digit tariff line, the measure is one in both cases. We see that out of the 353 tariff lines mapped to CROP, there are 264 that have at least one Food Safety measure applied where there are positive imports. We apply a similar methodology for Phytosanitary measures and Veterinary measures; we see that in CROP in Ukraine, there are 307 tariff lines with at least one phytosanitary measure applied with positive imports and zero veterinary measures. We apply the same methodology for all other sectors of our model. This explains the data in columns 1, 2 and 3.

Column 5 is the Frequency Measure of equation (13). If a particular ten-digit tariff line has both a Food Safety and a Phytosanitary measure applied, it is scored at one by a Frequency Measure. Our Prevalence measure, however, scores this tariff line at 2. Column 5 is the total number of tariff lines mapped to the sector, for example CROP. Consistent with the standard methodology of Frequency and Prevalence Indices, we ignore tariff lines with zero imports.

Column 6 is our Prevalence Measure of equation (13). Unlike the Frequency measure, the Prevalence Measure sums the dummy variables for all three food safety SPS measures in its numerator. It is the ratio

$$\frac{\textbf{Sum of columns 1 + 2 + 3}}{\textbf{column 4}}.$$

6.2 Technical Barriers to Trade (TBTs). The methodology for TBT measures is identical to the methodology for SPS measures. However, instead of three categories of SPS measures, there are 59 categories of TBTs. We calculate these in a separate file and present the results of the Frequency and Prevalence Measures in columns 7 and 8 of table 4. In column 9, we sum the Prevalence indices for SPS and TBT to get our overall Prevalence Index for each sector.

7. Decision Rule on Adaption of the Central AVE Estimates based on our Prevalence Indices of SPS and TBT measures.

We consider two aggregated groups of sectors: (i) Agriculture, Forestry, Fishing; and (ii) Manufacturing and Mining. Using our definition of $P(i)$ as the Prevalence index of sector i, define the average

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[68] For example, all sub-codes of HS 060110 "Bulbs, tubers, corms, crowns and rhizomes, dormant" belonging to CROP are not subject to any food safety regulation.

unweighted Prevalence Index for each of these two groups as: $\bar{P} = \sum_{i=1}^{n} P(i)/n$ where n is the number

of sectors in the group. These average values are 1.25 for Agriculture, Forestry, Fishing; and 1.41 for

Mining and Manufacturing. Define $y(i) = P(i) - \bar{P}$, which is, for each sector, the difference

between its Prevalence index and the average Prevalence index of the group of sectors. These values are

in column 12. Note that, since the y(i) are defined as deviations from the average P(i), the sum over all the

y(i) = 0:

$$\sum_{i=1}^{n} y(i) = \sum_{i=1}^{n} [P(i) - \bar{P}] = \left[\sum_{i=1}^{n} P(i) \right] - n\bar{P} = \left[\sum_{i=1}^{n} P(i) \right] - n \frac{\sum_{i=1}^{n} P(i)}{n} = 0 \qquad (16)$$

Define AVE(i) as our estimated ad valorem equivalents in sector i. We begin with our estimate of the

AVE for the aggregate sect*or* and use the adjustment coefficient as: $1 + \dfrac{y(i)}{5}$. The values for the

adjustment coefficients are in column 13. We define

$$AVE(i) = AVE(Aggregate)\left[1 + \frac{y(i)}{5}\right], \qquad (17)$$

where $AVE(i)$ is our *unscaled* estimate of the ad valorem equivalent of sector i and

$AVE(Aggregate)$ is 5.5% percent in the aggregate mining and manufacturing sector and 3.3 percent

in the aggregate agriculture sector. These values are in column 15.

Note that since $\sum_{i=1}^{n} y(i) = 0$, our adjustment retains the central average ad valorem equivalent

for the group. That is:

$$\sum_{i=1}^{n} AVE(i) = AVE(Aggregate)\left[\sum_{i=1}^{n}\left(1 + \frac{y(i)}{5}\right)\right] = AVE(Aggregate)\left[n + \frac{\sum_{i=1}^{n} y(i)}{5}\right] = AVE(Aggregat$$

,

$$\text{or} \qquad \frac{\sum_{i=1}^{n} AVE(i)}{n} = AVE(Aggregate) \qquad\qquad (18)$$

8. Disaggregated AVEs in Agriculture, Forestry, Fishing and Mining

We have four sectors in our model representing agriculture, forestry, fishing and mining. For these

sectors, $\overline{P}$, the unweighted average of these ten indices, is 1.25. $y(i) = P(i)$- 1.25. Applying equation (17)

, the AVE(i) for the model is:

$$AVE(i) = 3.3\left[1 + \frac{y(i)}{5}\right], \qquad\qquad (19)$$

where 3.3 is the estimate from Kee *et al*. for the aggregate group of agricultural sectors, which we take for

mining as well. The results are in columns 0 and 16.

9. Adjustment for Sectors with no SPS or TBT Measures

If there are no non-tariff measures in a sector, the AVE should be zero. Accordingly, we define the AVE

of sectors with a Prevalence index of zero, to have an AVE of zero. As a result, we will get

$$\frac{\sum_{i=1}^{n} AVE(i)}{n} < AVE(Aggregate) \quad \text{or} \quad \frac{k\sum_{i=1}^{n} AVE(i)}{n} = AVE(Aggregate)$$

We solve for k from:

$$k = \frac{n * AVE(Aggregate)}{\sum_{i=1}^{n} AVE(i)} . \qquad\qquad (20)$$

Since there are no sectors with zero NTMs in Agriculture, there is no scaling in Agriculture, or

equivalently, the value of k is one. The value of k that solves equation (20) for Mining and Manufacturing

is 1.054. Our final estimated ad valorem equivalent for each sector is $k * AVE(i)$. With this

adjustment, we have an average AVE equal to the aggregate estimate for the group and we have AVE(i) =

0 if P(i) = 0. These values are in columns 0 and 16.

10. Disaggregated AVEs in Mining and Manufacturing

There are 51 sectors in manufacturing and mining. The unweighted average of these 51 Prevalence

indices is 1.41. There are four sectors in this group with no non-tariff measures: Mining of coal; Printing;

Electric Power Generation; and Manufacture and Distribution of Gas. For these sectors P(i) = 0. If P(i) =

0, we define AVE(i) = 0. For each P(i), where P(i) > 0, define y(i) = P(i) – 1.41, which is, for each sector, the difference between its Prevalence index and the average Prevalence index of the Mining and Manufacturing group of sectors. Then define the AVE(i) as:

$$AVE(i) = 5.5 * 1.054 \left[1 + \frac{y(i)}{5} \right] \quad \text{if} \ \ P(i) > 0$$
$$= 0 \ \ \text{if} \ \ P(i) = 0$$

(21)

, where 5.5 is our estimate of the AVE in percent for the aggregate mining and manufacturing group of Ukraine and 1.054 = k, the value of the scaling factor we solve for from equation (20). Then the average AVE across the disaggregated sectors is consistent with our aggregate estimate for mining and manufacturing of 5.5 percent. The results are in columns 0 and 16.

11. Conclusion

We have calculated Frequency and Prevalence indices of Sanitary and Phyto-Sanitary (SPS) measures and Technical Barriers to Trade (TBTs) for the 10,000 plus ten-digit tariff lines of the Ukrainian custom code of 2019; and we aggregate these indices to 55 goods sectors. We describe the progressive liberalization of the non-tariff barriers in Ukraine during the last 25 years, from the stifling GOST system of the post-Soviet era, to the changes implemented with WTO accession in 2008, to harmonization with European Union under the DCFTA. We estimate the ad valorem equivalents of NTMs in Ukraine for 55 manufacturing sectors in two steps: (i) We calculate Frequency indices of Ukrainian SPS measures in 2005 and compare the total number of SPS measures in 2019 with those in 2005; we use those data to update the estimate of Kee, Nicita and Olarreaga (2009) for the aggregate AVE for mining and manufacturing; and (ii) we use our Prevalence indices by sector to generate the disperse AVEs across the sectors of Ukraine.

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Table B.1: Price Comparisons of Ukrainian and Policy Prices of Domestic Appliances in 2018 and 2019

Date of comparison/article	Name of a product	Brand of the product	Price in Ukraine (UAH)*	Price in Poland, (UAH)*	Link to data source	Ratio Ukraine/Poland
13-14.03.2018	TV	Philips 32PFT4132/12	8,137	7,792	https://shoppingpl.com/post/160-pobutova-tekhnika-v-ukrajini-ta-polshchi-de-deshevshe	1.04
	TV	LG 43LJ594V	13,200	10,912		1.21
	Music system	Philips BTM1360/12	3,299	3,900		0.85
	Music system	LG CJ45	7,599	8,580		0.89
	Washing machine	Beko HTV 8733 XS0	12,640	15,592		0.81
	Washing machine	Electrolux EWM11044SEU	9,078	8,572		1.06
	Hairdryer	Babyliss D414PE	899	1,076		0.84
	Hairdryer	RemingtonAC8820 Keratin Protect	1,220	1,856		0.66
	Gas surface	Electrolux EGT 46142NK	5,773	5,452		1.06
	Gas surface	Bosch PGH6B5B60	6,299	6,872		0.92
	Electric oven	Whirlpool AKZM 6560 IXL	16,769	17,152		0.98
	Electric oven	Bosch HBA23BN61	14,699	11,614		1.27
	Dishwasher	Whirlpool WIC 3C23 PEF	13,299	13,252		1.00
	Dishwasher	Siemens SN636X01KE	19,199	12,472		1.54
	Food processor	Kenwood Prospero KM289	8,999	7,800		1.15
	Food processor	Philips HR7778/00	6,999	6,388		1.10
	Microwave	SHARP R760BK	3,429	3,502		0.98
	Microwave	Whirlpool MWD 122 WH	1,947	2,332		0.83
12/5/2019	Robot vacuum	ILIFE A8	5,307	4,996	https://shoppingpl.com/post/376-roboty-pylososy-porivnyannya-tsin-u-polshchi-ta-ukrajini	1.06
	Robot vacuum		5,825	5,905		0.99
	Robot vacuum	TESLA RoboStar T50	5,898	6,094		0.97
	Robot vacuum	ROBOROCK S50	9,210	9,754		0.94
	Robot vacuum	IROBOT Roomba 965	10,630	12,200		0.87
	Robot vacuum	5SGM	13,408	12,194		1.10
3/28/2019	Vacuum cleaner	Electrolux EUS8X3CB	6,999	5,325	https://shoppingpl.com/post/303-de-vyhidno-kupuvaty-pylososy-porivnyannya-tsin-v-ukrajini-ta-polshchi	1.31
	Vacuum cleaner	Electrolux EEG41IW	2,799	2,485		1.13
	Vacuum cleaner	Karcher WD 3	2,999	2,123		1.41
	Cordless vacuum cleaner	Bosch BBS1224	18,999	13,419		1.42
	Cordless vacuum cleaner	Philips SpeedPro Max FC6823/01	12,999	10,643		1.22
	Cordless vacuum cleaner	Electrolux EER77SSM	6,999	6,390		1.10
	Cordless vacuum cleaner	Electrolux PF91-ALRGY	18,999	14,193		1.34
	Water vacuum cleaner	Thomas PERFECT AIR ALLERGY P	6,899	5,673		1.22
	Robot vacuum	iRobot Roomba i7	20,999	29,813		0.70
	Robot vacuum	iLife V55	5,479	4,963		1.10
					Average ratio	**1.06**

*Note: Prices are converted to UAH based on current exchanges at the time of the article; and they have not been adjusted for differences in transportation charges or differences in taxes.

Source: "Home Appliances in Ukraine and Poland: where are they cheaper," *Shopping in Poland, March 13-14, 2018; in Ukrainian. Avaialable at link in the table.*

"Vacuum Cleaners in Poland and Ukraine," " *Shopping in Poland* , December 5, 2019; in Ukrainian. Avaialable at link in the table.

"Where to buy vacuum cleaners: price comparison in Ukraine and Poland," Shopping in Poland, March 28, 2019; in Ukrainian. Avaialable at link in the table.

Table 2: The Number of Ukrainian Tariff Lines Subject to Mandatory Controls: 2005 and 2019 Compared.

Controls/Year	2005	2019	2005	2019
Comparable controls:	Number of 10-digit tariff lines subject to this control		Percent of all 10-digit tariff lines subject to this control	
Phytosanitary control	1228	623	11%	6%
Veterinary control	1146	141	10%	1%
Partly comparable controls:				
Sanitary & epidemiological control	3357	*not applied*	31%	*not applied*
Food safety control	*not applied*	2577	*not applied*	24%
Control abolished by 2019:				
Ecological control	2464	*not applied*	22%	*not applied*
Total number of 10-digit tariff lines subject to any of the above measures	**8195**	**3341**		
Ratio of total measures applied 2019/2005		**0.41**		

Sources: Authors' estimates based on (i) Annex 2 of Cabinet of Ministers of Ukraine (CMU) Decree dated October 24, 2002 No 1569 "About the approval of the Procedure of collecting single fees at state border checkpoints"; (ii) the CMU Decree dated October 24, 2018, No 960 "Some issues of official control of goods imported into the customs territory of Ukraine (including for transit)"

Table 3. Reference Prices for Customs Valuation: Percentage of Tariff Lines Subject to Reference prices by Sector in Ukraine 1997-2000.

Industry/Year	1997	1998	1999	2000
agriculture, hunting	0	7	7	0
forestry	0	0	0	0
fishing	0	0	0	0
mining of coal and peat	0	0	0	0
production of hydrocarbons	0	0	0	0
production of non-energy materials	0	0	0	0
food-processing	3	22	22	2.5
textile and leather	0	13.5	16.2	0
wood, furniture, paper, publishing	0	0	0	0
production of coke	0	0	0	0
petroleum refineries	0	0	0	0
chemicals, rubber and plastic	0.3	0.4	0.8	0.8
non-metallic mineral products	0	0	0	0
metallurgy and metal processing	0	0	0	0
machinery and equipment	0.8	1.3	1.3	0.8
other products	0	2	2	0
electricity	0	0	0	0
Total	**0.2**	**2.7**	**2.9**	**0.2**

Source: Authors' calculations based on (i) the Cabinet of Ministers of Ukraine (CMU) Decree dated November 3, 1997, No 1215 "On the establishment of the minimum customs value of separate types of goods"; (ii) the CMU Decree dated July 27, 1998, No 1164 "On the establishment of the minimum customs value of certain types of imported goods"; (iii) the CMU Decree dated May 26, 1997, No 502 "On the establishment of the minimum customs value on some goods which are subject to the excise duty."

Table 4: Ad Valorem Equivalents by Sector for Ukraine in 2019: Adjusted by SPS and TBT Prevalence Indices

Sector code	Type of SPS Measure			Total number of tariff lines with imports in this sector	SPS Frequency Measure	SPS Prevalence Measure: columns (1+2+3)/ 4	TBT Frequency Measure	TBT Prevalence Measure	P(i) = Prevalence Measure Total: columns (6 + 8)	y(i) = P(i)- average P(i)*	adjustment coefficient = 1 + [y(i)/5]	Central AVE	AVEs adjusted but unscaled	AVEs for the model
	Number of tariff lines with at least one of this type of SPS measure													
	Food Safety: Number of tariff lines with at least one measure	Phyto-sanitary	Veteri-nary											
	1	2	3	4	5	6	7	8	9	10	11	12	12	13
CROP	235	307	0	318	0.98	1.70	0.02	0.03	1.73	0.48	1.10	3.3	3.6	3.6
ANIM	23	3	67	87	0.98	1.07	0.08	0.16	1.23	-0.02	1.00	3.3	3.3	3.3
LOGG	0	23	0	26	0.88	0.88	0.08	0.15	1.03	-0.22	0.96	3.3	3.2	3.2
FISH	84	2	12	98	1.00	1.00	0.02	0.02	1.02	-0.23	0.95	3.3	3.1	3.1
COAL	0	0	0	5	0.00	0.00	0.00	0.00	0.00	-1.25	NA	5.5	0.0	0.0
CGAS	0	0	0	3	0.00	0.00	1.00	1.00	1.00	-0.25	0.95	5.5	5.2	5.5
ORES	0	0	0	16	0.00	0.00	0.06	0.06	0.06	-1.19	0.76	5.5	4.2	4.4
SAND	0	0	0	30	0.00	0.00	0.13	0.17	0.17	-1.08	0.78	5.5	4.3	4.5
CHMN	1	1	0	11	0.18	0.18	0.64	0.73	0.91	-0.34	0.93	5.5	5.1	5.4
OTMN	0	1	0	23	0.04	0.04	0.35	0.35	0.39	-0.86	0.83	5.5	4.6	4.8
PRMT	222	0	0	222	1.00	1.00	0.00	0.00	1.00	-0.41	0.92	5.5	5.0	5.3
PRFS	331	0	0	331	1.00	1.00	0.00	0.00	1.00	-0.41	0.92	5.5	5.0	5.3
PRFV	422	36	0	422	1.00	1.09	0.00	0.00	1.09	-0.32	0.94	5.5	5.1	5.4
OILS	127	2	0	129	0.98	1.00	0.68	0.68	1.68	0.27	1.05	5.5	5.8	6.1
DAIR	162	0	0	162	1.00	1.00	0.03	0.06	1.06	-0.35	0.93	5.5	5.1	5.4
MILL	93	73	0	96	0.97	1.73	0.05	0.11	1.84	0.43	1.09	5.5	6.0	6.3
FEED	28	0	0	28	1.00	1.00	0.00	0.00	1.00	-0.41	0.92	5.5	5.0	5.3
OTFD	409	44	0	434	0.96	1.04	0.13	0.17	1.21	-0.20	0.96	5.5	5.3	5.6
TEXT	3	3	0	776	0.01	0.01	0.97	1.60	1.61	0.20	1.04	5.5	5.7	6.0
WEAR	0	0	0	367	0.00	0.00	0.98	2.52	2.52	1.11	1.22	5.5	6.7	7.1
LEAT	1	0	0	163	0.01	0.01	0.55	1.37	1.38	-0.03	0.99	5.5	5.5	5.8
WOOD	0	46	0	151	0.30	0.30	0.21	0.23	0.53	-0.88	0.82	5.5	4.5	4.8
PAPR	0	0	0	189	0.00	0.00	0.58	0.78	0.78	-0.63	0.87	5.5	4.8	5.1
PRNT	0	0	0	3	0.00	0.00	0.00	0.00	0.00	-1.41	NA	5.5	0.0	0.0
COKE	0	0	0	5	0.00	0.00	0.20	0.20	0.20	-1.21	0.76	5.5	4.2	4.4
PETR	0	0	0	127	0.00	0.00	0.96	2.50	2.50	1.09	1.22	5.5	6.7	7.1
BSCH	28	0	0	856	0.03	0.03	0.99	1.66	1.69	0.28	1.06	5.5	5.8	6.1
AGCH	0	0	0	34	0.00	0.00	1.00	1.00	1.00	-0.41	0.92	5.5	5.0	5.3
PNTS	0	0	0	50	0.00	0.00	1.00	2.60	2.60	1.19	1.24	5.5	6.8	7.2
FIBR	0	0	0	42	0.00	0.00	1.00	2.12	2.12	0.71	1.14	5.5	6.3	6.6
SOAP	24	0	0	234	0.10	0.10	0.90	1.35	1.45	0.04	1.01	5.5	5.5	5.8
PHAR	9	2	33	109	0.39	0.40	0.89	1.30	1.70	0.29	1.06	5.5	5.8	6.1
RUBB	7	0	0	250	0.03	0.03	0.91	2.09	2.12	0.71	1.14	5.5	6.3	6.6
GLAS	0	0	0	143	0.00	0.00	0.53	0.71	0.71	-0.70	0.86	5.5	4.7	5.0
CLAY	0	0	0	52	0.00	0.00	0.25	0.31	0.31	-1.10	0.78	5.5	4.3	4.5

Sector code	Type of SPS Measure			Total number of tariff lines with imports in this sector	SPS Frequency Measure	SPS Prevalence Measure: columns (1+2+3)/ 4	TBT Frequency Measure	TBT Prevalence Measure	P(i) = Prevalence Measure Total: columns (6 + 8)	y(i) = P(i)- average P(i)*	adjustment coefficient = 1 + [y(i)/5]	Central AVE	AVEs adjusted but unscaled	AVEs for the model
	Number of tariff lines with at least one of this type of SPS measure													
	Food Safety: Number of tariff lines with at least one measure	Phyto-sanitary	Veteri-nary											
CEMT	0	0	0	26	0.00	0.00	0.58	1.00	1.00	-0.41	0.92	5.5	5.0	5.3
STON	0	0	0	79	0.00	0.00	0.43	0.49	0.49	-0.92	0.82	5.5	4.5	4.7
BSME	0	0	0	608	0.00	0.00	0.79	1.23	1.23	-0.18	0.96	5.5	5.3	5.6
MEPR	0	0	0	390	0.00	0.00	0.74	1.49	1.49	0.08	1.02	5.5	5.6	5.9
GPMA	0	0	0	213	0.00	0.00	0.97	2.49	2.49	1.08	1.22	5.5	6.7	7.0
OTMA	0	0	0	235	0.00	0.00	0.92	2.80	2.80	1.39	1.28	5.5	7.0	7.4
AGMA	0	0	0	62	0.00	0.00	0.97	3.05	3.05	1.64	1.33	5.5	7.3	7.7
MEMA	0	0	0	123	0.00	0.00	0.88	0.89	0.89	-0.52	0.90	5.5	4.9	5.2
SPMA	0	0	2	247	0.01	0.01	0.86	1.47	1.48	0.07	1.01	5.5	5.6	5.9
COMP	0	0	0	40	0.00	0.00	0.90	3.85	3.85	2.44	1.49	5.5	8.2	8.6
ELTR	0	0	0	109	0.00	0.00	0.84	2.14	2.14	0.73	1.15	5.5	6.3	6.6
OPTC	0	0	0	375	0.00	0.00	0.79	2.28	2.28	0.87	1.17	5.5	6.5	6.8
BATT	0	0	0	364	0.00	0.00	0.99	3.62	3.62	2.21	1.44	5.5	7.9	8.4
APPL	0	0	0	78	0.00	0.00	1.00	5.56	5.56	4.15	1.83	5.5	10.1	10.6
VEHL	0	0	0	222	0.00	0.00	1.00	1.70	1.70	0.29	1.06	5.5	5.8	6.1
TREQ	0	0	0	130	0.00	0.00	0.58	1.15	1.15	-0.26	0.95	5.5	5.2	5.5
FURN	2	1	0	321	0.01	0.01	0.49	1.08	1.09	-0.32	0.94	5.5	5.1	5.4
ELEC	0	0	0	1	0.00	0.00	0.00	0.00	0.00	-1.41	NA	5.5	0.0	0.0
GASS	0	0	0	0	0.00	0.00	0.00	0.00	0.00	-1.41	NA	5.5	0.0	0.0
WAST	1	0	0	51	0.02	0.02	0.33	0.49	0.51	-0.90	0.82	5.5	4.5	4.8

*Average Prevalence Index, P(i), in Agriculture, Forestry and Fishery = 1.25. Average P(i) in Mining and Manufacturing = 1.41.
Source: Authors' estimates

Table 5 Ad Valorem Equivalents of Non-Tariff Barriers on Ukrainian Exports by region of the model in percent

Sector/Destination Region:	Code	Turkey	China	Russia	USA	EU	FTA regions*	Rest of World**
Growing of crops, mixed farming	CROP	6.0%	6.1%	16.9%	14.8%	27.0%	12.0%	19.4%
Animal production; hunting, trapping and related service activities	ANIM	6.0%	6.1%	16.9%	14.8%	27.0%	12.0%	19.4%
Forestry and logging	LOGG	6.0%	6.1%	16.9%	14.8%	27.0%	12.0%	19.4%
Fishing and aquaculture	FISH	6.0%	6.1%	16.9%	14.8%	27.0%	12.0%	19.4%
Mining of coal and lignite	COAL	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Extraction of crude petroleum and natural gas	CGAS	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Mining of metal ores	ORES	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Quarrying of stone, sand and clay	SAND	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Mining of chemical and fertiliser minerals	CHMN	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Other mining and quarrying n.e.c., mining support service activities	OTMN	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Processing and preserving of meat and production of meat products	PRMT	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Processing and preserving of fish, crustaceans and molluscs	PRFS	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Processing and preserving of fruit and vegetables	PRFV	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of vegetable and animal oils and fats	OILS	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of dairy products	DAIR	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of grain mill products, starches and starch products	MILL	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of prepared animal feeds	FEED	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of other food products n.e.c.; beverages; tobacco products	OTFD	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of textiles	TEXT	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of wearing apparel	WEAR	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of leather and related products	LEAT	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of wood and wood products , except furniture	WOOD	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of paper and paper products	PAPR	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Printing and reproduction of recorded media	PRNT	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of coke	COKE	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of refined petroleum products	PETR	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Chemicals, fertilisers, plastics and synthetic rubber in primary forms	BSCH	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of pesticides and other agrochemical products	AGCH	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Paints, varnishes and similar coatings, printing ink and mastics	PNTS	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of man-made fibres	FIBR	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Soap, cleaning, polishing and toilet preparations, perfumes	SOAP	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Pharmaceutical products and preparations	PHAR	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of rubber and plastic products	RUBB	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of glass and glass products	GLAS	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Refractory products; clay building materials; other porcelain and ceramic	CLAY	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Cement, lime and plaster and related articles	CEMT	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Stone and non-metallic mineral products n.e.c.	STON	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of basic metals	BSME	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Fabricated metal products, except machinery and equipment	MEPR	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of general — purpose machinery	GPMA	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of other general-purpose machinery	OTMA	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of agricultural and forestry machinery	AGMA	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of metal forming machinery and machine tools	MEMA	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of other special-purpose machinery	SPMA	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of computers and peripheral equipment	COMP	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Electronic components and boards, communication equipment	ELTR	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Consumer electronics, optical and electromedical equipment; instruments for measuring, testing and navigation; watches and clocks	OPTC	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Electric motors, generators, transformers; batteries; other electrical equip	BATT	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of domestic appliances	APPL	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of motor vehicles, trailers and semi-trailers	VEHL	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of other transport equipment	TREQ	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Furniture; jewelry, musical instruments, toys; repair of machinery	FURN	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Electric power generation, transmission and distribution	ELEC	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%
Manufacture of gas; distribution of gaseous fuels through mains	GASS	5.2%	5.1%	9.2%	3.3%	2.3%	0.9%	5.7%

*FTA region is an unweighted average of Canada, Iceland, Israel, Norway, Switzerland.
**Rest of World is an unweighted average of Australia, Brazil, Egypt, Indonesia, India, japan, New Zealand, South Africa, South Korea and Thailand.
Source: All Agriculture, Mining and Manufacturing data are from Kee et al. (2009)

Appendix C: Elasticities of Demand for the Dataset and Classification of Sectors as either Perfectly Competitive or Monopolistically Competitive

1. Classification of Sectors based on Elasticities of Demand

The calibration procedure for the Krugman model with large group monopolistic competition allows calibration to either the elasticity of substitution between varieties (known as the Dixit-Stiglitz elasticity) or an estimate of economies of scale, but not both. To see this, we note that the equilibrium output the firm in a Small Open Economy model must satisfy

$$q = (\sigma - 1) \frac{fc}{mc} \ , \tag{22}$$

where q is the output of the firm, σ is the Dixit-Stiglitz elasticity of substitution and fc and mc are fixed costs and marginal costs, respectively.[69] In the calibration, the output q is given by the data. If we have either the Dixit-Stiglitz elasticity or the ratio of fixed to marginal costs (which reflects economies of scale), the other parameter is not a free parameter.

As is common in the literature, we assume that the inputs required for both fixed and marginal costs are identical, and the costs of these inputs may be represented by a function that is a linearly homogeneous, quasi-concave composite function of all inputs. It follows (Balistreri and Tarr, 2000, p. 17), that with the large group monopolistic competition assumption and the CES demand function for firm varieties, output per firm is constant. That is, there are no rationalization gains in our model and results in the monopolistic competition model differ from the perfectly competitive model only due to the variety externality. Since the value of a variety declines as the Dixit-Stiglitz elasticity of substitution increases, and as the elasticity becomes large, the monopolistic competition model provides results close to the perfect competition model, we generally calibrate on the elasticity, not on economies of scale (the ratio of fixed to variable costs). There are several cases that we indicate, however, where we define a sector based on economies of scale.

2. Elasticity of Demand Sources

Our source for the elasticities in goods, perfectly competitive services sectors and trade (TRAD), computer programming (PROG) and professional services (LEGL) is the GTAP dataset. These values are documented in Hertel and van der Mensbrugghe (2019). For six monopolistically competitive, business services sectors, we did a survey of the literature on elasticity estimates and employed the estimates from

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[69] See Markusen, Rutherford and Tarr (2005, equation 9).

that survey. These sectors are: telecommunications; land, water and air transportation; insurance and banking (other financial services), and used those estimates.

Since there are often multiple sectors from the GTAP dataset mapped into a single sector in our model, we took an unweighted average of the GTAP elasticities of substitution between imports. The resulting elasticities are reported in table A1, column labelled Sigma(M,M). The values in bold are averages of multiple sectors in GTAP mapped to the sector of our model. The median elasticity is 5.9. For most sectors, we classify sectors as perfectly competitive (CRTS in the table) if the elasticity of the sector is above 5.9; and monopolistically competitive if it is less than or equal to 5.9. We classify some sectors as perfectly competitive based on our judgement that there are low economies of scale. These are: Agriculture, Forestry, Fishing which we classify as perfectly competitive. We also place Mining and various Minerals (Sand, Clay, Stone) and Cement among the perfectly competitive sectors based on our judgement that there is little product differentiation. On the other hand, we classify Oils, Textiles (not Apparel), Pharmaceuticals and Transport Equipment as imperfectly competitive, due to the evidence of economies of scale in these sectors. We take all business services sectors as IRTS, and all other services sectors as perfectly competitive.

We provide the results of our survey of estimates of elasticities of demand in the key business services sectors as a separate appendix. Our results for elasticities and sector classification are in in table A.1. Our mapping from the GTAP sectors to the 85 sectors of our disaggregated dataset is in table A.2

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Table C.1: Estimated Elasticities of Substitution for Varieties in Ukrainian Imperfectly Competitive Goods Sectors and Classification of Sectors as Perfectly Competitive or Monopolistically Competitive

GTAP sector code	GTAP sector description	GTAP esub(M,M)	Our Model Sector classification	Sector code	Sigma(M,M)	calculations for many to one
pdr	Paddy rice	10.1	CRTS	CROP	**5.3**	
wht	Wheat	8.9	CRTS	ANIM	**6.7**	CROP
gro	Cereal grains nec	2.6	CRTS	LOGG	5	5.4
v_f	Vegetables, fruit, nuts	3.7	CRTS	FISH	2.5	2.6
osd	Oil seeds	4.9	CRTS	COAL	6.1	6.5
c_b	Sugar cane, sugar beet	5.4	CRTS	CGAS	**22.4**	4.9
pfb	Plant-based fibers	5	CRTS	ORES	1.8	5
ocr	Crops nec	6.5	CRTS	SAND	1.8	3.7
ctl	Bovine cattle, sheep and goats, horses	4	CRTS	CHMN	1.8	8.9
oap	Animal products nec	2.6	CRTS	OTMN	1.8	**5.3**
rmk	Raw milk	7.3	CRTS	PRMT	**8.25**	
wol	Wool, silk-worm cocoons	12.9	IRTS	PRFS	4	ANIM
frs	Forestry	5	IRTS	PRFV	4	4
fsh	Fishing	2.5	IRTS	OILS	6.6	2.6
coa	Coal	6.1	CRTS	DAIR	7.3	7.3
oil	Crude Oil extraction	10.4	IRTS	MILL	5.2	12.9
gas	Gas	34.4	IRTS	FEED	4	**6.7**
oxt	Minerals nec	1.8	IRTS	OTFD	**3.15**	
cmt	Bovine meat products	7.7	IRTS	TEXT	7.5	
omt	Meat products nec	8.8	CRTS	WEAR	7.4	
vol	Vegetable oils and fats	6.6	CRTS	LEAT	8.1	
mil	Dairy products	7.3	CRTS	WOOD	6.8	
pcr	Processed rice	5.2	CRTS	PAPR	5.9	
sgr	Sugar	5.4	CRTS	PRNT	5.9	
ofd	Food products nec	4	IRTS	COKE	4.2	
b_t	Beverages and tobacco products	2.3	IRTS	PETR	4.2	

Table C.1 (Continued)

GTAP sector code	GTAP sector description					GTAP esub(M,M)	Our Model		
							Sector classification	Sector code	Sigma(M,M)
tex	Textiles					7.5	CRTS	BSCH	6.6
wap	Wearing apparel					7.4	CRTS	AGCH	6.6
lea	Leather products					8.1	CRTS	PNTS	6.6
lum	Wood products					6.8	CRTS	FIBR	6.6
ppp	Paper products, publishing					5.9	CRTS	SOAP	6.6
p_c	Petroleum, coal products					4.2	IRTS	PHAR	6.6
chm	Chemical products					6.6	CRTS	RUBB	6.6
bph	Basic pharmaceutical products					6.6	CRTS	GLAS	5.8
rpp	Rubber and plastic products					6.6	CRTS	CLAY	5.8
nmm	Mineral products nec					5.8	CRTS	CEMT	5.8
i_s	Ferrous metals					5.9	CRTS	STON	5.8
nfm	Metals nec					8.4	CRTS	BSME	**7.15**
fmp	Metal products					7.5	CRTS	MEPR	7.5
ele	Electricity					5.6	CRTS	GPMA	8.1
eeq	Electrical equipment					8.8	CRTS	OTMA	8.1
ome	Machinery and equipment nec					8.1	CRTS	AGMA	8.1
mvh	Motor vehicles and parts					5.6	CRTS	MEMA	8.1
otn	Transport equipment nec					8.6	CRTS	SPMA	8.1
omf	Manufactures nec					7.5	IRTS	COMP	5.6
ely	Electricity					5.6	CRTS	ELTR	5.6
gdt	Gas manufacture, distribution					5.6	IRTS	OPTC	5.6
wtr	Water					5.6	CRTS	BATT	8.8

Table C.1 (continued)

GTAP sector code	GTAP sector description				GTAP esub(M,M)	Our Model Sector classification	Our Model Sector code	Sigma(M,M)
cns	Construction				3.8	CRTS	CNST	3.8
trd	wholesale and retail trade				3.8	IRTS	TRAD	3.8
afs	Accommodation and Food services				3.8	IRTS	LTRA	2.0
otp	Transport nec				2.0	IRTS	WTRA	2.0
wtp	Water transport				2.0	IRTS	ATRA	2.0
atp	Air transport				2.0	CRTS	TRAS	2.0
whs	Warehousing and support activities				3.8	CRTS	POST	3.8
cmn	Communication				2.5	CRTS	HOSP	3.8
ofi	Financial services nec				2.9	CRTS	CRET	3.8
ins	Insurance				2.0	IRTS	TELE	2.5
rsa	Real estate activities				3.8	IRTS	PROG	3.8
obs	Business services nec				3.8	IRTS	FINS	2.9
ros	Recreational and other services				3.8	IRTS	INSR	2.0
osg	Public Administration and Defense				3.8	IRTS	FAUX	2.9
edu	Education				3.8	CRTS	REAL	3.8
hht	Human health and social work activities				3.8	IRTS	LEGL	3.8
dwe	Dwellings				3.8	CRTS	RDEV	3.8
						CRTS	ADVR	3.8
						CRTS	RENT	3.8
						CRTS	ADMS	3.8
						CRTS	PUBL	3.8
						CRTS	EDUC	3.8
						CRTS	HLTH	3.8
						CRTS	ARTS	3.8
						CRTS	NGOS	3.8
						CRTS	OTHS	3.8

Notes:

1. Values in bold show that the value is an average of elasticities of multiple GTAP sectors. Averages are unweighted.

2. When one GTAP sector maps to multiple sectors of our model, e.g., fsh in GTAP to FISH and ANIM in our model, we choose the dominant sector in our model, in this case FISH.

3. We allow one GTAP sector to be mapped to multiple sectors in our model, if there are no other GTAP sectors mapped to those sectors. For example, nmm, manufacture of non-metalic mineral products is mapped to GLAS, CLAY, CEMT, and STON.

Source: For all elasticities except for six business services sectors: T. Hertel and D. van der Mensbrugghe (2019), "Behavorial Parameters," Chapter 14 in GTAP 10 Database Documentation. Available at: https://www.gtap.agecon.purdue.edu/resources/download/9557.pdf. For telecommunications; land, water and air transportation; insurance and banking (other financial services) a literature review of estimates of elasticities in these sectors by the authors, available as an appendix.

Table C.2 Mapping matrix from GTAP to sectors to the sectors of our dataset for elasticity calculations

Notes on the mapping		Model sector description	Model code		GTAP code	GTAP sector description
	1	Growing of crops, mixed farming	CROP	1	c_b	Cane & Beet: sugar crops
	1	Growing of crops, mixed farming	CROP	1	frs	Forestry: forestry, logging and related service activities
	1	Growing of crops, mixed farming	CROP	1	gro	Other Grains: maize (corn), sorghum, barley, rye, oats, millets, other cereals
	1	Growing of crops, mixed farming	CROP	1	ocr	Other Crops: stimulant; spice and aromatic crops; forage products; plants and parts of plants
ocr and v_f	1	Growing of crops, mixed farming	CROP	1	osd	Oil Seeds: oil seeds and oleaginous fruit
are included	1	Growing of crops, mixed farming	CROP	excluded	pdr	Rice: seed, paddy (not husked)
	1	Growing of crops, mixed farming	CROP	1	pfb	Fibres crops
Paddy rice	1	Growing of crops, mixed farming	CROP	1	v_f	Veg & Fruit: vegetables, fruit and nuts, edible roots and tubers, pulses
is excluded	1	Growing of crops, mixed farming	CROP	1	wht	Wheat: seed, other
	2	Animal production; hunting, trapping and related serv	ANIM	1	ctl	Cattle: bovine animals, live, other ruminants, horses and other equines, bovine semen
	2	Animal production; hunting, trapping and related serv	ANIM	excluded	fsh	Fishing: hunting, trapping and game propagation including related service activities, fishing, fis
oap in included	2	Animal production; hunting, trapping and related serv	ANIM	1	oap	Other Animal Products: swine; poultry; other live animals; eggs of hens or other birds in shell,
in ANIM	2	Animal production; hunting, trapping and related serv	ANIM	1	rmk	Raw milk
	2	Animal production; hunting, trapping and related serv	ANIM	1	wol	Wool: wool, silk, and other raw animal materials used in textile
	3	Support activities to agriculture and post-harvest crop	AGSP	0		
	4	Forestry and logging	LOGG	1	frs	Forestry: forestry, logging and related service activities
	4	Forestry and logging	LOGG	1	ocr	Other Crops: stimulant; spice and aromatic crops; forage products; plants and parts of plants
	4	Forestry and logging	LOGG	1	v_f	Veg & Fruit: vegetables, fruit and nuts, edible roots and tubers, pulses
	5	Fishing and aquaculture	FISH	1	fsh	Fishing: hunting, trapping and game propagation including related service activities, fishing, fis
	5	Fishing and aquaculture	FISH	excluded	oap	Other Animal Products: swine; poultry; other live animals; eggs of hens or other birds in shell,
	6	Mining of coal and lignite	COAL	0	coa	Coal: mining and agglomeration of hard coal, lignite and peat
	7	Extraction of crude petroleum and natural gas	CGAS	1	gas	Gas: extraction of natural gas, service activities incidental to oil and gas extraction excluding su
	7	Extraction of crude petroleum and natural gas	CGAS	1	oil	Oil: extraction of crude petroleum, service activities incidental to oil and gas extraction excludi
	8	Mining of metal ores	ORES	0	oxt	Other Mining Extraction (formerly omn): mining of metal ores; other mining and quarrying
Bev and Tab.	9	Quarrying of stone, sand and clay	SAND	0	oxt	Other Mining Extraction (formerly omn): mining of metal ores; other mining and quarrying
in OTFD	10	Mining of chemical and fertiliser minerals	CHMN	0	oxt	Other Mining Extraction (formerly omn): mining of metal ores; other mining and quarrying
	11	Other mining and quarrying n.e.c., mining support ser	OTMN	excluded	gas	Gas: extraction of natural gas, service activities incidental to oil and gas extraction excluding su
	11	Other mining and quarrying n.e.c., mining support ser	OTMN	excluded	oil	Oil: extraction of crude petroleum, service activities incidental to oil and gas extraction excludi
	11	Other mining and quarrying n.e.c., mining support ser	OTMN	1	oxt	Other Mining Extraction (formerly omn): mining of metal ores; other mining and quarrying
	12	Processing and preserving of meat and production of	PRMT	1	cmt	Cattle Meat: fresh or chilled; meat of buffalo, fresh or chilled; meat of sheep, fresh or chilled;
	12	Processing and preserving of meat and production of	PRMT	excluded	oap	Other Animal Products: swine; poultry; other live animals; eggs of hens or other birds in shell,
	12	Processing and preserving of meat and production of	PRMT	1	omt	Other Meat: meat of pigs, fresh or chilled; meat of rabbits and hares, fresh or chilled; meat of
	12	Processing and preserving of meat and production of	PRMT	excluded	vol	Vegetable Oils: margarine and similar preparations; cotton linters; oil-cake and other residues
	13	Processing and preserving of fish, crustaceans and mo	PRFS	0	ofd	Other Food: prepared and preserved fish, crustaceans, molluscs and other aquatic invertebrat
	14	Processing and preserving of fruit and vegetables	PRFV	0	ofd	Other Food: prepared and preserved fish, crustaceans, molluscs and other aquatic invertebrat
	15	Manufacture of vegetable and animal oils and fats	OILS	excluded	oap	Other Animal Products: swine; poultry; other live animals; eggs of hens or other birds in shell,
	15	Manufacture of vegetable and animal oils and fats	OILS	1	vol	Vegetable Oils: margarine and similar preparations; cotton linters; oil-cake and other residues
	16	Manufacture of dairy products	DAIR	1	mil	Milk: dairy products
	16	Manufacture of dairy products	DAIR	excluded	ofd	Other Food: prepared and preserved fish, crustaceans, molluscs and other aquatic invertebrat
	17	Manufacture of grain mill products, starches and starc	MILL	excluded	ofd	Other Food: prepared and preserved fish, crustaceans, molluscs and other aquatic invertebrat
	17	Manufacture of grain mill products, starches and starc	MILL	1	pcr	Processed Rice: semi- or wholly milled, or husked
	17	Manufacture of grain mill products, starches and starc	MILL	excluded	vol	Vegetable Oils: margarine and similar preparations; cotton linters; oil-cake and other residues
	18	Manufacture of prepared animal feeds	FEED	0	ofd	Other Food: prepared and preserved fish, crustaceans, molluscs and other aquatic invertebrat

	Model sector description	Model code		GTAP code	GTAP sector description
19	Manufacture of other food products n.e.c.; beverages	OTFD	1	b_t	Beverages and Tobacco products
19	Manufacture of other food products n.e.c.; beverages	OTFD	excluded	mil	Milk: dairy products
19	Manufacture of other food products n.e.c.; beverages	OTFD	excluded	ofd	Other Food: prepared and preserved fish, crustaceans, molluscs and other aquatic invertebrat
19	Manufacture of other food products n.e.c.; beverages	OTFD	excluded	omt	Other Meat: meat of pigs, fresh or chilled; meat of rabbits and hares, fresh or chilled; meat of
19	Manufacture of other food products n.e.c.; beverages	OTFD	1	sgr	Sugar and molasses
20	Manufacture of textiles	TEXT	0	tex	Manufacture of textiles
21	Manufacture of wearing apparel	WEAR	0	wap	Manufacture of wearing apparel
22	Manufacture of leather and related products	LEAT	0	lea	Manufacture of leather and related products
23	Manufacture of wood and of products of wood and co	WOOD	0	lum	Lumber: manufacture of wood and of products of wood and cork, except furniture; manufact
24	Manufacture of paper and paper products	PAPR	0	ppp	Paper & Paper Products: includes printing and reproduction of recorded media
25	Printing and reproduction of recorded media	PRNT	0	ppp	Paper & Paper Products: includes printing and reproduction of recorded media
26	Manufacture of coke	COKE	0	p_c	Petroleum & Coke: manufacture of coke and refined petroleum products
27	Manufacture of refined petroleum products	PETR	0	p_c	Petroleum & Coke: manufacture of coke and refined petroleum products
28	Manufacture of basic chemicals, fertilisers and nitroge	BSCH	0	chm	Manufacture of chemicals and chemical products
29	Manufacture of pesticides and other agrochemical pro	AGCH	0	chm	Manufacture of chemicals and chemical products
30	Manufacture of paints, varnishes and similar coatings	PNTS	0	chm	Manufacture of chemicals and chemical products
31	Manufacture of man-made fibres	FIBR	0	chm	Manufacture of chemicals and chemical products
32	Manufacture of soap and detergents, cleaning and po	SOAP	0	chm	Manufacture of chemicals and chemical products
33	Manufacture of basic pharmaceutical products and ph	PHAR	0	bph	Manufacture of pharmaceuticals, medicinal chemical and botanical products
34	Manufacture of rubber and plastic products	RUBB	0	rpp	Manufacture of rubber and plastics products
35	Manufacture of glass and glass products	GLAS	0	nmm	Manufacture of other non-metallic mineral products
36	Manufacture of refractoryproducts; clay building mate	CLAY	0	nmm	Manufacture of other non-metallic mineral products
37	Manufacture of cement, lime and plaster; articles of c	CEMT	0	nmm	Manufacture of other non-metallic mineral products
38	Cutting, shaping and finishing of stone; manufacture c	STON	0	nmm	Manufacture of other non-metallic mineral products
39	Manufacture of basic metals	BSME	1	i_s	Iron & Steel: basic production and casting
39	Manufacture of basic metals	BSME	1	nfm	Non-Ferrous Metals: production and casting of copper, aluminium, zinc, lead, gold, and silver
40	Manufacture of fabricated metal products, except ma	MEPR	0	fmp	Manufacture of fabricated metal products, except machinery and equipment
41	Manufacture of general — purpose machinery	GPMA	0	ome	Manufacture of machinery and equipment n.e.c.
42	Manufacture of other general-purpose machinery	OTMA	0	ome	Manufacture of machinery and equipment n.e.c.
43	Manufacture of agricultural and forestry machinery	AGMA	0	ome	Manufacture of machinery and equipment n.e.c.
44	Manufacture of metal forming machineryand machine	MEMA	0	ome	Manufacture of machinery and equipment n.e.c.
45	Manufacture of other special-purpose machinery	SPMA	0	ome	Manufacture of machinery and equipment n.e.c.
46	Manufacture of computers and peripheral equipment	COMP	0	ele	Manufacture of computer, electronic and optical products
47	Manufacture of electronic components and boards, co	ELTR	0	ele	Manufacture of computer, electronic and optical products
48	Manufacture of consumer electronics, instruments an	OPTC	0	ele	Manufacture of computer, electronic and optical products
49	Manufacture of electric motors, generators, transform	BATT	0	eeq	Manufacture of electrical equipment
50	Manufacture of domestic appliances	APPL	0	eeq	Manufacture of electrical equipment
51	Manufacture of motor vehicles, trailers and semi-trail	VEHL	0	mvh	Manufacture of motor vehicles, trailers and semi-trailers
52	Manufacture of other transport equipment	TREQ	0	otn	Manufacture of other transport equipment
53	Manufacture of furniture; jewelry, musical instrument	FURN	0	omf	Other Manufacturing: includes furniture
54	Electric power generation, transmission and distributi	ELEC	0	ely	Electricity; steam and air conditioning supply
55	Manufacture of gas; distribution of gaseous fuels thro	GASS	0	gdt	Gas manufacture, distribution
56	Steam and air conditioning supply	STEA	0	ely	Electricity; steam and air conditioning supply
57	Water collection, treatment and supply	WCOL	0	wtr	Water supply; sewerage, waste management and remediation activities
58	Waste collection, treatment and disposal activities; ma	WAST	0	wtr	Water supply; sewerage, waste management and remediation activities
59	Sewerage; remediation activities and other waste mar	SWRG	0	wtr	Water supply; sewerage, waste management and remediation activities

Mapping matrix from GTAP to sectors of our model for elasticity calculations

	Mapping matrix from GTAP to sectors of our model for elasticity calculations			
	Model sector description	Model code	GTAP code	**GTAP sector description**
60	Construction	CNST	0	cns	Construction: building houses factories offices and roads
61	Wholesale trade, except of motor vehicles and motor	TRAD	0	trd	Wholesale and retail trade; repair of motor vehicles and motorcycles
62	Maintenance and repair of motor vehicles; sale, maint	REPR	0	trd	Wholesale and retail trade; repair of motor vehicles and motorcycles
63	Land transport and transport via pipelines	LTRA	0	otp	Land transport and transport via pipelines
64	Water transport	WTRA	0	wtp	Water transport
65	Air transport	ATRA	0	atp	Air transport
66	Warehousing and support activities for transportation	TRAS	0	whs	Warehousing and support activities
67	Postal and courier activities	POST	0	cmn	Information and communication
68	Accommodation and food service activities	HOSP	0	afs	Accommodation, Food and service activities
69	Publishing, motion picture, video, television programn	CRET	0	cmn	Information and communication
70	Telecommunications	TELE	0	cmn	Information and communication
71	Computer programming, consultancy, and information	PROG	0	cmn	Information and communication
72	Financial service activities, except insurance and pensi	FINS	0	ofi	Other Financial Intermediation: includes auxiliary activities but not insurance and pension fun
73	Insurance, reinsurance and pension funding, except c	INSR	0	ins	Insurance (formerly isr): includes pension funding, except compulsory social security
74	Activities auxiliary to financial services and insurance	FAUX	1	ins	Insurance (formerly isr): includes pension funding, except compulsory social security
74	Activities auxiliary to financial services and insurance	FAUX	1	ofi	Other Financial Intermediation: includes auxiliary activities but not insurance and pension fun
75	Real estate activities	REAL	0	rsa	Real estate activities
76	Legal and accounting activities; activities of head office	LEGL	0	obs	Other Business Services nec
77	Scientific research and development	RDEV	0	obs	Other Business Services nec
78	Advertising and market research; other professional, s	ADVR	0	obs	Other Business Services nec
79	Rental and leasing activities	RENT	0	obs	Other Business Services nec
80	Employment activities; travel agency, tour operator re	ADMS	0	obs	Other Business Services nec
81	Public administration and defense; compulsory social	PUBL	0	osg	Other Services (Government): public administration and defense; compulsory social security, a
82	Education	EDUC	0	edu	Education
83	Human health activities, residential care activities and	HLTH	0	hht	Human health and social work
84	Arts, entertainment and recreation	ARTS	0	ros	Recreation & Other Services: recreational, cultural and sporting activities, other service activitie
85	Activities of membership organisations	NGOS	0	ros	Recreation & Other Services: recreational, cultural and sporting activities, other service activitie
86	Other service activities; activities of households as em	OTHS	0	ros	Recreation & Other Services: recreational, cultural and sporting activities, other service activitie

Source: Authors mappings. XXX

Appendix D: Estimates of the Elasticities of Substitution for Business Services.

In goods sectors, we employ the estimates of the GTAP consortium for the Dixit-Stiglitz elasticities of substitution in the monopolistic competition sectors and for the elasticity of substitution for imports of different regions in the perfectly competitive sectors. In the goods sectors the GTAP estimates are specific to the sectors in the GTAP model. In the case of services, however, the GTAP elasticities are equal to -3.8 in all sectors. We shall use the GTAP elasticities in the perfectly competitive services sectors and for three of our nine business services sectors: professional services; computer programming; and wholesale and retail trade. But for six business services sectors (telecommunications, insurance, banking and other financial services, air transportation, water transportation and land transportation) we employ estimates from the literature.

Most of the literature provides estimates of the price elasticity of demand, whereas what we need for our model are elasticities of substitution. Our business services sectors are modeled as monopolistically competitive. In the framework of a monopolistic competition model, the elasticity of substitution is equal to the negative of the price elasticity of demand of the firm, see Dixit and Stiglitz (1977).[70]

In a monopolistic competition model, firms will not operate in a region of the demand curve were the elasticity of demand is less than one. In estimating demand in an industry assumed to be monopolistically competitive, to be consistent with the model, it would make sense to constrain the estimates to be greater than one. For that reason, in our literature search, we give less weight to or ignore estimates less than one.

1. Telecommunications

Dewenter and Haucap (2007) use a variety of econometric techniques and estimate a range of price elasticities of demand from -0.19 to -3.56. Using a structural model of mobile telephony, Parker and Roller (1997) estimate an elasticity of demand in the United States of -2.5. For the purpose of this study, we shall employ -2.5 as our estimate, which is the estimate of Parker and Roller.[71]

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[70] Dixit, Avinash and Joseph Stiglitz (1977), "Monopolistic Competition and Product Diversity," *American Economic Review*, Vol. 67 (3), 297-308.

[71] Many of the estimates of the demand for mobile telecommunications show inelastic price elasticity of demand. This includes Ahn and Lee (1999), Hausman (2000) and the United Kingdom Competition Commission (2003).

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2003.

2. Insurance

Estimates of the elasticities of demand for insurance depend on the type of insurance. The literature on the elasticity of demand for health insurance is the most extensive and use this sector as our proxy for all of insurance. Pendzialek, Simic and Stock (2016) review the 45 studies from a range of countries. They find that empirical studies show a range between -0.2 and -1.0 for the United States, about -0.5 for The Netherlands, between -0.6 and -4.2 for Germany and around -2 for Switzerland. We select the value for Switzerland of -2 for this study.

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3. Banking

Banks and related financial institutions provide a large number of services, and there are estimates of the elasticity of demand for many of the services separately. Gross and Soules (2002) estimate that the elasticity of demand for credit card debt with respect to the interest rate is -1.3. Karlan and Zinman (2019) employ a randomized control group methodology to estimate that the elasticity of demand for small loans in Mexico with respect to the interest rate. The estimate an elasticity of -2.9. Dick (2008) estimates the elasticity of demand for deposit services. With respect to the interest rate it is -6 and with respect to fees

on deposit services it is either -1 or -3.5, depending on the methodology. For this study we apply the estimate of Karlan and Zinman of -2.9.

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4. Transportation Services

4.1 Air Transport Services

We rely on the report prepared for IATA by InterVistas (2007). The report synthesized 23 studies and concluded that the price elasticity of demand depends in significant measure of the region of the world and the length of the travel. The results are summarized in the table on page v. For Ukraine, we take the estimate for European carriers on intra-European flights. This elasticity is -2

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4.2 Maritime Shipping Services

Demand for martime passenger services is rather elastic, especially for cruise lines. As part of their merger investigation for the US Federal Trade Commission, Coleman *et al*. (2003, p. 12) examined a natural experiment in which cruise lines were faced with a large short run increase in capacity. Despite the large capacity increase, the cruise lines were able to fill up their berths. These data and other data led them to conclude that cruise lines compete in a broader vacation market. As a result, they their estimates of elasticity of demand for cruise line services are equal to 2 or greater in the short run and they believe probably larger in the long run.

On the other hand, Hummels, Lugovskyy and Skiba (2009) note that shipping services are not demanded for their own sake and are only consumed indirectly as a function of import demand. They show that if σ_k is the elasticity of demand for good k, then the elasticity of demand for maritime freight services is equal to $\sigma_k \times S_{ij}^k$, where S_{ij}^k is the share of freight costs in the total delivered cost of the good k. While elasticity σ_k will vary with the elasticity of demand for the kth good, the elasticity will be reduced by the

share of freight costs in price of the good. Application of this model would lead to low estimates of the elasticity of demand for maritime freight services. But the model does not take into account competition with air, rail and truck freight services would increase the estimated elasticity of demand (in absolute value). As discussed below, other elasticity estimates in the transportation field that consider inter-modal substitution find demand to be more elastic.

As a long run elasticity, we take a value of -2 for the elasticity of demand for maritime transportation services.

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4.3 Land Transport Services[72]

Freight Services. For truck freight services, we report a range of own price elasticity estimates ranging from -1.34 (Oum *et al.*, 1992) to -2.2 (Fitzpatrick and Taplin, 1972). For rail freight services, the range of own price elasticity estimates is from -1.5 (Oum *et al.*, 1992) to -3.5 (Friedlander and Spady, 1980).

Passenger Services. For bus passenger transportation services, we report a range of own price elasticity estimates from -1.3 to -1.6 (Oum and Gillen, 1983). For rail transportation services, the range of own price elasticity estimates is from -1.1 for the United Kingdom (Owen and Philips, 1987) and -1.2 for the United States (Small and Winston, 1999) to -1.5 for Canada (Oum and Gillen, 1983); and Hortelano et al. (2016) report a high elasticity of demand for high-speed passenger rail travel in Spain.[73]

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[72] The Australian Department of Infrastructure, Transport, Regional Development and Communications maintains a very useful database that is a compilation of the estimates of the elasticities of demand for transport services. The database contains estimates elasticities (usually price elasticities) of 396 types of transport services.

[73] Hortelano et al. (2016) observed that in response to an 11% cut in prices on the high-speed rail network in Spain, there was a huge increase in capacity utilization. They found that the impact depended on competition from alternate modes of transportation. For short routes connecting small- and medium-sized cities with big metropolitan areas, growth in demand was achieved at the expense of the car and the bus, whereas for long routes,…the growth occurred mainly at the expense of air transportation, and induced demand also was triggered. As a consequence of this policy, occupancy rates were increased hugely.

We take a value of -2 as our overall elasticity of demand.

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Table D.1 Summary of Elasticities of Substitution in the Business Services Sector of the Model among firms with a domestic presence.

Sector	code	Elasticity Estimate*
Telecommunications	TELE	2.5
Insurance	INSR	2
Banking	FINS	2.9
Air transportation	ATRA	2
Water transportation	WTRA	2
Land transportation	LTRA	2
Professional services	LEGL	3.8
Computer programming	PROG	3.8
Wholesale and retail trade	TRAD	3.8

Appendix E: The elasticity of supply of varieties with respect to price—larger from large technologically rich countries in research and development intensive goods and services.

Grossman and Helpman (1991) have developed models of economic growth that have highlighted the role of trade in a greater variety of intermediate goods as a vehicle for technological spillovers that allow less developed countries to close the technological gap with industrialized countries. Similarly, Romer (1994) has argued that product variety is a crucial and often overlooked source of gains to the economy from trade liberalization. In our model, it is the greater availability of varieties that is the engine of productivity growth, but we believe there are other mechanisms as well through which trade may increase productivity.[74] Consequently, we take variety as a metaphor for the various ways increased trade can increase productivity. Winters et al. (2004) summarize the empirical literature by concluding that "the recent empirical evidence seems to suggest that openness and trade liberalization have a strong influence on productivity and its rate of change." Some of the key articles regarding product variety are the following. Broda and Weinstein (2004) find that increased product variety contributes to a fall of 1.2 percent per year in the "true" import price index. Hummels and Klenow (2005) and Schott (2004) have shown that product variety and quality are important in explaining trade between nations. Feenstra et al. (1999) show that increased variety of exports in a sector increases total factor productivity in most manufacturing sectors in Taiwan (China) and Korea, and they have some evidence that increased input variety also increases total factor productivity. In business services, because of the high cost of using distant suppliers, the close availability of a diverse set of business services may be even more important for growth than in goods. The evidence for this was cited in the introduction section.

Beginning with the path-breaking work of Coe and Helpman (1995), a rich literature now exists that has empirically investigated the transmission of knowledge through the purchase of imported intermediate goods and through foreign direct investment. Coe and Helpman found that OECD countries benefit from foreign research and development (R&D), that they benefit more from trading with countries that have a larger stock of research and development, and that the benefits are greater the more open the country is to

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[74] Trade or services liberalization may increase growth indirectly through its positive impact on the development of institutions (see Rodrik, Subramananian and Trebbi, 2004). It may also induce firms to move down their average cost curves, or import higher quality products or shift production to more efficient firms within an industry. Tybout and Westbrook (1995) find evidence of this latter type of rationalization for Mexican manufacturing firms.

foreign trade. Moreover, while in large countries the elasticity of total factor productivity (TFP) with respect to domestic R&D capital stocks is larger than that with respect to foreign R&D capital stocks, the opposite holds in small countries; that is, foreign R&D is more important for small countries. Coe, Helpman, and Hoffmaister (1997) extend these results based on a sample of 77 developing countries. They find developing countries that do little R&D on their own, have benefited substantially from industrialized country R&D through trade in intermediate products and capital equipment with industrialized countries. They find that R&D spillovers through trade with the U.S. are the largest, since the U.S. stock of R&D is the highest and it is the most important trading partner for many developing countries. A one percent increase in the R&D stock of the U.S. raises total factor productivity for all 77 developing countries in their sample by 0.03 percent. By comparison, a one percent increase in the R&D stock of Japan, Germany, France or the U.K. raises total factor productivity only between 0.004 percent and 0.008 percent. Crucially, they find that countries that trade more with the U.S., such as the Latin American countries, get more productivity spillover increases from the U.S. R&D stocks. And the relatively more open East Asian countries have benefited the most from foreign R&D through trade. Keller (2000) also finds that trade is an important conveyor of R&D and is especially important for small countries. Several other studies, including Lumenga-Neso et al. (2005), Schiff et al., (2002) and Falvey et al., (2002), confirm these results. Lumenga-Neso et al. (2005) show that technological spillovers can occur from indirect trade with technologically advanced countries. i.e., imports from the U.K. embody some U.S. technology due to U.K. imports from the U.S. Since the data show that OECD countries have the vast majority of R&D stocks,[75] it implies that it is important for small developing countries to trade with large technologically rich countries, such as the U.S. and the EU, at least indirectly.

Regarding the impact of FDI on the productivity of firms, the results depend on intra-industry versus inter-industry impacts. Since FDI in the same industry may bring spillovers, but has an adverse competitive or market share impact, the literature has found mixed results on the productivity of firms in the same industry that receives the FDI. But several papers have found significant productivity spillovers from FDI in both upstream (supplying) industries (e.g., Javorcik, 2004; Blalock and Gertler, 2008; and Javorcik and Spatareanu, 2008) and downstream (using) industries (e.g., Wang, forthcoming; Jabbour and Mucchielli, 2007; and Harris and Robinson, 2004).

Schiff and Wang (2006) estimate the relative importance for technology diffusion to developing countries of trade with industrialized versus developing countries. They note that technology from the industrialized countries may indirectly diffuse to a developing country through trade with another developing country, if

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[75] Coe, Helpman and Hoffmaister (1997) calculate that 96 percent of the world's R&D expenditures took place in industrial countries in 1990 and this number stood at 94.5 percent in 19995.

the other developing country has traded with industrialized countries. They conclude that trade with industrialized countries has a stronger impact on productivity in developing countries and that spillovers from developing country trade occurs with more of a lag. They find that the elasticity of productivity (TFP) with respect to current trade with all industrialized countries is 0.16, but only 0.01 for current trade with all developing countries. That is, trade with the industrialized countries in 16 times better for productivity spillovers. In addition, since trade may be expected to have an impact on productivity with a lag, Schiff and Wang estimate the impact of lagged trade with developing countries. They find that the productivity spillovers from **current** trade with industrialized countries are only about 1.5 times greater than the productivity spillovers from **lagged** trade with developing countries.[76] Moreover, Schiff et al. (2002) show that developing country trade with technologically advanced countries is very important in technology intensive sectors, but trade with developing countries can be important for productivity spillovers in less technologically complex products in which developing countries have comparative advantage. So on low R&D products like footwear and textiles and apparel, trade with China and Indonesia could be as important for technology diffusion as trade with the EU and the US.

In summary, this literature shows that FDI and the purchase of intermediate inputs from industrialized countries is an important mechanism for the transmission of R&D and productivity growth in developing countries. For small developing countries, trading with large technologically advanced countries is crucial for TFP growth. But for products in which developing countries have a comparative advantage, developing country trade may be important for spillovers.

In our model, the parameter that reflects the ability of a region to increase total factor productivity through the transmission of new technologies is the elasticity of varieties with respect to the price. Schiff *et al*., (2002, table 1) have shown that for R&D intensive sectors, trade with industrialized countries contributes significantly to total factor productivity in developing countries, but trade with developing countries does not. Averaging over the industries in Schiff *et al*.,(2002, table 3) yields that *trade with industrialized countries in R&D intensive products is about eight times more valuable for developing country TFP increases*. On the other hand, *for sectors that are low in R&D intensity, their results suggest that for technology diffusion, trade with developing countries can be as important as trade with industrialized countries*.

Based on these considerations, we first classify the increasing returns to scale sectors of our manufacturing sectors into low, medium-low, medium-high and high technology sectors. The

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[76] Schiff and Wang do not compare lagged industrialized trade to lagged developing country trade, which may bias the results against the relative benefits of industrialized trade.

classification is defined by the share of R&D expenditures in total sales. For goods sectors, we use the paper of the Joint Research Institute of the European Commission by Alexander Loschky (2010). He classifies sectors in four categories based on their total R&D expenditures as a percent of sales, where the total expenditures include direct expenditures on R&D plus indirect expenditures; indirect expenditures are the R&D expenditures embodied in the sector's purchases of intermediates. Loschky does not estimate R&D expenditures in services. For services our estimates are based on data from the U.S. National Science Foundation, which has produced data on R&D expenditures as a percent of sales, by sector. We use this information to set the elasticities of firm supply in each region by sector. The greater the elasticity of firm supply in a sector the more varieties will be received in response to a price increase with respect to that country.

We classify foreign regions according to the extent of technological spillover likely from additional trade, based on results of Schiff et al., (2002). The ranking is Turkey, China and Russia as lowest transmitters of technology; next is the region which includes the countries with which Ukraine has a free trade agreement (this includes the EFTA countries and the CIS countries); finally, we have the European Union, the USA and the Rest of the World as the regions from which Ukraine can expect to obtain the largest technology transfer per dollar of trade.

The estimates of Schiff *et al.* (2002) indicate that for technologically complex products, technology transfer occurs at between 3 to 6 times faster rates when trading with R&D intense countries compared with than countries that do little R&D; but for technologically simple products, the relative rates of technology transfer is closer to a ratio of 1. We take the elasticity of supply as 3 for Ukraine, Turkey, China and Russia[77] in most IRTS sectors. We assume that the elasticity of supply is between 1 and 6 times the Ukrainian elasticity of supply for other regions, depending on the R&D intensity of the sector and the R&D intensity of the foreign region. The detailed elasticity values, by sector and region, are in appendix E, table E.1 We conduct sensitivity analysis on these parameters, to determine the impact of these parameters on the results.

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Table E.1: Estimates of elasticities of supply of firms with respect to price by sector and trading partner.

Sector	code	R&D intensity*	Ukraine	Turkey	China	European Union	Russia	USA	Countries with Free Trade Agreements with Ukraine	Rest of the World
Business Services										
Wholesale and Retail Trade	TRAD	LOW	3	3	3	3	3	3	3	3
Land transport	LTRA	LOW	3	3	3	3	3	3	3	3
Water transport	WTRA	MEDIUM	3	3	3	9	3	12	6	12
Air transport,	ATRA	MEDIUM	3	3	3	9	3	12	9	12
Telecommunications,	TELE	HIGH	3	3	3	18	9**	18	9	18
Computer and information service	PROG	HIGH	3	3	3	18	3	18	9	18
Insurance	INSR	LOW	3	3	3	3	3	3	3	3
Banking and other financial service	FINS	LOW	3	3	3	3	3	3	9	3
Other professional services	LEGL	HIGH	3	3	3	18	3	18	9	18
Manufacturing										
processed fish	PRFS	LOW	3	3	3	3	3	3	3	3
fruit and vegetables	PRFV	LOW	3	3	3	3	3	3	3	3
fats and oils	OILS	LOW	3	3	3	3	3	3	3	3
grain mill products	MILL	LOW	3	3	3	3	3	3	3	3
animal feeds	FEED	LOW	3	3	3	3	3	3	3	3
other food products	OTFD	LOW	3	3	3	3	3	3	3	3
textiles	TEXT	LOW	3	3	3	3	3	3	3	3
paper	PAPR	MEDIUM-LOW	3	3	3	9	3	9	4.5	9
printing	PRNT	MEDIUM-LOW	3	3	3	9	3	9	4.5	9
coke	COKE	LOW	3	3	3	3	3	3	3	3
petroleum products	PETR	LOW	3	3	3	3	3	3	3	3
pharmaceuticals	PHAR	HIGH	3	3	3	18	3	18	9	18
computers and peripherals	COMP	HIGH	3	3	3	18	3	18	9	18
electronic components	ELTR	MEDIUM-HIGH	3	3	3	15	3	15	7.5	15
consumer electronics	OPTC	MEDIUM-HIGH	3	3	3	15	3	15	7.5	15
electronic motors	BATT	MEDIUM-HIGH	3	3	3	15	3	15	7.5	15
household appliances	APPL	MEDIUM-HIGH	3	3	3	15	3	15	7.5	15
motor vehicles	VEHL	MEDIUM-HIGH	3	3	3	15	3	15	7.5	15
other transport equipment	TREQ	MEDIUM-HIGH	3	3	3	15	3	15	7.5	15
electric power generation	ELEC	MEDIUM-LOW	3	3	3	9	3	9	4.5	9

*R&D intensity is the ratio of R&D expenditures to sales.

**We assess telecommunications to be a relatively technologically advanced sector in Russia.

Source: For services: R&D intensity data are from the National Science Foundation, Division of Science Resources Statistics, Survey of Industrial Research and Development, 2005, Data Tables. For manufactured goods, R&D intensity is classified by Loschky (2010, table 1).

Appendix F: Calculation of the Value-Added, Export and Import Shares of the Disaggregated 85-Sector IO table

The disaggregated 2017 input-output (IO) table developed within the project encompasses 85 sectors of the economy. The starting point for the construction of the disaggregated IO table was the original 2017 input-output table featuring 42 sectors, some of which were disaggregated. For the purposes of this appendix, we use the expression "model sectors" to refer to sectors in the 85-sector dataset. In the main text we reserve the term model sector for the 45-sector policy model.

Table F1 presents the list of sectors included in the original 2017 input-output table and the decomposition applied. As shown, 26 out 42 sectors of the original 2017 input-output table remained unchanged, while 16 sectors required decomposition. For the input-output coefficients of the disaggregated sectors, we used the 2005 input-output table of Ukraine featuring 80 full-scale sectors where available. In the case of the split of textiles (TEXT) and wearing apparel (WEAR), since these were not split in the 2005 Ukrainian table, we used the GTAP database.

To calibrate the disaggregated dataset to the most recent economic statistics, we used three variables:

- Value-added, 2018
- Exports of goods and services, 2018
- Imports of goods and services, 2018

For each of three variables, we used their shares within decomposed sectors for the calibration. Below we explain the steps for share calculations in detail.

Value-added shares

The data about value-added at factor costs for private establishments for 2018 are available at Ukrstat: http://ukrstat.gov.ua/operativ/operativ2018/fin/pssg/pssg_u/dvvsg_ek_2013_2018_u.xlsx.

We defined a mapping between our 85 model sectors and the Ukrstat data using the most aggregated level of the NACE code to allows us to define a full mapping between our model sectors and the NACE classification.[78] Table F2 contains this mapping.

The steps to calculate the within sector value-added shares are the following:

- Map the value-added at factor costs reported by NACE rev.2 codes to the 85 sectors of our dataset

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[78] The data are generally available at all four levels of the NACE rev.2 classification. However, due to the confidentiality clause, most frequently data are not reported at two most disaggregated classifications, known in the NACE system as groups and classes within groups.

- For any sector of the original 2017 IO table, sum up the value-added of the disaggregated sectors within that sector.
- Calculate the within shares of value-added for sectors that require the decomposition in the original 2017 IO table by dividing the value for model sector on the value of the corresponding original 2017 IO table sector. The sum of shares has to be unity for each sector of the original 2017 IO table.

The resulted value-added and their shares are reported in Table F3. This process was only used for the shares of value-added of the disaggregated sectors. We did not change the value-added of the aggregate sector in the 2017 IO table.

Export and import shares

To calculate the within sector shares for exports and imports, we used the following data sources:

- Exports and imports of goods, 2018, World Integrated Trade Solution (WITS), https://wits.worldbank.org/WITS/WITS/Restricted/Login.aspx

- Exports and imports of services, 2018, National Bank of Ukraine, https://bank.gov.ua/files/ES/BOP_y.xlsx.

- Exports and imports of goods and services from IO table, 2005, Ukrstat, http://ukrstat.gov.ua/operativ/operativ2009/vvp/an_tvv/IOT05exp.rar

The correspondence between the model sectors and trade in goods data was established using the mapping developed within the project:

https://drive.google.com/file/d/1kWotssOAuzfER5Pwv0_ata7Rq8JyivZN/view?usp=sharing. The correspondence between the model sectors and service sectors in the balance of payments is established based on the sector descriptions.

The steps of the export and import shares calculation are the following:

- Map trade data with model sectors. For goods sectors, we used WITS; for service sectors – the balance of payments data or the 2005 IO data if the sector is not included in the balance of payments statistics.
- Sum up exports and imports by model sectors whenever needed to correspond to the original 2017 IO table sectors
- Calculate the within shares of exports and imports for sectors that require the decomposition in the original 2017 IO table by dividing the value for the model sector by the value of the corresponding original 2017 IO table sector. The sum of shares has to be unity for each sector of the original 2017 IO table.

- For the original 2017 IO table sectors, for which the single source of data does not allow full sector decomposition, make the rebalancing using the shares from the 2005 IO table as fixed and then adjust other shares obtained from the WITS and the NBU.

For instance, the decomposition of the original 2017 IO table sector "Agriculture, forestry and fishing" includes 5 sub-sectors, one of which is a service subsector AGSP "Support activities to agriculture and post-harvest crop activities." The only information about the share of this sub-sector is available in the 2005 IO table. For the other four subsectors, the data source is WITS.

To estimate the final shares, we assumed that AGSP preserves its export and import shares from 2005 and reduce the share of the largest subsector by this amount, in this case CROP "Growing of crops, mixed farming.

In the case of export shares, the similar procedure was applied to other three sectors of the original 2017 IO table, namely for "Electricity, gas, steam and air conditioning supply", "Water supply; sewerage, waste management and remediation activities" and "Financial and insurance activities." In the case of import shares, the producer was applied for "Financial and insurance activities" only.

- We assumed export and import shares for two original 2017 IO table sectors, as no data for decomposition were available. These sectors are "Administrative and support service activities" and "Other service activities." The assumed shares are also applied for imports of sector "Water supply; sewerage, waste management and remediation activities."

The estimates and resulted shares of exports are reported in Table F4 and for imports – in Table F5.

Table F1: The list of 2017 IO table sectors with the decomposition status

No.	Description of 2017 IO table sectors	NACE rev. 2	Status	No.	Description of model sectors	4dcode
1	Agriculture, forestry and fishing	A01-A03	decomposed into 5 sub-sectors	1	Growing of crops, mixed farming	CROP
				2	Animal production; hunting, trapping and related service activities	ANIM
				3	Support activities to agriculture and post-harvest crop activities	AGSP
				4	Forestry and logging	LOGG
				5	Fishing and aquaculture	FISH
2	Mining of coal and lignite	B05	IO2017 original	6	Mining of coal and lignite	COAL
3	Extraction of crude petroleum and natural gas	B06	IO2017 original	7	Extraction of crude petroleum and natural gas	CGAS
4	Mining of metal ores; other mining and quarrying; mining support service activities	B07-B09	decomposed into 4 sub-sectors	8	Mining of metal ores	ORES
				9	Quarrying of stone, sand and clay	SAND
				10	Mining of chemical and fertiliser minerals	CHMN
				11	Other mining and quarrying n.e.c., mining support service activities	OTMN
5	Manufacture of food products; beverages and tobacco products	C10-C12	decomposed into 8 sub-sectors	12	Processing and preserving of meat and production of meat products	PRMT
				13	Processing and preserving of fish, crustaceans and molluscs	PRFS
				14	Processing and preserving of fruit and vegetables	PRFV
				15	Manufacture of vegetable and animal oils and fats	OILS
				16	Manufacture of dairy products	DAIR
				17	Manufacture of grain mill products, starches and starch products	MILL
				18	Manufacture of prepared animal feeds	FEED
				19	Manufacture of other food products n.e.c.; beverages; tobacco products	OTFD
6	Manufacture of textiles, wearing apparel, leather and related products	C13-C15	decomposed into 3 sub-sectors	20	Manufacture of textiles	TEXT
				21	Manufacture of wearing apparel	WEAR
				22	Manufacture of leather and related products	LEAT
7	Manufacture of wood, paper, printing and reproduction	C16-C18	decomposed into 3 sub-sectors	23	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	WOOD
				24	Manufacture of paper and paper products	PAPR
				25	Printing and reproduction of recorded media	PRNT
8	Manufacture of coke	C19.1	IO2017 original	26	Manufacture of coke	COKE
9	Manufacture of refined petroleum products	C19.2	IO2017 original	27	Manufacture of refined petroleum products	PETR
10	Manufacture of chemicals and chemical products	C20	decomposed into 5 sub-sectors	28	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	BSCH
				29	Manufacture of pesticides and other agrochemical products	AGCH

No.	Description of 2017 IO table sectors	NACE rev. 2	Status	No.	Description of model sectors	4dcode
				30	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	**PNTS**
				31	Manufacture of man-made fibres	**FIBR**
				32	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations; other chemical products n.e.c.	**SOAP**
11	Manufacture of basic pharmaceutical products and pharmaceutical preparations	**C21**	IO2017 original	33	Manufacture of basic pharmaceutical products and pharmaceutical preparations	**PHAR**
12	Manufacture of rubber and plastic products	**C22**	IO2017 original	34	Manufacture of rubber and plastic products	**RUBB**
13	Manufacture of other non-metallic mineral products	**C23**	decomposed into 4 sub-sectors	35	Manufacture of glass and glass products	**GLAS**
				36	Manufacture of refractory products; clay building materials; other porcelain and ceramic products	**CLAY**
				37	Manufacture of cement, lime and plaster; articles of concrete, cement and plaster	**CEMT**
				38	Cutting, shaping and finishing of stone; manufacture of abrasive products and non-metallic mineral products n.e.c.	**STON**
14	Manufacture of basic metals	**C24**	IO2017 original	39	Manufacture of basic metals	**BSME**
15	Manufacture of fabricated metal products, except machinery and equipment	**C25**	IO2017 original	40	Manufacture of fabricated metal products, except machinery and equipment	**MEPR**
16	Manufacture of machinery and equipment n.e.c.	**C28**	decomposed into 5 sub-sector	41	Manufacture of general — purpose machinery	**GPMA**
				42	Manufacture of other general-purpose machinery	**OTMA**
				43	Manufacture of agricultural and forestry machinery	**AGMA**
				44	Manufacture of metal forming machinery and machine tools	**MEMA**
				45	Manufacture of other special-purpose machinery	**SPMA**
17	Manufacture of computer, electronic and optical products	**C26**	decomposed into 3 sub-sectors	46	Manufacture of computers and peripheral equipment	**COMP**
				47	Manufacture of electronic components and boards, communication equipment	**ELTR**
				48	Manufacture of consumer electronics, instruments and appliances for measuring, testing and navigation; watches and clocks; irradiation, electro-medical and electrotherapeutic equipment; optical instruments and photographic equipment; f magnetic and optical media	**OPTC**
18	Manufacture of electrical equipment	**C27**	decomposed into 2 sub-sectors	49	Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus; batteries and accumulators; wiring and wiring devices; electric lighting equipment; other electrical equipment	**BATT**
				50	Manufacture of domestic appliances	**APPL**
19	Manufacture of motor vehicles, trailers and semi-trailers	**C29**	IO2017 original	51	Manufacture of motor vehicles, trailers and semi-trailers	**VEHL**

No.	Description of 2017 IO table sectors	NACE rev. 2	Status	No.	Description of model sectors	4dcode
20	Manufacture of other transport equipment	C30	IO2017 original	52	Manufacture of other transport equipment	TREQ
21	Manufacture of furniture; jewelry, musical instruments, toys; repair and installation of machinery and equipment	C31-C33	IO2017 original	53	Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	FURN
22	Electricity, gas, steam and air conditioning supply	D35	decomposed into 3 sub-sectors	54	Electric power generation, transmission and distribution	ELEC
				55	Manufacture of gas; distribution of gaseous fuels through mains	GASS
				56	Steam and air conditioning supply	STEA
23	Water supply; sewerage, waste management and remediation activities	E36-E39	decomposed into 3 sub-sectors	57	Water collection, treatment and supply	WCOL
				58	Waste collection, treatment and disposal activities; materials recovery	WAST
				59	Sewerage; remediation activities and other waste management services	SWRG
24	Construction	F41-F43	IO2017 original	60	Construction	CNST
25	Wholesale and retail trade; repair of motor vehicles and motorcycles	G45-G47	IO2017 original	61	Wholesale trade, except of motor vehicles and motorcycles; retail trade, except of motor vehicles and motorcycles; sale of motor vehicles, parts and accessories, motor vehicle maintenance	TRAD
26	Transport, warehousing	H49-H52	decomposed into 4 sub-sectors	62	Land transport and transport via pipelines	LTRA
				63	Water transport	WTRA
				64	Air transport	ATRA
				65	Warehousing and support activities for transportation	TRAS
27	Postal and courier activities	H53	IO2017 original	66	Postal and courier activities	POST
28	Accommodation and food service activities	I55-I56	IO2017 original	67	Accommodation and food service activities	HOSP
29	Publishing, motion picture, video, television programme production; sound recording, programming and broadcasting activities	J58-J60	IO2017 original	68	Publishing, motion picture, video, television programme production; sound recording, programming and broadcasting activities	CRET
30	Telecommunications	J61	IO2017 original	69	Telecommunications	TELE
31	Computer programming, consultancy, and information service activities	J62-J63	IO2017 original	70	Computer programming, consultancy, and information service activities	PROG
32	Financial and insurance activities	K64-K66	decomposed into 3 sub-sectors	71	Financial service activities, except insurance and pension funding	FINS
				72	Insurance, reinsurance and pension funding, except compulsory social security	INSR
				73	Activities auxiliary to financial services and insurance activities	FAUX
33	Real estate activities	L68	IO2017 original	74	Real estate activities	REAL

No.	Description of 2017 IO table sectors	NACE rev. 2	Status	No.	Description of model sectors	4dcode
34	Legal and accounting activities; activities of head offices; management consultancy activities; architectural and engineering activities; technical...	M69-M71	IO2017 original	75	Legal and accounting activities; activities of head offices; management consultancy activities; architectural and engineering activities; technical testing and analysis	LEGL
35	Scientific research and development	M72	IO2017 original	76	Scientific research and development	RDEV
36	Advertising and market research; other professional, scientific and technical activities; veterinary activities	M73-M75	IO2017 original	77	Advertising and market research; other professional, scientific and technical activities; veterinary activities	ADVR
37	Administrative and support service activities	N77-N82	decomposed into 2 sub-sectors	78	Rental and leasing activities	RENT
				79	Employment activities; travel agency, tour operator reservation service and related activities; security and investigation activities; services to buildings and landscape activities; office administrative, office support and other business support activities	ADMS
38	Public administration and defense; compulsory social security	O84	IO2017 original	80	Public administration and defense; compulsory social security	PUBL
39	Education	P85	IO2017 original	81	Education	EDUC
40	Human health activities, residential care activities and social work activities without accommodation	Q86-Q88	IO2017 original	82	Human health activities, residential care activities and social work activities without accommodation	HLTH
41	Arts, entertainment and recreation	R90-R93	IO2017 original	83	Arts, entertainment and recreation	ARTS
42	Other service activities	S94-S96, T97	decomposed into 2 sub-sectors	84	Activities of membership organizations	NGOS
				85	Other service activities; activities of households as employers of domestic personnel	OTHS

Source: Ukrstat (http://ukrstat.gov.ua/druk/publicat/kat_u/2019/zb/05/zb_tvvoz2017xl.zip), mapping between model sectors and 2017 IO table is developed by the project team

Table F2: The mapping between the model sectors and minimum required NACE rev.2 codes

4-character code	NACE rev 2	4-character code	NACE rev 2	4-character code	NACE rev 2	4-character code	NACE rev 2	4-character code	NACE rev 2	4-character code	NACE rev 2
CROP	A01.2	MILL	C10.6	CLAY	C23.2	BATT	C27.2	LTRA	H49	DVR	M75
CROP	A01.5	FEED	C10.9	CLAY	C23.3	BATT	C27.4	WTRA	H50	RENT	N77
CROP	A01.1	OTFD	C12	CLAY	C23.4	BATT	C27.1	ATRA	H51	ADMS	N79
CROP	A01.3	OTFD	C10.7	CEMT	C23.5	BATT	C27.9	TRAS	H52	ADMS	N82
ANIM	A01.7	OTFD	C10.8	CEMT	C23.6	APPL	C27.5	POST	H53	ADMS	N80
ANIM	A01.4	OTFD	C11	STON	C23.7	VEHL	C29	HOSP	I56	ADMS	N78
AGSP	A01.6	TEXT	C13	STON	C23.9	TREQ	C30	HOSP	I55	ADMS	N81
LOGG	A02	WEAR	C14	BSME	C24	FURN	C31	CRET	J60	PUBL	O84
FISH	A03	LEAT	C15	MEPR	C25	FURN	C32	CRET	J58	EDUC	P85
COAL	B05	WOOD	C16	GPMA	C28.1	FURN	C33	CRET	J59	HLTH	Q86
CGAS	B06	PAPR	C17	OTMA	C28.2	ELEC	D35.1	TELE	J61	HLTH	Q87
ORES	B07	PRNT	C18	AGMA	C28.3	GASS	D35.2	PROG	J62	HLTH	Q88
SAND	B08.1	COKE	C19.1	MEMA	C28.4	STEA	D35.3	PROG	J63	ARTS	R91
CHMN	B08.91	PETR	C19.2	SPMA	C28.9	WCOL	D36	FINS	K64	ARTS	R90
OTMN	B08.92	BSCH	C20.1	COMP	C26.2	WAST	D38	INSR	K65	ARTS	R92
OTMN	B08.93	AGCH	C20.2	ELTR	C26.1	SWRG	D37	FAUX	K66	ARTS	R93
OTMN	B08.99	PNTS	C20.3	ELTR	C26.3	SWRG	D39	REAL	L68	NGOS	S94
OTMN	B09	FIBR	C20.6	OPTC	C26.4	CNST	F41	LEGL	M70	OTHS	S95
PRMT	C10.1	SOAP	C20.4	OPTC	C26.8	CNST	F42	LEGL	M71	OTHS	S96
PRFS	C10.2	SOAP	C20.5	OPTC	C26.7	CNST	F43	LEGL	M69	OTHS	T97
PRFV	C10.3	PHAR	C21	OPTC	C26.5	TRAD	G45	RDEV	M72		
OILS	C10.4	RUBB	C22	OPTC	C26.6	TRAD	G46	ADVR	M73		
DAIR	C10.5	GLAS	C23.1	BATT	C27.3	TRAD	G47	ADVR	M74		

Table F3: The value-added shares in 2018 for the decomposed sectors

	2017 IO table sectors description	4 character code	Model sector description	VA2018, UAH thous	within-sector shares, 2018
1	Agriculture, forestry and fishing	CROP	Growing of crops, mixed farming	164,614,582	0.82
		ANIM	Animal production; hunting, trapping and related service activities	21,375,389	0.11
		AGSP	Support activities to agriculture and post-harvest crop activities	5,238,282	0.03
		LOGG	Forestry and logging	10,340,011	0.05
		FISH	Fishing and aquaculture	369,537	0.00
4	Mining of metal ores; other mining and quarrying; mining support service activities	ORES	Mining of metal ores	66,573,667	0.81
		SAND	Quarrying of stone, sand and clay	10,577,430	0.13
		CHMN	Mining of chemical and fertiliser minerals	10,850	0.00
		OTMN	Other mining and quarrying n.e.c., mining support service activities	5,328,356	0.06
5	Manufacture of food products; beverages and tobacco products	PRMT	Processing and preserving of meat and production of meat products	13,770,042	0.11
		PRFS	Processing and preserving of fish, crustaceans and molluscs	2,393,031	0.02
		PRFV	Processing and preserving of fruit and vegetables	5,597,937	0.05
		OILS	Manufacture of vegetable and animal oils and fats	32,555,937	0.27
		DAIR	Manufacture of dairy products	11,977,376	0.10
		MILL	Manufacture of grain mill products, starches and starch products	5,519,911	0.05
		FEED	Manufacture of prepared animal feeds	2,853,646	0.02
		OTFD	Manufacture of other food products n.e.c.; beverages; tobacco products	46,989,819	0.39
6	Manufacture of textiles, wearing apparel, leather and related products	TEXT	Manufacture of textiles	3,635,690	0.25
		WEAR	Manufacture of wearing apparel	7,249,386	0.49
		LEAT	Manufacture of leather and related products	3,779,841	0.26
7	Manufacture of wood, paper, printing and reproduction	WOOD	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	12,909,797	0.43
		PAPR	Manufacture of paper and paper products	11,425,466	0.38
		PRNT	Printing and reproduction of recorded media	5,552,571	0.19
10	Manufacture of chemicals and chemical products	BSCH	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	10,402,757	0.57
		AGCH	Manufacture of pesticides and other agrochemical products	348,112	0.02

2017 IO table sectors description	4 character code	Model sector description	VA2018, UAH thous	within-sector shares, 2018
	PNTS	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	1,840,882	0.10
	FIBR	Manufacture of man-made fibres	85,878	0.00
	SOAP	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations; other chemical products n.e.c.	5,727,804	0.31
13 Manufacture of other non-metallic mineral products	GLAS	Manufacture of glass and glass products	4,079,312	0.14
	CLAY	Manufacture of refractory products; clay building materials; other porcelain and ceramic products	5,064,379	0.17
	CEMT	Manufacture of cement, lime and plaster; articles of concrete, cement and plaster	14,495,342	0.49
	STON	Cutting, shaping and finishing of stone; manufacture of abrasive products and non-metallic mineral products n.e.c.	5,962,696	0.20
16 Manufacture of machinery and equipment n.e.c.	GPMA	Manufacture of general — purpose machinery	8,773,597	0.30
	OTMA	Manufacture of other general-purpose machinery	6,304,759	0.22
	AGMA	Manufacture of agricultural and forestry machinery	3,945,861	0.14
	MEMA	Manufacture of metal forming machinery and machine tools	293,149	0.01
	SPMA	Manufacture of other special-purpose machinery	9,757,270	0.34
17 Manufacture of computer, electronic and optical products	COMP	Manufacture of computers and peripheral equipment	1,410,755	0.15
	ELTR	Manufacture of electronic components and boards, communication equipment	2,408,011	0.26
	OPTC	Manufacture of consumer electronics, instruments and appliances for measuring, testing and navigation; watches and clocks; irradiation, electro-medical and electrotherapeutic equipment; optical instruments and photographic equipment; f magnetic and optical media	5,323,547	0.58
18 Manufacture of electrical equipment	BATT	Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus; batteries and accumulators; wiring and wiring devices; electric lighting equipment; other electrical equipment	13,738,027	0.90
	APPL	Manufacture of domestic appliances	1,473,805	0.10

	2017 IO table sectors description	4 character code	Model sector description	VA2018, UAH thous	within-sector shares, 2018
22	Electricity, gas, steam and air conditioning supply	ELEC	Electric power generation, transmission and distribution	101,347,706	0.75
		GASS	Manufacture of gas; distribution of gaseous fuels through mains	26,476,806	0.20
		STEA	Steam and air conditioning supply	7,213,704	0.05
23	Water supply; sewerage, waste management and remediation activities	WCOL	Water collection, treatment and supply	7,321,598	0.51
		WAST	Waste collection, treatment and disposal activities; materials recovery	5,039,674	0.35
		SWRG	Sewerage; remediation activities and other waste management services	1,913,731	0.13
26	Transport, warehousing	LTRA	Land transport and transport via pipelines	105,461,020	0.49
		WTRA	Water transport	1,311,945	0.01
		ATRA	Air transport	17,885,498	0.08
		TRAS	Warehousing and support activities for transportation	90,505,801	0.42
32	Financial and insurance activities	FINS	Financial service activities, except insurance and pension funding	26,857,655	0.62
		INSR	Insurance, reinsurance and pension funding, except compulsory social security	13,372,000	0.31
		FAUX	Activities auxiliary to financial services and insurance activities	3,358,042	0.08
37	Administrative and support service activities	RENT	Rental and leasing activities	12,503,461	0.27
		ADMS	Employment activities; travel agency, tour operator reservation service and related activities; security and investigation activities; services to buildings and landscape activities; office administrative, office support and other business support activities	33,702,657	0.73
42	Other service activities	NGOS	Activities of membership organisations		0.00
		OTHS	Other service activities; activities of households as employers of domestic personnel	2,436,286	1.00

Source: Ukrstat (http://ukrstat.gov.ua/druk/publicat/kat_u/2019/zb/05/zb_tvvoz2017xl.zip), own estimates

Table F4: The export shares in 2018 for the decomposed sectors

	Description IO2017	4-character code	IO2005 export	Shares	BOP export	shares	WITS export	shares	FINAL export share
1	Agriculture, forestry and fishing	CROP	8587	0.906			9,499,453	0.971	0.970
		ANIM	63	0.007			239,873	0.025	0.025
		AGSP	7	0.001					0.001
		LOGG	796	0.084			42,693	0.004	0.004
		FISH	29	0.003			956	0.000	0.000
4	Mining of metal ores; other mining and quarrying; mining support service activities	ORES					3,023,918	0.885	0.885
		SAND					365,783	0.107	0.107
		CHMN					2,930	0.001	0.001
		OTMN					23,613	0.007	0.007
5	Manufacture of food products; beverages and tobacco products	PRMT					692,053	0.077	0.077
		PRFS					36,375	0.004	0.004
		PRFV					371,702	0.041	0.041
		OILS					5,576,985	0.622	0.622
		DAIR					317,470	0.035	0.035
		MILL					133,066	0.015	0.015
		FEED					14,857	0.002	0.002
		OTFD					1,819,707	0.203	0.203
6	Manufacture of textiles, wearing apparel, leather and related products	TEXT					320,711	0.268	0.268
		WEAR					561,252	0.469	0.469
		LEAT					313,774	0.262	0.262
7	Manufacture of wood, paper, printing and reproduction	WOOD					1,381,337	0.708	0.708
		PAPR					564,789	0.289	0.289
		PRNT					5,068	0.003	0.003
10	Manufacture of chemicals and chemical products	BSCH					1,209,145	0.797	0.797
		AGCH					10,697	0.007	0.007
		PNTS					20,651	0.014	0.014
		FIBR					23,985	0.016	0.016
		SOAP					251,732	0.166	0.166
13	Manufacture of other non-metallic mineral products	GLAS					170,476	0.334	0.334
		CLAY					145,679	0.286	0.286
		CEMT					39,480	0.077	0.077
		STON					154,176	0.302	0.302
16	Manufacture of machinery and equipment n.e.c.	GPMA					531,975	0.410	0.410
		OTMA					302,636	0.233	0.233
		AGMA					95,265	0.073	0.073
		MEMA					32,697	0.025	0.025
		SPMA					336,307	0.259	0.259
17	Manufacture of computer, electronic and optical products	COMP					17,995	0.029	0.029
		ELTR					406,516	0.649	0.649

Description IO2017	4-character code	IO2005 export	Shares	BOP export	shares	WITS export	shares	FINAL export share
	OPTC					202,215	0.323	0.323
18 Manufacture of electrical equipment	BATT					2,140,165	0.835	0.835
	APPL					422,552	0.165	0.165
22 Electricity, gas, steam and air conditioning supply	ELEC	945	0.97			331,942	1.000	0.972
	GASS	2	0.00				0.000	0.002
	STEA	25	0.03				0.000	0.026
23 Water supply; sewerage, waste management and remediation activities	WCOL	9					0.000	0.000
	WAST	0				151,494	1.000	1.000
	SWRG	11					0.000	0.000
26 Transport, warehousing	LTRA			3,803	0.66			0.657
	WTRA			522	0.09			0.090
	ATRA			1,221	0.21			0.211
	TRAS			243	0.04			0.042
32 Financial and insurance activities	FINS	269	0.556936	106	0.848			0.790
	INSR	186	0.385093	19	0.152			0.152
	FAUX	28	0.057971		0			0.058
37 Administrative and support service activities	RENT							0.500
	ADMS							0.500
42 Other service activities	NGOS							0.100
	OTHS							0.900

Source: WITS, NBU, Ukrstat, own estimates

Table F5: The import shares in 2018 for the decomposed sectors

	Description IO2017	4-character code	IO2005 import	Shares	BOP import	shares	WITS import	shares	FINAL import share
1	Agriculture, forestry and fishing	CROP	3366	0.685			1327031	0.863006	0.86
		ANIM	385	0.078			93112.07	0.060553	0.06
		AGSP	12	0.002					0.00
		LOGG	58	0.012			3434.181	0.002233	0.00
		FISH	1090	0.222			114106.5	0.074207	0.07
4	Mining of metal ores; other mining and quarrying; mining support service activities	ORES					490089.8	0.690943	0.69
		SAND					96878.43	0.136582	0.14
		CHMN					33685.98	0.047491	0.05
		OTMN					88651.51	0.124983	0.12
5	Manufacture of food products; beverages and tobacco products	PRMT					219954.7	0.06	0.06
		PRFS					524321.6	0.15	0.15
		PRFV					265312.3	0.07	0.07
		OILS					260613.7	0.07	0.07
		DAIR					96366.75	0.03	0.03
		MILL					108886.7	0.03	0.03
		FEED					195793.9	0.06	0.06
		OTFD					1886571	0.53	0.53
6	Manufacture of textiles, wearing apparel, leather and related products	TEXT					1368104	0.549439	0.55
		WEAR					529382.6	0.212603	0.21
		LEAT					592513	0.237957	0.24
7	Manufacture of wood, paper, printing and reproduction	WOOD					298565.2	0.195217	0.20
		PAPR					1213381	0.793369	0.79
		PRNT					17457.75	0.011415	0.01
10	Manufacture of chemicals and chemical products	BSCH					4101442	0.589308	0.59
		AGCH					968736.3	0.139191	0.14
		PNTS					334561.8	0.048071	0.05
		FIBR					142703.1	0.020504	0.02
		SOAP					1412317	0.202926	0.20
13	Manufacture of other non-metallic mineral products	GLAS					294160.2	0.327241	0.33
		CLAY					335749.1	0.373507	0.37
		CEMT					86777.33	0.096536	0.10
		STON					182224.2	0.202717	0.20
16	Manufacture of machinery and equipment n.e.c.	GPMA					943887.4	0.184435	0.18
		OTMA					1407243	0.274974	0.27
		AGMA					1147098	0.224142	0.22
		MEMA					270814.3	0.052917	0.05
		SPMA					1348684	0.263532	0.26
17	Manufacture of computer, electronic and optical products	COMP					828205.6	0.206043	0.21
		ELTR					2185537	0.543722	0.54

Description IO2017	4-character code	IO2005 import	Shares	BOP import	shares	WITS import	shares	FINAL import share
	OPTC					1005843	0.250235	0.25
18 Manufacture of electrical equipment	BATT					2331724	0.757565	0.76
	APPL					746196.2	0.242435	0.24
22 Electricity, gas, steam and air conditioning supply	ELEC					1402.288	0.010989	0.01
	GASS						0	0.00
	STEA					126207.1	0.989011	0.99
23 Water supply; sewerage, waste management and remediation activities	WCOL	0						0.00
	WAST	0						1.00
	SWRG	0						0.00
26 Transport, warehousing	LTRA			813	0.37			0.37
	WTRA			577	0.26			0.26
	ATRA			775	0.35			0.35
	TRAS			54	0.02			0.02
32 Financial and insurance activities	FINS	1770	0.805278	476	0.875			0.87
	INSR	417	0.189718	68	0.125			0.13
	FAUX	11	0.005005					0.01
37 Administrative and support service activities	RENT							0.50
	ADMS							0.50
42 Other service activities	NGOS							0.10
	OTHS							0.90

Source: WITS, NBU, Ukrstat, own estimates

Appendix G: Decomposition of Labor Shares into Skilled and Unskilled

Ukrstat does not report the decomposition of labor by skills in the format required for the 85-sector dataset. Therefore, we did the decomposition combining information from several available datasets. The following sources of data were used:

- For the number of employees by sector and the level of education: "Labor of Ukraine in 2013", Ukrstat, link: http://ukrstat.gov.ua/druk/publicat/kat_u/2014/zb/07/zb_prU_2013.zip. The data contain the total number of employees, the number of employees with incomplete or basic higher education, and the number of employees with higher education, and their shares in total employment by sector. It was the last publication that reported this information. Subsequently, Ukrstat continued to collect data on the number of employees by sector; but they stopped collecting data on the number of employees by education level at the sector level.

- For average wages by sector and occupation: "Wages by professional groups in 2016 (according to the survey)", Ukrstat, link: http://ukrstat.gov.ua/druk/publicat/kat_u/2017/zb/12/zb_zppg2016w.zip. The data contain aggregate average wage and average wage by sector and occupation groups. It is the most recent publication on this topic.

Fpr 2013, the number of employees by sector and by the level of education is available for 23 sectors, mostly at the level of the NACE sections (letter codes) and in some cases disaggregated at the level of the NACE division (two-digit code). Therefore, it is not possible to establish one-to-one correspondence between the sectors in the 85-sector dataset and the reported sectoral structure of employment by the level of education. Instead, we assume that several sectors in the 85-sector dataset have the identical structure of the employment. The concordance between the sectors in the 85-sector dataset and the NACE codes used for mapping employment data is presented in Table G1.

For 2016, the data on average wage by sector and occupation category are reported for 19 sectors corresponding to the NACE sections (letter codes). Therefore, we had to assume that multiple 85-sector dataset sectors have the same structure of wages by occupation category. The concordance between the sectors in the 85-sector dataset and the NACE codes used for mapping wage data is presented in Table G2.

We also had to make assumptions about the correspondence between the skill level, the level of education and the occupation category. The assumptions are the following:

- Employees with higher education, including also incomplete or basic higher education, are considered as skilled. All other employees belong to the category of unskilled labor.

- The occupations belonging to Group 1 "Managers", Group 2 "Professional" and Group 3 "Technicians and Associated Professional" are considered as having higher education and thus belong to skilled labor. The remaining occupations are considered unskilled. The educational requirements for occupations are established using the National Classification of Occupations (https://zakon.rada.gov.ua/rada/show/va327609-10#Text) that in turn is based on the International Standard Classification of Occupations (ISCO) by the International Labor Organization.

The decomposition of labor compensation into the compensation paid to skilled and unskilled labor included the following steps:

- Map the data on the total number of employees, the share of employees with incomplete or basic higher education, and the share of employees with higher education into the 85-sector dataset's sectors.

- Map the data on the average wage and average wage for occupations belonging to Group 1 "Managers", Group 2 "Professional" and Group 3 "Technicians and Associated Professional" into the 85-sector dataset's sectors.

- For the resultant balanced dataset, for each sector calculate:

  o Average wage of skilled employee that is assumed to be equal to:

  (10% * Average Wage of Group 1 "Managers") +

  + (45% * Average Wage of Group 2 "Professional") +

  + (45% * Average Wage of Group 2 "Technicians and Associated Professional")

  o The share of skilled labor in the employment is assumed to be equal to:

  (The share of employees with incomplete or basic higher education) +

  + (The share of employees with higher education)

  o Total wage bill of the sector being equal to:

  (Aggregate average wage) * (Total number of employees)

  o Wage bill for skilled employees being equal to:

  (Average wage of skilled employee) * (Total number of employees) *

  * (The share of skilled labor)

  o The share of skilled labor in wage bill being equal to:

  (Wage bill for skilled employees) / (Total wage bill) * 100%

  o The share of unskilled labor in wage bill being equal to:

  100% - (The share of skilled labor in wage bill)

The calculations and the resultant shares are presented in Table G3.

Table G1: The concordance between the sectors in the 85-sector dataset and the NACE codes used for the number of employees mapping

4-character code	NACE	4-character code	NACE	4-character code	NACE	4-character code	NACE
AGSP	A01	FIBR	C	TEXT	C	INSR	K
ANIM	A01	FURN	C	TREQ	C	REAL	L
CROP	A01	GLAS	C	VEHL	C	LEGL	M69
LOGG	A02	GPMA	C	WEAR	C	LEGL	M70
FISH	A03	LEAT	C	WOOD	C	LEGL	M71
CGAS	B	MEMA	C	ELEC	D	RDEV	M72
CHMN	B	MEPR	C	GASS	D	ADVR	M73
COAL	B	MILL	C	STEA	D	ADVR	M74
ORES	B	OILS	C	SWRG	D	ADVR	M75
OTMN	B	OPTC	C	WAST	D	ADMS	N
SAND	B	OTFD	C	WCOL	D	RENT	N
AGCH	C	OTMA	C	CNST	F	PUBL	O
AGMA	C	PAPR	C	TRAD	G	EDUC	P
APPL	C	PETR	C	LTRA	H49	HLTH	Q
BATT	C	PHAR	C	WTRA	H50	ARTS	R
BSCH	C	PNTS	C	ATRA	H51	NGOS	S
BSME	C	PRFS	C	TRAS	H52	OTHS	S
CEMT	C	PRFV	C	POST	H53		
CLAY	C	PRMT	C	HOSP	I		
COKE	C	PRNT	C	CRET	J		
COMP	C	RUBB	C	PROG	J		
DAIR	C	SOAP	C	TELE	J		
ELTR	C	SPMA	C	FAUX	K		
FEED	C	STON	C	FINS	K		

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Table G2: The concordance between the sectors in the 85-sector dataset and the NACE codes used for the wage mapping

4-character code	NACE_1d	4-character code	NACE_1d	4-character code	NACE_1d	4-character code	NACE_1d
AGSP	A	FIBR	C	TEXT	C	INSR	K
ANIM	A	FURN	C	TREQ	C	REAL	L
CROP	A	GLAS	C	VEHL	C	ADVR	M
FISH	A	GPMA	C	WEAR	C	LEGL	M
LOGG	A	LEAT	C	WOOD	C	RDEV	M
CGAS	B	MEMA	C	ELEC	D	ADMS	N
CHMN	B	MEPR	C	GASS	D	RENT	N
COAL	B	MILL	C	STEA	D	PUBL	O
ORES	B	OILS	C	SWRG	D	EDUC	P
OTMN	B	OPTC	C	WAST	D	HLTH	Q
SAND	B	OTFD	C	WCOL	D	ARTS	R
AGCH	C	OTMA	C	CNST	F	NGOS	S
AGMA	C	PAPR	C	TRAD	G	OTHS	S
APPL	C	PETR	C	ATRA	H		
BATT	C	PHAR	C	LTRA	H		
BSCH	C	PNTS	C	POST	H		
BSME	C	PRFS	C	TRAS	H		
CEMT	C	PRFV	C	WTRA	H		
CLAY	C	PRMT	C	HOSP	I		
COKE	C	PRNT	C	CRET	J		
COMP	C	RUBB	C	PROG	J		

DAIR	C		SOAP	C		TELE	J
ELTR	C		SPMA	C		FAUX	K
FEED	C		STON	C		FINS	K

Table G3: The decomposition of the labor shares into skilled and unskilled

4-character code	Average wage, total, UAH	Average monthly wage for Group 1 "Managers", UAH	Average monthly wage for Group 2 "Professional", UAH	Average monthly wage for Group 3 "Technicians and Associate Professionals", UAH	Average wage of skilled employees, UAH	Number of employees, total, thous	Share of employees with incomplete or basic higher education, %	Share of employees with higher education, %	Share of skilled labor, %	Wage bill total, UAH thous	Wage bill of skilled employees, UAH thous	Share of skilled employees in wage bill, %	Share of unskilled employees in wage bill, %
(1)	(2)	(3)	(4)	(5)	(6) = 0.1*(3) + 0.45*(4) + 0.45*(5)	(7)	(8)	(9)	(10) = (8) + (9)	(11) = (2)*(7)	(12) = (6)*(7)*(10)	(13) = (12) / (11)	(14) = 100% - (13)
CROP	3,812	5,347	4,710	4,139	4,516	449	16%	14%	30%	1,713,266	610,619	36%	64%
ANIM	3,812	5,347	4,710	4,139	4,516	449	16%	14%	30%	1,713,266	610,619	36%	64%
AGSP	3,812	5,347	4,710	4,139	4,516	449	16%	14%	30%	1,713,266	610,619	36%	64%
LOGG	3,812	5,347	4,710	4,139	4,516	63	26%	21%	46%	240,940	132,331	55%	45%
FISH	3,812	5,347	4,710	4,139	4,516	63	26%	21%	46%	240,940	132,331	55%	45%
COAL	7,084	10,937	7,894	6,959	7,778	422	23%	17%	39%	2,987,964	1,293,429	43%	57%
CGAS	7,084	10,937	7,894	6,959	7,778	422	23%	17%	39%	2,987,964	1,293,429	43%	57%
ORES	7,084	10,937	7,894	6,959	7,778	422	23%	17%	39%	2,987,964	1,293,429	43%	57%
SAND	7,084	10,937	7,894	6,959	7,778	422	23%	17%	39%	2,987,964	1,293,429	43%	57%
CHMN	7,084	10,937	7,894	6,959	7,778	422	23%	17%	39%	2,987,964	1,293,429	43%	57%
OTMN	7,084	10,937	7,894	6,959	7,778	422	23%	17%	39%	2,987,964	1,293,429	43%	57%
PRMT	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
PRFS	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
PRFV	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%

4-character code	Average wage, total, UAH	Average monthly wage for Group 1 "Managers", UAH	Average monthly wage for Group 2 "Professional", UAH	Average monthly wage for Group 3 "Technicians and Associate Professionals", UAH	Average wage of skilled employees, UAH	Number of employees, total, thous	Share of employees with incomplete or basic higher education, %	Share of employees with higher education, %	Share of skilled labor, %	Wage bill total, UAH thous	Wage bill of skilled employees, UAH thous	Share of skilled employees in wage bill, %	Share of unskilled employees in wage bill, %
OILS	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
DAIR	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
MILL	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
FEED	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
OTFD	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
TEXT	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
WEAR	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
LEAT	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
WOOD	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
PAPR	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
PRNT	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
COKE	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
PETR	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
BSCH	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
AGCH	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
PNTS	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
FIBR	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
SOAP	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
PHAR	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
RUBB	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
GLAS	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
CLAY	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
CEMT	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
STON	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
BSME	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%

4-character code	Average wage, total, UAH	Average monthly wage for Group 1 "Managers", UAH	Average monthly wage for Group 2 "Professional", UAH	Average monthly wage for Group 3 "Technicians and Associate Professionals", UAH	Average wage of skilled employees, UAH	Number of employees, total, thous	Share of employees with incomplete or basic higher education, %	Share of employees with higher education, %	Share of skilled labor, %	Wage bill total, UAH thous	Wage bill of skilled employees, UAH thous	Share of skilled employees in wage bill, %	Share of unskilled employees in wage bill, %
MEPR	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
GPMA	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
OTMA	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
AGMA	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
MEMA	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
SPMA	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
COMP	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
ELTR	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
OPTC	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
BATT	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
APPL	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
VEHL	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
TREQ	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
FURN	5,086	7,289	6,011	5,552	5,932	1,692	21%	26%	47%	8,606,393	4,711,124	55%	45%
ELEC	6,402	10,829	8,640	6,590	7,936	412	26%	31%	57%	2,637,554	1,857,901	70%	30%
GASS	6,402	10,829	8,640	6,590	7,936	412	26%	31%	57%	2,637,554	1,857,901	70%	30%
STEA	6,402	10,829	8,640	6,590	7,936	412	26%	31%	57%	2,637,554	1,857,901	70%	30%
WCOL	6,402	10,829	8,640	6,590	7,936	412	26%	31%	57%	2,637,554	1,857,901	70%	30%
WAST	6,402	10,829	8,640	6,590	7,936	412	26%	31%	57%	2,637,554	1,857,901	70%	30%
SWRG	6,402	10,829	8,640	6,590	7,936	412	26%	31%	57%	2,637,554	1,857,901	70%	30%
CNST	4,005	4,666	3,611	4,105	3,939	277	19%	28%	47%	1,108,161	512,435	46%	54%
TRAD	5,120	8,573	6,319	4,516	5,733	931	24%	36%	59%	4,765,063	3,156,680	66%	34%
LTRA	5,743	7,888	7,484	7,145	7,372	275	21%	21%	42%	1,581,048	860,295	54%	46%
WTRA	5,743	7,888	7,484	7,145	7,372	275	21%	21%	42%	1,581,048	860,295	54%	46%
ATRA	5,743	7,888	7,484	7,145	7,372	275	21%	21%	42%	1,581,048	860,295	54%	46%

4-character code	Average wage, total, UAH	Average monthly wage for Group 1 "Managers", UAH	Average monthly wage for Group 2 "Professional", UAH	Average monthly wage for Group 3 "Technicians and Associate Professionals", UAH	Average wage of skilled employees, UAH	Number of employees, total, thous	Share of employees with incomplete or basic higher education, %	Share of employees with higher education, %	Share of skilled labor, %	Wage bill total, UAH thous	Wage bill of skilled employees, UAH thous	Share of skilled employees in wage bill, %	Share of unskilled employees in wage bill, %
TRAS	5,743	7,888	7,484	7,145	7,372	443	23%	23%	46%	2,544,723	1,507,543	59%	41%
POST	5,743	7,888	7,484	7,145	7,372	102	24%	14%	38%	588,083	287,502	49%	51%
HOSP	2,995	4,684	3,883	3,704	3,883	102	27%	26%	53%	306,438	212,000	69%	31%
CRET	8,694	12,253	10,169	6,856	8,887	187	20%	56%	76%	1,624,120	1,267,233	78%	22%
TELE	8,694	12,253	10,169	6,856	8,887	187	20%	56%	76%	1,624,120	1,267,233	78%	22%
PROG	8,694	12,253	10,169	6,856	8,887	187	20%	56%	76%	1,624,120	1,267,233	78%	22%
FINS	8,484	11,987	8,889	5,302	7,585	308	21%	67%	88%	2,615,759	2,053,125	78%	22%
INSR	8,484	11,987	8,889	5,302	7,585	308	21%	67%	88%	2,615,759	2,053,125	78%	22%
FAUX	8,484	11,987	8,889	5,302	7,585	308	21%	67%	88%	2,615,759	2,053,125	78%	22%
REAL	4,081	6,492	4,398	3,948	4,405	129	20%	29%	49%	525,620	275,739	52%	48%
LEGL	6,938	11,596	6,274	5,629	6,516	205	17%	61%	78%	1,424,302	1,048,399	74%	26%
RDEV	6,938	11,596	6,274	5,629	6,516	115	13%	67%	80%	800,606	601,412	75%	25%
ADVR	6,938	11,596	6,274	5,629	6,516	205	17%	61%	78%	1,424,302	1,048,399	74%	26%
RENT	3,836	6,708	6,365	6,378	6,405	235	22%	25%	47%	902,230	712,891	79%	21%
ADMS	3,836	6,708	6,365	6,378	6,405	235	22%	25%	47%	902,230	712,891	79%	21%
PUBL	4,255	6,083	4,832	4,459	4,789	625	18%	67%	85%	2,658,099	2,536,866	95%	5%
EDUC	4,251	5,819	5,282	3,631	4,593	1,743	19%	54%	73%	7,408,643	5,835,089	79%	21%
HLTH	3,246	5,437	4,326	3,339	3,993	1,260	43%	22%	65%	4,091,258	3,264,237	80%	20%
ARTS	4,788	6,250	5,340	5,012	5,283	181	32%	40%	72%	867,107	687,899	79%	21%
NGOS	4,537	6,932	6,481	4,503	5,636	47	23%	34%	57%	213,693	150,481	70%	30%
OTHS	4,537	6,932	6,481	4,503	5,636	47	23%	34%	57%	213,693	150,481	70%	30%

Sources: Ukrstat, own estimates