# Trade liberalization gains under different trade theories: A case study for Ukraine[†]

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## Abstract

Given Ukraine's difficult political and economic situation, the EU focuses its efforts on providing financial and economic support as well as accelerating the establishment and ratification of the Association Agreement (AA) incorporating the Deep and Comprehensive Free Trade Area (DCFTA). To analyze the DCFTA between Ukraine and the EU we develop a GTAP 8.1 based multi-regional CGE model with three different setups. In addition to the standard model specification of trade based on the Armington assumption of regionally differentiated goods, we implement monopolistic competition and competitive selection of heterogeneous firms suggested by Krugman [1980] and Melitz [2003]. This allows us to capture trade growth in new varieties and changes in aggregate productivity due to within industry reallocation of resources. The core results indicate substantial benefit for Ukraine whereas the gains for the EU are quite small. A comparison of welfare results for Ukraine across the different structural assumptions shows that the impact is much higher under the Armington assumption than under either the Krugman or Melitz trade formulations. Deep integration with the EU intensifies import competition in the increasing returns sectors, while inducing a movement of resources into Ukraine's traditional export sectors which produce under constant returns. The indication is that traditional CGE models may overstate the gains from the DCFTA between Ukraine and EU. Consistent with Balistreri *et al.* [2003] and Arkolakis *et al.* [2012] the gains from trade can be lower under an assumption of monopolistic competition if trade reduces the set of goods produced. This is our finding for Ukraine. We caution, however, that our model does not include capital flows, so EU firms supply Ukraine's markets on a cross-border bases. Allowing for capital flows might change the story if the EU firms were to engage in FDI, which would increase the number of EU varieties while increasing the demand for workers in Ukraine.

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# 1 Introduction

Ukraine's recent revolution and Russia's annexation of Ukrainian territories let the country be in focus of the worlds' community events and concerns. Being in a situation of a continuing political and economic crises with a high external debt and substantial public budget deficit, Ukraine receives the urgently necessary assistance not only from the EU and USA but also from different international organizations such as the International Monetary Fund (IMF) and the World Bank.

The EU makes an effort to accelerate the establishment and ratification of the new type of trade agreement with Ukraine, which is widely expected to bring long-term economic gains and therefore a way out of the existent crises. As a part of the AA, the DCFTA constitutes a new type of agreement as it involves not only a bilateral import tariff elimination. It additionally envisages the harmonization of Ukraine's regulations in competition policy, state aid, public procurement, sanitary and phyto-sanitary measures, technical regulations and service trade liberalization. The political provisions of the AA between the EU and Ukraine were signed in March 2014 and the signature process of the remaining parts, including the DCFTA, was completed in June 2014. Moreover, since April 2014 the EU has temporarily removed customs duties on Ukrainian exports as an Autonomous Trade Measure (ATM). This unilateral transitional trade measure allowed Ukraine to benefit substantially from the advantages offered by the DCFTA even before the implementation of the tariffs-related section of the AA provisions.[1]

A comprehensive analysis of the DCFTA effects on Ukrainian economy is necessary to detect possible problems and sensitive issues of this trade liberalization. That will assist the country's integration with the EU by giving some guidelines and suggestions concerning the liberalization process. Hence, it will provide Ukraine with the highest possible benefit and opportunities for sustainable economic development and prosperity.

There is some research on the EU-Ukraine economic integration predicting welfare gains from trade liberalization. However, the standard CGE studies with perfect competition and constant returns to scale fail to capture the new developments in the trade theory suggested by Krugman [1980] and Melitz [2003]. In particular, the models do not allow trade liberalization to induce trade growth in new varieties and productivity changes due to a within industry reallocation of resources. To avoid this we develop a GTAP 8.1 based multi-regional CGE model incorporating monopolistic competition and competitive selection of heterogenous firms. To compare the outcomes from different model specifications we run the model in three different setups consistent with the different trade theories: Armington, Krugman and Melitz.

[1] See European Council [2014d], European Council [2014a], European Council [2014b], European Council [2014c] and European Council [2014e] available at `http://eeas.europa.eu/ukraine/news/`.

## 2 Literature review

Different steps in liberalizing Ukraine's trade are widely evaluated in the literature. After applying for the WTO membership in 1993, a detailed analysis of Ukraine's WTO accession was executed by Pavel *et al.* [2004], Jensen *et al.* [2005] and Kosse [2002]. Measuring the impact of an import tariff reduction in a standard static CGE model with perfect competition and constant returns to scale (CRTS), Kosse [2002] finds the WTO membership beneficial for Ukraine due to a positive impact on the national welfare. In the same modeling framework Pavel *et al.* [2004] simulate the full WTO accession accounting for improved market access and adjustment of domestic taxation in addition to the tariff reduction. They identify a welfare gain of 3% and an increase of real GDP by 1.9%. Jensen *et al.* [2005] support these findings by prediction of an overall welfare gain of 5.2% and a rise of real GDP by 2.4% using an extended model concerning imperfect competition and increasing returns to scale (IRTS) for some manufacturing sectors and incorporating a reform of FDI barriers to service sectors.

After Ukraine's accession to the WTO in 2008, the negotiations on the AA including a DCFTA with the EU were launched and this issue became the first priority for economic research. Analyzing different potential FTAs between Ukraine and the EU, Emerson *et al.* [2006] and Ecorys & CASE-Ukraine [2007] show that the DCFTA, which additionally incorporates a reduction of different non-tariff barriers (NTBs) and liberalization of trade in services, would have a stronger positive impact on Ukraine's welfare (up to 7%) compared to the simple one (incorporating tariff reductions only) where the effects are small or even slightly negative.[2] Maliszewska *et al.* [2009] support these findings by simulating different FTAs between the EU and five CIS countries: Armenia, Azerbaijan, Georgia, Ukraine and Russia. Their results show that Ukraine benefits the most among the CIS countries and the gains from the deeper integration (5.83%) are higher than from the simple tariff reduction (1.76%). The same question is studied by Francois & Manchin [2009] in a multi-regional model with a higher number of included CIS countries.[3] According to their results, a bilateral tariff reduction would lead to a decrease of real income for the CIS region as a whole and for Ukraine in particular (-0.83 and -2.12%, respectively). Modeling the DCFTA by adding services liberalization and reduction of barriers to efficient trade facilitation, they find a smaller real income decrease for Ukraine of -0.4%. von Cramon-Taubadel *et al.* [2010] focus mainly on the agricultural sectors of the GTAP7 dataset and find that a 50% reduction in all bilateral tariffs would only result in moderate gains for Ukraine and the EU. Thus, the greatest possible benefit is found in case of improved agricultural productivity modeled by a 5% exogenous boost in technical change.

The most recent study is done by Movchan & Giucci [2011] and investigate a broader

[2] A slightly negative long-term welfare effect of -0.06% is found for Ukraine by Emerson *et al.* [2006].

[3] Francois & Manchin [2009] present detailed results for Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Russia and Ukraine.

range of Ukraine's integration strategies. They compare the effects of different FTAs with the EU on the one hand and Ukraine's accession to the customs union with Russia, Belarus and Kazakhstan on the other hand. Simulating the DCFTA with 2.5% reduction of boarder dead-wight costs on trade in addition to the tariff elimination, they find a long-run welfare effect of 11.8% which is significantly higher than the impact of a simple FTA (4.6%). Thus, an implementation of a joint external tariff in case of the customs union would lead to a welfare loss up to 3.7%.

The most of presented studies implement standard static CGE models with assumptions of perfect competition and CRTS as well as differentiation of goods by region of origin (Armington [1969]) to model foreign trade. However, Kehoe [2005] criticizes the performance of applied general equilibrium (GE) models commonly used in trade policy analysis. After comparing different multi-sectoral static GE models for investigation of impact of NAFTA, he concludes that these models do not allow trade liberalization

1. to induce trade growth in new varieties (extensive margin of trade) and

2. to capture changes in aggregate productivity.

To avoid the critique concerning new varieties, some of the recent studies (e.g. Maliszewska *et al.* [2009], Ecorys & CASE-Ukraine [2007], Francois & Manchin [2009], Movchan & Giucci [2011]) apply imperfect competition and IRTS in manufacturing sectors and services assuming firm level product differentiation (suggested by Krugman [1980]) on the bottom level of an Armington aggregate. Thus, trade liberalization allows consumers to enjoy new foreign varieties what creates higher welfare gains.

Changes in aggregate productivity remain still out of scope of the existing studies on Ukraine's trade liberalization despite strong evidence in the recent empirical and theoretical literature. Due to variation in productivity levels among coexisting firms,[4] a within industry reallocation of production factors from less- to more productive plants (including exit of the lowest productivity plants) is an important channel through which trade policy may influence the aggregate productivity growth.[5] These endogenous productivity changes as well as trade growth along the extensive margin are incorporated in the model derived by Melitz [2003] (new new trade (NNT) theory).

To illustrate the differences between Armington and Melitz based trade, Balistreri *et al.* [2003] show that the results are equivalent only in case of an unrealistic one sector model given an appropriate parametrization. Once multiple sectors are considered, the results diverge strongly. For instance, Balistreri *et al.* [2011] demonstrate that a reduction of tariffs under Melitz structure indicates welfare gains four times larger than a standard

[4] See for example Bartelsman & Doms [2000] for differences in firm level productivity within an industry and Bernard *et al.* [2003] for differences in productivity of exporters and non-exporters .

[5] Aw *et al.* [2001] illustrate an overall productivity growth for Taiwanese manufacturing caused by reallocation of market share from less productive to more productive firms. Trefler [2004] provides an evidence for linking trade policy changes to labor productivity growth. An extended empirical literature review on heterogenous firms and international trade structure is given in Balistreri *et al.* [2011].

Armington model specification. Corcos *et al.* [2011] apply a partial equilibrium model for the EU and find much larger gains from trade in the presence of selection effects with substantial variability across countries and sectors. Furthermore, Balistreri & Rutherford [2012] implement a Melitz-based analysis of economic integration and find also important variety effects due to endogenous firm entry as well as the aforementioned productivity effects related to the competitive selection of more productive firms.

Our paper contributes to the ongoing discussion on the recently initialled DCFTA between the EU and Ukraine stressing the differences in predicted outcomes modeling three different trade theories: Armington, Krugman and Melitz based trade.

## 3 Theoretical background

Standard CGE models with perfect competition and constant returns to scale usually use the Armington assumption of differentiated regional products to model foreign trade.[6] In this formulation firm-level products and technologies are assumed to be identical within a region, whereas product varieties from different places of production are imperfect substitutes. Thus, consumers do consume home as well as foreign varieties of the same good which are aggregated to a composite commodity in a Constant Elasticity of Substitution (CES) function using the so-called Armington elasticity of substitution. Given the use of a high level of aggregation in a CGE model, the assumption of homogenous firm-level goods within one region is pretty unrealistic. Nonetheless, the Armington formulation works in order to model the intra-industry foreign trade which accounts for over 80% for some Ukrainian sectors such as textiles, chemicals, manufacture of machinery and equipment.

Product differentiation at the firm level was first suggested by Krugman [1980] and provided an intuitive explanation for intra-industry trade. He developed a theory of trade under large-group monopolistic competition among symmetric firms producing under the same increasing returns to scale technology (known as new trade theory). In the initial Krugman [1980] model, which does not include firms' entry or exit, trade allows consumers to benefit from new foreign varieties not available in autarky. Aggregating the differentiated firm level goods through a CES activity generates a composite commodity available for consumption or intermediate use. This CES aggregation is consistent with the Dixit & Stiglitz [1977] love-of-variety formulation and therefore indicates industry-wide scale effects from new varieties reflected in additional gains for agents. These gains constitute purely demand-side variety gains independent of the increasing returns to scale formulation.

Extending the Krugman [1980] model by incorporating endogenous firms entry allows for adjustments along the extensive margin as a response to trade. Though, such a model specification with trade induced entry considers gains from new varieties that did not

[6] See Armington [1969], Dervis *et al.* [1982], pp. 221-223 and 226-227.

exit before. However, the gains under monopolistic competition may be lower than in the Armington formulation if trade leads to an exit of firms. Though, the Krugman style models still do not reflect the reality as the assumption of symmetric small firms with a fixed markup is not supported by micro data.

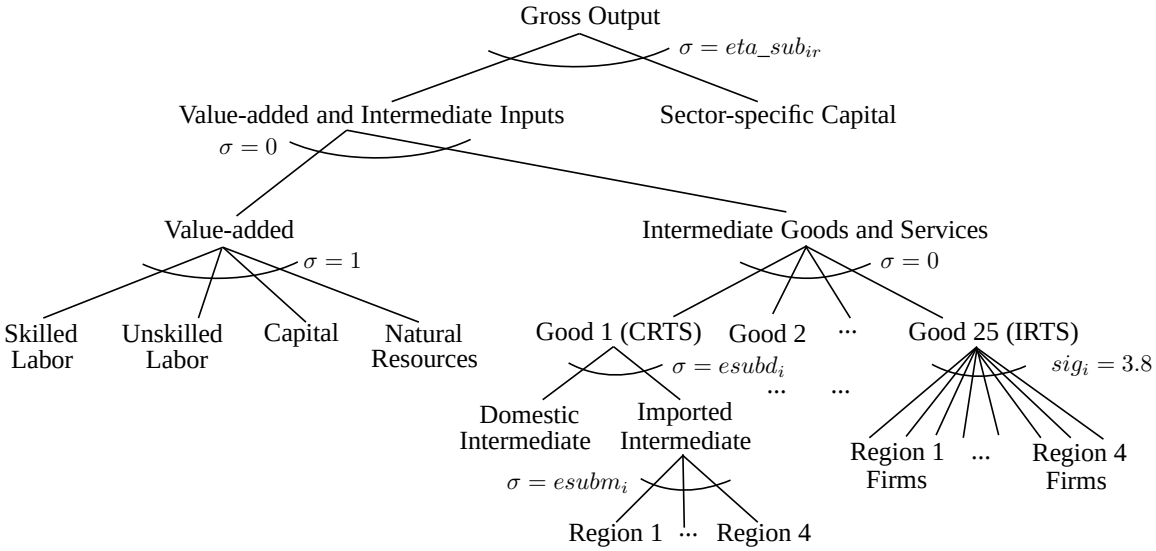
Melitz [2003] introduced a model with monopolistic competition within and across borders including a competitive selection of heterogeneous firms. The differentiated firm level goods are also aggregated according to the Dixit-Stiglitz specification of preferences, but these varieties are produced under different increasing-returns technologies. Though, the competitive selection of firms constitutes the key component of the model. Following this selection mechanism each firm can first choose to pay entry cost[7] for a productivity draw (assumed to come from a Pareto distribution) which therefore determines its marginal cost of production: a firm with higher productivity has a lower marginal cost and vice versa. Then it has to make a decision on how much to produce and in which markets to operate. As all firms face a market specific fixed cost in addition to marginal cost of production, some firms with low productivity draws will not operate in any market because their costs will exceed the expected profits. Other firms with higher productivity draws may decide to produce only for domestic market or even for multiple markets including export markets. Exporting firms are hereby among the most productive ones as foreign markets are associated with higher fixed costs. In this framework trade liberalization affects the distribution of firms causing the exit of low-productivity firms due to increased competition from abroad. Moreover, it also induces some relatively productive firms to enter external markets. This exit and entry lead to a reallocation of resources toward the more productive firms within an industry and generates thereby an overall productivity growth.

## 4 Model description

Our empirical model is directly developed from the model presented by Balistreri & Rutherford [2012]. The backbone of the modeling exercise consists of a standard CGE model with perfect competition, constant returns to scale and regional differentiation (Armington). Though, we allow for imperfect competition and increasing returns to scale in some manufacturing sectors and services. Figure 1 illustrates the structure of production for each sector and region of the model. It involves a combination of intermediate inputs and primary factors. We assume a Cobb-Douglas function over the mobile primary factors (skilled and unskilled labor, capital and natural resources)[8] and a Leontief production function combining intermediate goods and services with the factors of production composite. Sector-specific capital enters the top nest of the production function together with an aggregate of mobile production factors and intermediate inputs with an elasticity

[7] Sunk cost which has no influence on Firm's decision to operate in a given bilateral market.
[8] These production factors are mobile across sectors within a region, but immobile across regions.

Figure 1: Production structure




of substitution $eta\_sub_{ir}$, which is calibrated according to the specific elasticity of supply used for modeling of Krugman and Melitz based goods.[9]

Each region of the model has two agents: a government and a single representative household. Consumption of final goods is given by a Cobb-Douglas utility function over sectoral commodity bundles. Final as well as intermediate demand are composed of the same Armington aggregate of domestic and imported goods. In the CRTS formulation, this Armington aggregate is modeled as a nested CES function where consumers first allocate their expenditures among domestic and foreign goods and then decide between imported varieties from different regions (this structure is presented for good 1 in Figure 1). Allowing for imperfect competition and IRTS in some selected manufacturing sectors and services, we differentiate between domestic and foreign products on the firm level. This requires an assumption of the same elasticity between firms and products. Thus, the composite of differentiated firm level goods is modeled by a single level CES function with all domestic and imported varieties competing directly (this structure is illustrated for good 25 in Figure 1). General equilibrium is then defined by zero profits for all producers, balanced budgets for representative households and government in each region, as well as market clearance for all goods and factor markets.

The description of our general equilibrium (GE) model still does not include the specification of Krugman and Melitz formulation for the IRTS sectors as these are captured by two partial equilibrium (PE) models. Thus, we use a decomposition algorithm[10] described by Balistreri & Rutherford [2012] which subdivides the system into two related equilibrium problems:

[9] This supply elasticity is used in the partial equilibrium models for Krugman and Melitz formulation, which are described later in this section.

[10] This technique is also used by Balistreri *et al.* [2011].

$\Rightarrow$ A PE model either for Krugman or for Melitz industrial organization and

$\Rightarrow$ A constant-returns GE model of global trade in composite input bundles.

The PE models incorporate the industrial organization in selected IRTS sectors and the associated impact on prices as well as on productivity in case of Melitz structure. Hereby, aggregate income and supply schedules are taken as given. The GE model takes industrial structure as given (including bilateral trade patterns, price indices, number of operating firms and productivity) and determines relative prices, comparative advantage and the terms of trade. Thus, we iterate between the two subsystems so that industrial structure is passed from the PE to the GE module, whereas aggregate demand and supply prices of inputs are passed back from the GE to the PE module. We iterate until the models get consistent and we receive a solution to the multi-regional and multi-sectoral general equilibrium with monopolistic competition and even competitive selection of heterogenous firms (in Melitz formulation). Solving the industrial organization models in isolation from aggregate income changes allows us to avoid dealing with computational limits caused by excessively high dimensionalities that would otherwise arise in case of a large number of commodities, regions and agents.

Let us now specify the equations of the two PE models. In terms of notation $i \in I$ indicate a commodity or sector, $r \in R$ and $s \in R$ indicate a region. The set of commodities is decomposed into the Armington, Krugman ($k \in K \subset I$) and Melitz ($m \in M \subset I$) goods. All the equations of PE models are listed in Table 1 together with associated variables.

Table 1: Equations of the partial equilibrium models

| Equation description | Associated variable | | Equation number | |
|---|---|---|---|---|
| | | | Krugman | Melitz |
| Demand by sector | $P_{kr}$ or $P_{mr}$: | Composite commodity price | (1) | (1) |
| Composite price index | $Q_{kr}$ or $Q_{mr}$: | Aggregate quantity | (2) | (7) |
| Firm-level demand | $p_{krs}$ or $\tilde{p}_{mrs}$: | Firm-level price | (3) | (8) |
| Firm-level price | $q_{krs}$ or $\tilde{q}_{mrs}$: | Firm output | (4) | (9) |
| Firm-level productivity | $\tilde{\varphi}_{mrs}$: | Average productivity | | (12) |
| Free entry (zero profit) | $N_{kr}$ or $M_{mr}$: | Entered firms | (5) | (11) |
| Composite-input market | $c_{kr}$ or $c_{mr}$: | Unit cost index | (6) | (13) |
| Zero cutoff profits | $N_{mrs}$: | Number of operating firms | | (10) |

In both PE models producers face the same regional demand ($Q_{kr}$) for the sectoral composite commodity (including imported and domestic varieties) which is determined in the GE. At this point we present the aggregate demand equation only for Krugman[11] goods:

$$Q_{kr} = \bar{Q}_{kr} \left( \frac{\bar{P}_{kr}}{P_{kr}} \right)^{\eta}, \tag{1}$$

[11]The aggregate demand equation for Melitz goods is the same, only index $k$ is replaced by $m$.

where $\eta \geq 0$[12] is the price elasticity of demand, $P_{kr}$ is a composite price of commodity $k$ in region $r$ and symbols with a bar indicate benchmark (calibrated) levels. Thus, for each iteration of the PE model aggregate demand is recentered on the last GE solution point.

Specifying Krugman PE model first, let $p_{krs}$ be the firm-level price (gross of trade cost and taxes) set by a firm from region $r$ selling in market $s$. Then the Dixit-Stiglitz price index for a composite commodity $k$ in region $s$ is given by:

$$P_{ks} = \left[ \sum_r \lambda_{krs} N_{kr} p_{krs}^{1-\sigma_k} \right]^{\frac{1}{1-\sigma_k}}, \tag{2}$$

where $\sigma_k > 1$ is the elasticity of substitution, $\lambda_{krs}$ indicates the bilateral preference weights and $N_{kr}$ is the number of active firms in region $r$. The corresponding bilateral firm-level demand $q_{krs}$ (i.e. import quantity delivered to region $s$ by a firm from $r$) is defined by:

$$q_{krs} = \lambda_{krs} Q_{kr} \left( \frac{P_{ks}}{p_{krs}} \right)^{\sigma_k}. \tag{3}$$

Assuming large-group monopolistic competition we allow firms to have market power over their unique variety. However, their pricing has a negligible impact on the composite price $P_{ks}$, so they face a constant-elasticity demand with $P_{ks}$ assumed constant. The firms maximize their profits by setting a price with an optimal markup over marginal cost:

$$p_{krs} = \frac{\tau_{krs} c_{kr} (1 + t_{krs})}{1 - \frac{1}{\sigma_k}}, \tag{4}$$

where $t_{krs}$ indicates the tariff rate and $c_{kr}$ is a composite input unit cost, so that $\tau_{krs} c_{kr}$ constitute the marginal cost of delivering product $k$ from region $r$ to $s$ under the iceberg cost assumption.

As the firms incur a fixed cost $f_k$[13] in addition to marginal cost, zero profit condition indicates that the number of firms (a complementary variable) will adjust so that nominal fixed cost payments equal profits:

$$c_{kr} f_k = \sum_s \frac{p_{krs} q_{krs}}{\sigma_k (1 + t_{krs})}. \tag{5}$$

The last equation of the Krugman PE model is a market clearance condition for the composite input:

$$\bar{Y}_{kr} \left( \frac{c_{kr}}{\bar{c}_{kr}} \right)^{\mu} = N_{kr} (f_k + \sum_s \tau_{krs} q_{krs}). \tag{6}$$

The left-hand side represents the regional input supply $Y_{kr}$ with the supply elasticity

[12] The price elasticity of demand is assumed to be equal 0.75.

[13] $f_k$ is measured in composite input units as well as the iceberg trade cost $\tau_{krs}$

$\mu \geq 0$[14] which is determined in the GE and recentered on the last GE solution for each iteration. The right-hand side constitutes the total demand for composite inputs where $\tau_{krs}$ is considered as a real cost of delivering $q_{krs}$ units to the foreign market.

Specifying the Melitz PE model we can see in Table 1 that it includes the same equations as the Krugman model. However, according to heterogeneity of firms it additionally includes firm-level productivity and zero-cutoff-profit condition which determines the competitive selection of firms into the various bilateral markets. As the firms are heterogenous and have market power over their unique varieties, there is a continuum of firm-level prices, quantities and productivities. Following the initial Melitz's representation, we simplify this by using a representative (or average) firm's price $\tilde{p}_{mrs}$,[15] quantity $\tilde{q}_{mrs}$ and productivity $\tilde{\varphi}_{mrs}$. Considering this simplification we get a similar to the Krugman specification Dixit-Stiglitz price index for a composite commodity $m$ in region $s$:

$$P_{ms} = \left[ \sum_r \lambda_{mrs} N_{mrs} \tilde{p}_{mrs}^{1-\sigma_m} \right]^{\frac{1}{1-\sigma_m}}, \tag{7}$$

where $N_{mrs}$ is the number of firms operating on the $r$ to $s$ link. Demand for variety of the average firm shipping from $r$ to $s$ at a gross of trade costs and taxes price $\tilde{p}_{mrs}$ is:

$$\tilde{q}_{mrs} = \lambda_{mrs} Q_{mr} \left( \frac{P_{ms}}{\tilde{p}_{mrs}} \right)^{\sigma_m}. \tag{8}$$

Having the same assumptions as in the Krugman model, the average firm chooses an optimal price $\tilde{p}_{mrs}$:

$$\tilde{p}_{mrs} = \frac{\tau_{mrs} c_{mr} (1 + t_{mrs})}{\tilde{\varphi}_{mrs} \left( 1 - \frac{1}{\sigma_m} \right)}, \tag{9}$$

where the level of marginal cost is determined by the productivity of the average firm: $c_{mr}/\tilde{\varphi}_{mrs}$.

Let $M_{mr}$ denote the number of entered firms in region $r$. We assume that each of the entered firms choosing to pay entry cost receives a firm-specific productivity draw $\varphi$ from a Pareto distribution. Taking the fixed cost of operation on the $r$ to $s$ link ($f_{mrs}$) into account, there will be a marginal firm with the level of productivity such that the operating profits are zero. Linking this marginal firm in a given bilateral market to a representative firm with positive profits,[16] we can specify a zero-cutoff-profit condition in terms of average firm revenues:

$$c_{mr} f_{mrs} = \frac{\tilde{p}_{mrs} \tilde{q}_{mrs}}{(1 + t_{mrs})} \frac{(a + 1 - \sigma_m)}{a \sigma_m}, \tag{10}$$

[14] This supply elasticity is taken into account by calibrating the top nest elasticity $eta\_sub_{ir}$.
[15] $\tilde{p}_{mrs}$ is defined as the price set by a small firm with the CES weighted average productivity $\tilde{\varphi}_{mrs}$.
[16] Detailed description is provided by Balistreri & Rutherford [2012], pp. 13-14, Balistreri *et al.* [2011], pp.98-99.

where $a$ is the shape parameter of the Pareto distribution.[17] This condition defines the number of operating firms ($N_{mrs}$) meaning that the average-firm revenues ($\tilde{p}_{mrs}\tilde{q}_{mrs}$) fall with more firms shipping from $r$ to $s$.

Each of the entered firms pays fixed entry costs of $f^s_{mr}$ input units, so the nominal entry payment is equal to $c_{mr}f^s_{mr}$. Let $\delta$ be a probability of a bad shock that forces exit in each future period. Considering this, the firm-level annualized flow of entry payments is $c_{mr}\delta f^s_{mr}$. Setting these entry payments equal to the expected profits[18] from each potential market derives the free entry condition:

$$c_{mr}\delta f^s_{mr} = \sum_s \frac{\tilde{p}_{mrs}\tilde{q}_{mrs}}{(1+t_{mrs})}\frac{(\sigma_m-1)}{a\sigma_m}\frac{N_{mrs}}{M_{mr}}, \tag{11}$$

where $N_{mrs}/M_{mr}$ indicate the probability that a firm from $M_{mr}$ will operate in the market $s$. Given this probability and applying the Pareto distribution[19] we get the productivity of the average firm:

$$\tilde{\varphi}_{mrs} = b\left(\frac{a}{a+1-\sigma_m}\right)^{\frac{1}{\sigma_m-1}}\left(\frac{N_{mrs}}{M_{mr}}\right)^{-\frac{1}{a}}, \tag{12}$$

where $b$ is the minimum productivity determined by the Pareto distribution.[20]

After specifying the number of entered and operating firms, we can close the PE model with the market clearance condition for the composite input:

$$Y_{mr} = \delta f^s_{mr}M_{mr} + \sum_s N_{mrs}\left(f_{mrs} + \frac{\tau_{mrs}\tilde{q}_{mrs}}{\tilde{\varphi}_{mrs}}\right). \tag{13}$$

Supply of the composite input ($Y_{mr}$) is consistent with the Krugman PE model (left-hand side of the equation (6)), whereas composite input demand consists of three components:

1. inputs used in fixed entry costs ($\delta f^s_{mr}M_{mr}$),
2. inputs used in operating fixed costs ($\sum_s N_{mrs}f_{mrs}$) as well as
3. operating inputs ($\sum_s N_{mrs}\frac{\tau_{mrs}\tilde{q}_{mrs}}{\tilde{\varphi}_{mrs}}$).

Calibration issues concerning the both PE models are fully described by Balistreri & Rutherford [2012].

[17] This shape parameter of Pareto distribution is assumed to be 4.582, the central value estimated by Balistreri *et al.* [2011].

[18] Average profit of a firm from $r$ operating in $s$ is given by $\tilde{\pi}_{mrs} = \frac{\tilde{p}_{mrs}\tilde{q}_{mrs}}{(1+t_{mrs})\sigma_m} - c_{mr}f_{mrs}$. Substituting the operating fixed cost with (10) leads to $\tilde{\pi}_{mrs} = \frac{\tilde{p}_{mrs}\tilde{q}_{mrs}}{(1+t_{mrs})}\frac{\sigma_m-1}{a\sigma_m}$.

[19] For details see Balistreri *et al.* [2011], pp. 98-99.

[20] Following Bernard *et al.* [2007], this parameter is assumed to be equal 0.2.

## 5 Data sources and scenarios

Our model is calibrated to an aggregation of the GTAP 8.1 dataset. Table 2 shows sectors, primary factors of production and regions included. To analyze the DCFTA between Ukraine and the EU we include these regions together with the Commonwealth of Independent States (CIS) and the rest of the world (ROW). Detailed mapping of regions is presented in Table A.8. The 57 GTAP sectors are aggregated into 25 activities which are to a large extent consistent with the activities of the national input-output table of Ukraine.[21] 9 sectors with a share of intra-industry trade (IIT) over 60% produce under increasing returns to scale technology. Table A.9 demonstrates the detailed aggregation of the GTAP sectors.

Table 2: Scope of the model

| CRTS goods: | | IIT* | Regions: | |
|---|---|---|---|---|
| AGR | Agriculture and hunting | 57.55 | UKR | Ukraine |
| FRS | Forestry | 12.02 | EU | EU |
| FSH | Fishing | 4.67 | CIS | CIS and Georgia |
| COL | Coal | 42.71 | ROW | Rest of the world |
| HDC | Production of hydrocarbons | 13.25 | | |
| OMN | Minerals nec | 86.69 | Factors: | |
| FPI | Food-processing | 56.89 | lab | Unskilled labor |
| MET | Metallurgy and metal processing | 30.05 | skl | Skilled labor |
| OIL | Petroleum, coal products | 51.28 | cap | Capital |
| ELE | Electricity | 0.62 | res | Natural resources |
| GDT | Gas manufacture, distribution | 0 | | |
| WTR | Water | 0 | | |
| CNS | Construction | 53.30 | | |
| FNI | Financial services, insurance | 8.19 | | |
| ROS | Recreational and other services | 50.43 | | |
| OSG | Public services | 55.21 | | |
| IRTS goods: | | | | |
| TEX | Textiles and leather | 86.35 | | |
| CNM | Chemical and mineral products | 91.04 | | |
| OMF | Manufactures nec | 97.39 | | |
| WPP | Wood, paper products, publishing | 89.75 | | |
| MEQ | Manufacture of machinery and equipment | 85.46 | | |
| OBS | Business services nec | 61.71 | | |
| TRD | Trade | 89.97 | | |
| CMN | Communications | 91.25 | | |
| TRS | Transport | 65.24 | | |

*Calculation of the intra-industry trade share (in %) is based on the UN Comtrade data.

All the distortions in the GTAP dataset (import tariffs, export subsidies and different taxes) are incorporated in the model. As Ukraine is the country in focus, we use import tariffs taken from the Law of Ukraine "About the Customs Tariff of Ukraine" including all amendments made due to Ukraine's accession to the WTO in 2008. Due to different types of tariff rates (ad valorem, specific and mixed) we use the WTO *et al.* [2007] methodology

[21] This aggregation helps to combine the GTAP data with the national data for Ukraine.

to calculate the ad valorem equivalents (AVEs) of specific and mixed tariffs. The resulting tariff rates are transformed from the HS2000 into the NACE Rev.1 using correspondence tables and applying different averages (simple, weighted, import-weighted). The applied import-weighted Most Favored Nation (MFN) tariff rates on Ukraine's imports are shown in Table A.10.[22]

To simulate the establishment of the DCFTA between Ukraine and the EU we also need to apply the AVEs for non-tariff barriers (NTBs) to trade and for barriers to efficient trade facilitation. The values of all applied distortions for Ukraine and the EU are presented in Table A.10 and A.11. Concerning NTBs, we aggregate the AVEs estimated by Kee *et al.* [2009]. We use the values for the Overall Trade Restrictiveness Index (OTRI) and for the Tariff-only OTRI (OTRI_T).[23] The first index measures the uniform tariff equivalent of the country's tariffs and NTBs that would generate the same level of import value for the country in a given year. The second one focuses only on tariffs of each country.[24] Both indices are available for over 100 countries and for only two types of aggregated products: agricultural and manufacturing goods. Calculating the difference between OTRI and OTRI_T gives us an AVE for NTBs only. These AVEs are aggregated first to the GTAP regions and then to the regions of our model according to mapping given in Table A.8. Hereby, we simply assign the calculated values for Ukraine and the EU, whereas for CIS and ROW we compute weighted averages using GTAP countries' total imports at market prices as weights.

Concerning the AVEs for poor trade facilitation, we use the values based on the research of Hummels [2007], Hummels *et al.* [2007] and Hummels & Schaur [2013]. They estimate the value of one day saved in transit for more than 600 HS 4-digit level products. Using these estimates Minor [2013] provides country and product specific AVEs for trade time costs as a separate package of the GTAP 8.1 database.[25] To calculate the overall trade time costs by country and product we combine these estimates with the number of days needed to export or import goods in each country taken from the World Bank's Doing Business dataset for 2012. Aggregating these values to the model-specific regions and sectors gives us the bilateral AVEs of time in trade to import or export goods. The use of bilateral and sector-specific AVEs of time in trade is an important improvement in comparison to most CGE modeling of trade facilitation issues with a single AVE across all products.

[22] These tariff rates apply only to Ukraine's imports from the EU and from the rest of the world. Commodity trade with the CIS region is classified as free trade because of existing agreements between Ukraine and the CIS countries (since 1999).

[23] The dataset is available at `http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:22574446~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html`.

[24] We use the values for OTRI and OTRI_T based on applied tariffs which take into account the bilateral trade preferences.

[25] The dataset is available at `http://mygtap.org/resources/#Estimates`. It includes three different AVEs depending on the treatment of the missing values on the HS 4-digit level. As the first two methodologies are biased down, we apply the AVEs where missing estimates are replaced with the average value for the same GTAP category ($tau - 3$).

In order to analyze the DCFTA between Ukraine and the EU we conduct three different simulations. The first one (S1) reflects the simple FTA incorporating a bilateral elimination of import tariffs. In addition, we reduce the NTBs and barriers to efficient trade facilitation by 20% on the both sides in the second counterfactual simulation (S2). An analysis of such a modest percentage cut is motivated by the fact that these barriers cannot be eliminated completely. Thus, to be able to simulate an upper bound for trade liberalization between Ukraine and the EU we reduce the trade facilitation barriers to the intra EU level in the third simulation (S3). For this purpose we use the existing barriers between Greece and Germany which are situated on the approximately similar distance as the average distance between Ukraine and the member countries of the EU.

For comparison of results under different trade theories we run each simulation three times. The first run of each counterfactual simulation (S1.A, S2.A and S3.A) provides the results under Armington trade formulation. In the second run (S1.K, S2.K and S3.K) we assume Krugman trade and in the third one we apply Melitz structure with competitive selection of heterogenous firms.

## 6 Results

The aggregate results of all counterfactual experiments are represented in Table 3. Trade liberalization occurs to be welfare increasing for Ukraine and the EU, what is supported by a rise in real GDP and real consumption. Thereby, higher reductions of trade barriers are associated with higher benefits for the both trade partners. However, while the EU can gain from the policy reform only with a small rise of welfare up to 0.05%, Ukraine's benefits are much higher with a welfare increase up to 12.31%. Only in scenario S1.K and S1.M Ukraine suffers from trade liberalization with a reduction of real GDP by approximately 0.1% and a decline of welfare by 0.16%. The reason is the trade-induced net exit of firms and therefore a lower number of available varieties in the monopolistic competitions models. This finding is consistent with Balistreri *et al.* [2003] and Arkolakis *et al.* [2012]. Due to trade liberalization only between Ukraine and the EU, the other regions are affected slightly negatively. While trade diversion from the rest of the world is relatively small and has almost no impact on real GDP, consumption and welfare, the CIS region suffers more from trade diversion with a welfare decrease between 0.01% and 0.12%.

The bilateral reduction of trade barriers between Ukraine and the EU leads to an increase in imports and exports in all scenarios. Moreover, the higher the reductions, the stronger the effects on exports and imports are observed. These changes are between 2.25% and 13.78% for Ukraine. For the EU the effects are also positive, but under 1% in all simulations. Taking competitive selection of heterogenous firms into account (S1.M, S2.M, S3.M) leads to the highest impacts on trade flows as there is a reallocation of resources towards most productive exporting firms. Concerning the other regions, we find

a small diversion of trade from ROW and CIS. Hoverer, a decline of exports and imports in these regions remains under 0.7% across the simulations and the negative changes for ROW are smaller that for the CIS.

Table 3: Aggregate results

| | S0 | S1.A | S1.K | S1.M | S2.A | S2.K | S2.M | S3.A | S3.K | S3.M |
|---|---|---|---|---|---|---|---|---|---|---|
| Welfare (Hicksian welfare index), percentage change | | | | | | | | | | |
| UKR | | 0.55 | -0.17 | -0.16 | 6.37 | 3.84 | 4.00 | 12.31 | 8.62 | 9.02 |
| EU | | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.03 | 0.03 | 0.05 | 0.05 |
| CIS | | -0.01 | -0.01 | -0.01 | -0.06 | -0.05 | -0.05 | -0.12 | -0.10 | -0.11 |
| ROW | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Real GDP, bn USD | | | | | | | | | | |
| UKR | 64.6 | 64.8 | 64.5 | 64.6 | 66.5 | 65.5 | 65.6 | 68.1 | 66.5 | 66.8 |
| EU | 13269.6 | 13270.7 | 13270.6 | 13270.7 | 13271.7 | 13272.7 | 13272.8 | 13273.0 | 13275.0 | 13275.1 |
| CIS | 697.0 | 697.0 | 697.0 | 697.0 | 696.8 | 696.8 | 696.8 | 696.6 | 696.6 | 696.6 |
| ROW | 28166.2 | 28166.1 | 28166.4 | 28166.4 | 28165.8 | 28166.5 | 28166.6 | 28165.6 | 28166.5 | 28166.5 |
| Reall GDP, percentage change | | | | | | | | | | |
| UKR | | 0.28 | -0.13 | -0.10 | 2.96 | 1.36 | 1.55 | 5.38 | 2.97 | 3.39 |
| EU | | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.03 | 0.04 | 0.04 |
| CIS | | -0.01 | 0.00 | 0.00 | -0.03 | -0.03 | -0.02 | -0.06 | -0.06 | -0.05 |
| ROW | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Real Consumption, bn USD | | | | | | | | | | |
| UKR | 36.0 | 36.2 | 35.9 | 35.9 | 38.2 | 37.1 | 37.2 | 40.0 | 38.4 | 38.6 |
| EU | 7900.6 | 7900.8 | 7900.7 | 7900.7 | 7901.6 | 7902.5 | 7902.6 | 7902.7 | 7904.3 | 7904.4 |
| CIS | 365.8 | 365.7 | 365.7 | 365.7 | 365.6 | 365.6 | 365.6 | 365.4 | 365.4 | 365.4 |
| ROW | 17540.8 | 17540.5 | 17540.8 | 17540.8 | 17540.2 | 17540.9 | 17540.9 | 17540.0 | 17540.7 | 17540.8 |
| Exports, percentage change | | | | | | | | | | |
| UKR | | 2.45 | 2.99 | 3.75 | 4.89 | 7.30 | 9.11 | 7.44 | 10.97 | 13.78 |
| EU | | 0.07 | 0.07 | 0.10 | 0.19 | 0.21 | 0.26 | 0.32 | 0.35 | 0.43 |
| CIS | | -0.09 | -0.08 | -0.12 | -0.26 | -0.25 | -0.36 | -0.39 | -0.37 | -0.55 |
| ROW | | -0.05 | -0.05 | -0.06 | -0.11 | -0.11 | -0.13 | -0.17 | -0.17 | -0.21 |
| Imports, percentage change | | | | | | | | | | |
| UKR | | 2.25 | 2.77 | 3.48 | 4.43 | 6.69 | 8.41 | 6.67 | 9.99 | 12.65 |
| EU | | 0.06 | 0.07 | 0.08 | 0.17 | 0.19 | 0.23 | 0.29 | 0.31 | 0.39 |
| CIS | | -0.10 | -0.08 | -0.13 | -0.33 | -0.29 | -0.41 | -0.54 | -0.47 | -0.66 |
| ROW | | -0.04 | -0.05 | -0.05 | -0.09 | -0.09 | -0.12 | -0.14 | -0.15 | -0.18 |

Concerning factor earnings (see Table 4), we observe an increase of remuneration for all factors in Ukraine. Thus, the highest rise is found for unskilled labor and natural resources. This indicates a reallocation of production to the sectors producing with an intensive use of these two production factors.[26] For the EU we get somewhat opposite results. While factor returns for labor and capital rise slightly, the remuneration for provision of natural resources declines illustrating an opposite specialization of the EU. Concerning other regions, natural resources constitute the only production factor which loses from trade liberalization in ROW and benefits in the CIS region. That demonstrates a deepening of the CIS specialization on resource-intensive goods and away from them for ROW.

Comparing the Ukraine's welfare results across different trade theories we see that under Armington structure they are much higher than under Krugman and Melitz specification. This indicates that traditional CGE models may overstate the gains from the DCFTA between Ukraine and EU.

[26] Ukraine's specialization in labor-intensive goods is also found by Frey & Olekseyuk [2014].

Table 4: Factor earnings, change in %

| | S1.A | S1.K | S1.M | S2.A | S2.K | S2.M | S3.A | S3.K | S3.M |
|---|---|---|---|---|---|---|---|---|---|
| Capital returns | | | | | | | | | |
| UKR | 1.30 | 0.67 | 0.61 | 4.36 | 1.61 | 1.57 | 7.96 | 3.70 | 3.80 |
| EU | 0.02 | 0.02 | 0.02 | 0.04 | 0.06 | 0.05 | 0.05 | 0.08 | 0.08 |
| CIS | -0.02 | -0.02 | -0.02 | -0.08 | -0.07 | -0.09 | -0.11 | -0.10 | -0.13 |
| ROW | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 |
| Remuneration for the provision of natural resources | | | | | | | | | |
| UKR | -0.23 | -0.15 | 0.01 | 2.01 | 2.71 | 2.97 | 5.17 | 5.89 | 6.53 |
| EU | -0.03 | -0.03 | -0.04 | -0.05 | -0.09 | -0.10 | -0.08 | -0.15 | -0.16 |
| CIS | 0.02 | 0.00 | -0.01 | 0.11 | 0.05 | 0.02 | 0.21 | 0.10 | 0.06 |
| ROW | 0.00 | -0.01 | -0.01 | -0.01 | -0.03 | -0.05 | -0.03 | -0.06 | -0.08 |
| Skilled labor remuneration | | | | | | | | | |
| UKR | 1.18 | 0.15 | -0.07 | 4.84 | 0.50 | 0.10 | 8.81 | 2.12 | 1.67 |
| EU | 0.02 | 0.02 | 0.02 | 0.04 | 0.04 | 0.04 | 0.04 | 0.06 | 0.05 |
| CIS | -0.02 | -0.02 | -0.03 | -0.07 | -0.10 | -0.10 | -0.10 | -0.14 | -0.14 |
| ROW | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Unskilled labor remuneration | | | | | | | | | |
| UKR | 2.33 | 1.39 | 1.22 | 6.96 | 3.10 | 2.85 | 12.24 | 6.40 | 6.23 |
| EU | 0.03 | 0.03 | 0.02 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.04 |
| CIS | -0.02 | -0.03 | -0.03 | -0.08 | -0.11 | -0.12 | -0.11 | -0.16 | -0.17 |
| ROW | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 5: Number of firms under Krugman trade formulation, change in %

| | S1.K | | | | S2.K | | | | S3.K | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UKR | EU | CIS | ROW | UKR | EU | CIS | ROW | UKR | EU | CIS | ROW |
| CMN | -0.61 | -0.01 | 0.01 | 0.00 | -0.53 | 0.00 | 0.03 | 0.00 | -0.94 | 0.00 | 0.03 | 0.01 |
| CNM | -11.43 | 0.02 | 0.11 | 0.01 | -45.81 | 0.09 | 0.34 | 0.04 | -77.25 | 0.17 | 0.63 | 0.07 |
| MEQ | -0.88 | 0.00 | -0.07 | 0.00 | -1.38 | 0.00 | -0.31 | 0.00 | -1.52 | 0.00 | -0.47 | 0.00 |
| OBS | -0.61 | -0.01 | 0.02 | 0.00 | -0.90 | 0.00 | 0.04 | 0.01 | -2.00 | 0.00 | 0.06 | 0.01 |
| OMF | -6.19 | 0.00 | 0.02 | 0.01 | -18.68 | 0.01 | 0.06 | 0.01 | -28.57 | 0.03 | 0.09 | 0.01 |
| TEX | 5.86 | 0.00 | -0.05 | -0.01 | 7.50 | 0.01 | -0.11 | -0.01 | 8.76 | 0.02 | -0.13 | -0.01 |
| TRD | -0.32 | 0.00 | 0.00 | 0.00 | 0.21 | 0.01 | -0.01 | 0.00 | 0.45 | 0.02 | -0.02 | 0.00 |
| TRS | -0.71 | 0.00 | 0.01 | 0.00 | -0.95 | 0.01 | 0.02 | 0.00 | -2.20 | 0.03 | 0.03 | 0.00 |
| WPP | -0.81 | 0.00 | 0.02 | 0.00 | -24.74 | 0.03 | 0.24 | 0.01 | -12.98 | 0.01 | -0.09 | 0.01 |

Such diverging welfare results occur due to the weak trade links[27] and comparative disadvantage of Ukraine's IRTS goods on the EU markets. Under Krugman formulation policy reform induces an exit of Ukrainian firms in all IRTS sectors except textile industry (TEX) and trade services (TRD), while the number of European firms remains almost unchanged or slightly increased (see Table 5). Therefore, trade liberalization leads to a reduction of the set of goods produced in Ukraine. Under Melitz trade structure we can also observe a decline of number of Ukrainian firms operating in domestic and foreign markets for all IRTS sectors except manufacture of machinery and equipment (MEQ) and wood and paper industry (WPP) abroad (see Table A.13 in the appendix). Thus,

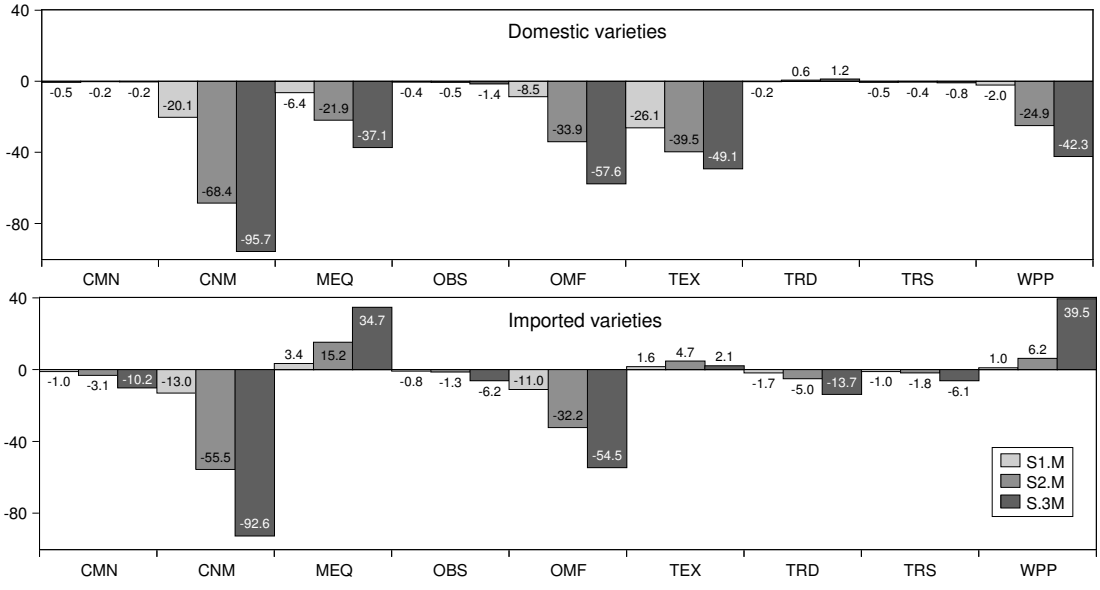
[27] The import shares of the EU from Ukraine are very low for the IRTS goods with the values between 0.22% and 1.12% (see Table A.12 in the appendix). Thus, for the CRTS goods there are import shares up to 10.6%. In Ukraine the situation is opposite. All the import shares from the EU are relatively high as the region is the most important trading partner after the CIS. Therefore, the import shares from the EU exceed 40% for the IRTS goods.

the number of European firms operating in Ukraine increases strongly in all considered sectors. This approves the EU's comparative advantage in the IRTS goods on Ukrainian market.

Table 6: Consumed varieties and Feenstra ratio, change in %

| Reported variable | IRTS sector | S1.M | S2.M | S3.M | S1.M | S2.M | S3.M |
|---|---|---|---|---|---|---|---|
| | | Ukraine | | | EU | | |
| Total varieties consumed | CMN | -0.62 | -0.90 | -2.71 | 0.01 | 0.18 | 0.83 |
| | CNM | -18.34 | -65.21 | -94.93 | 1.71 | 5.11 | 7.16 |
| | MEQ | -3.92 | -12.59 | -19.17 | 0.76 | 1.98 | 2.95 |
| | OBS | -0.53 | -0.67 | -2.59 | 0.00 | 0.00 | 0.34 |
| | OMF | -9.16 | -33.49 | -56.87 | 1.19 | 5.60 | 9.55 |
| | TEX | -19.17 | -28.47 | -36.29 | 2.65 | 4.23 | 5.18 |
| | TRD | -0.56 | -0.77 | -2.50 | 0.10 | 0.42 | 1.34 |
| | TRS | -0.60 | -0.72 | -2.12 | 0.02 | 0.09 | 0.47 |
| | WPP | -1.27 | -17.11 | -21.84 | 0.25 | 1.96 | 3.29 |
| Feenstra ratio | CMN | -0.15 | 0.02 | 0.20 | 0.00 | 0.00 | 0.00 |
| | CNM | 0.58 | 5.57 | 9.56 | 0.00 | 0.01 | 0.01 |
| | MEQ | 0.00 | 3.18 | 6.20 | 0.00 | 0.00 | 0.01 |
| | OBS | -0.10 | -0.08 | -0.05 | 0.00 | 0.00 | 0.00 |
| | OMF | 0.11 | 3.69 | 6.77 | 0.00 | 0.00 | 0.00 |
| | TEX | 0.93 | 4.71 | 7.02 | 0.00 | 0.01 | 0.02 |
| | TRD | -0.03 | 0.32 | 0.73 | 0.00 | 0.00 | 0.01 |
| | TRS | -0.09 | 0.01 | 0.25 | 0.00 | 0.01 | 0.01 |
| | WPP | 0.07 | 3.57 | 7.85 | 0.00 | 0.00 | 0.02 |

Figure 2: Domestic and imported varieties in Ukraine, change in %




The percentage changes in the number of firms under Melitz trade structure indicate the number of varieties consumed. While the number of total varieties consumed in the EU increases across all the IRTS sectors (see Table 6), it falls in Ukraine due to reduction of both domestic and imported varieties (see Figure 2).[28] However, counting up the

[28]Only manufacture of machinery and equipment (MEQ), textiles (TEX) and wood and paper industry (WPP)

varieties to explain the welfare changes along the extensive margin can be misleading as the varieties enter the expenditure system under different prices. Comparing equilibriums $t$ versus $t-1$, Feenstra [2010] shows that the variety gains can be measured by deviations in the following ratio from unity:

$$\left(\frac{\lambda_{hr}^{t}}{\lambda_{hr}^{t-1}}\right)^{-1/(\sigma_h-1)},$$

where $\lambda_{hr}^{z}$ is region-$r$'s share of expenditures at equilibrium $z$ on good-$h$ varieties available in both equilibria to the total expenditures on good-$h$ varieties at $z$. The bottom panel of Table 6 shows the percentage change of this Feenstra ratio. The results indicate no losses along the extensive margin for the EU. Though, for Ukraine we observe some losses from liberalization-induced changes in the number of varieties, in particular, in such sectors as business services (OBS), communications (CMN), transport (TRS) and trade (TRD).

Table 7: Productivity growth, in %

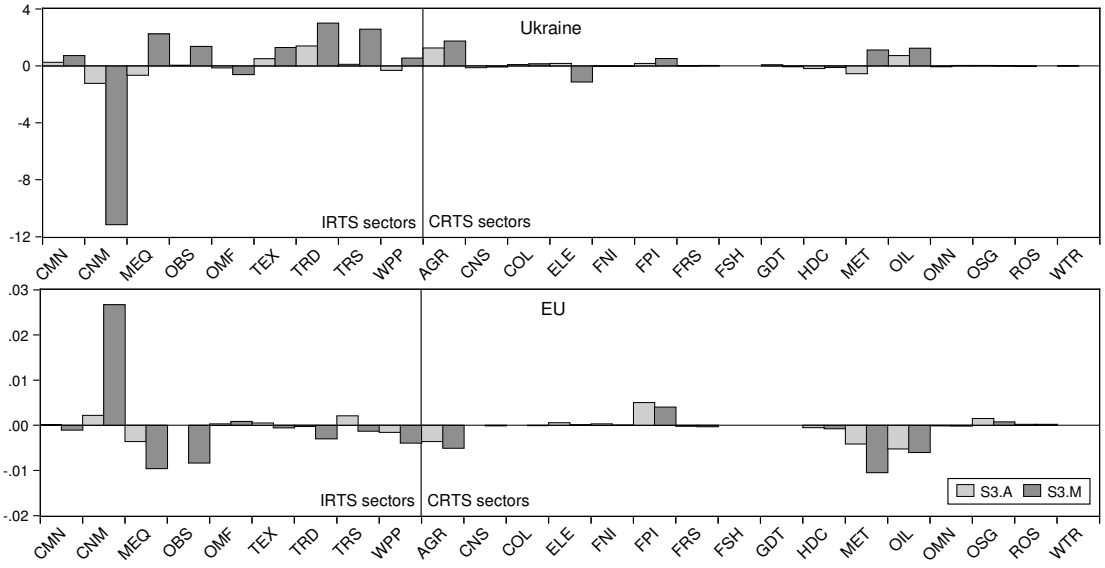
| Reported variable | IRTS sector | S1.M | S2.M | S3.M | S1.M | S2.M | S3.M |
|---|---|---|---|---|---|---|---|
| | | Ukraine | | | EU | | |
| Domestic firm productivity growth ($\varphi_{mrr}$) | CMN | -0,01 | -0,06 | -0,21 | 0,00 | 0,00 | 0,00 |
| | CNM | 1.25 | 5.35 | 8.93 | 0.01 | 0.02 | 0.03 |
| | MEQ | 1.31 | 5.44 | 10.77 | 0.00 | 0.01 | 0.01 |
| | OBS | -0.01 | -0.02 | -0.13 | 0.00 | 0.00 | 0.00 |
| | OMF | -0.15 | 0.38 | 1.07 | 0.00 | 0.01 | 0.02 |
| | TEX | 8.24 | 13.53 | 18.23 | 0.02 | 0.03 | 0.03 |
| | TRD | -0.02 | -0.07 | -0.19 | 0.00 | 0.00 | 0.00 |
| | TRS | -0.03 | -0.10 | -0.38 | 0.00 | 0.00 | 0.00 |
| | WPP | 0.34 | 4.09 | 12.83 | 0.00 | 0.00 | 0.01 |
| Industry wide productivity growth ($\sum_s \frac{N_{mrs}}{\sum_t N_{mrt}}\varphi_{mrs}$) | CMN | -0.02 | -0.13 | -0.48 | 0.00 | 0.02 | 0.07 |
| | CNM | 1.43 | 5.76 | 9.00 | 0.13 | 0.20 | 0.16 |
| | MEQ | 1.53 | 5.94 | 10.39 | 0.07 | 0.14 | 0.17 |
| | OBS | -0.02 | -0.04 | -0.25 | 0.00 | 0.00 | 0.03 |
| | OMF | -0.22 | 0.43 | 1.10 | 0.09 | 0.17 | -0.01 |
| | TEX | 8.61 | 13.72 | 17.82 | 0.18 | 0.20 | 0.20 |
| | TRD | -0.06 | -0.22 | -0.62 | 0.01 | 0.04 | 0.10 |
| | TRS | -0.04 | -0.13 | -0.52 | 0.00 | 0.01 | 0.04 |
| | WPP | 0.41 | 4.58 | 11.66 | 0.02 | 0.13 | 0.18 |

In addition to variety effects, under Melitz formulation we detect higher changes in aggregate productivity for Ukraine than for the EU (see Table 7). For such Ukrainian sectors as chemicals and production of mineral products (CNM), machinery and equipment (MEQ), textiles (TEX), wood and paper industry (WPP) we find a strong productivity growth across Ukrainian firms active in their domestic market. This indicates an exit of the least productive firms due to import competition. However, this measure does not

demonstrate an increase of imported varieties in Ukraine.

incorporate the industry wide productivity gains attributed to entry of relative productive firms into export markets. Such an impact is captured by the weighted average productivity across all markets, which rises for the same sectors. Comparing the both measures we can see that productivity is growing because of domestic exit and not because of selection into export markets, as the domestic firms' productivity growth is relatively large.

Figure 3: Revenue shares, change in %



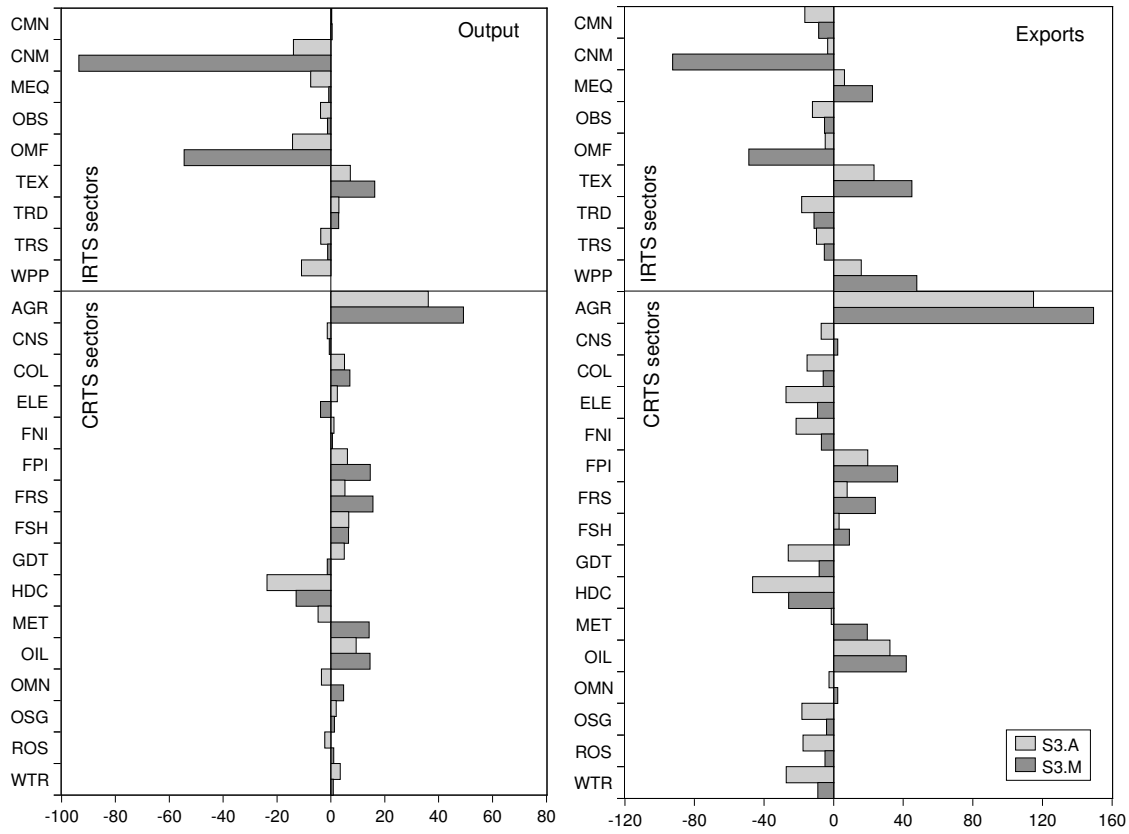

Described productivity changes occur together with entry of new firms in the mentioned sectors and therefore with reallocation effects. Figure 3 illustrates sectoral reallocation by examining how revenue shares of gross output change.[29] We see that in Ukraine the revenue shares of machinery and equipment (MEQ), textiles (TEX), wood and paper industry (WPP), trade (TRD) and transport (TRS), increase up to three percentage points. Moreover, most of this reallocation comes from the lost share of chemical and mineral products (CNM).[30] Concerning the reallocation effects in the EU, they are mach smaller and opposite to the changes in Ukraine.

Concerning disaggregate results (see Figure 4 and Tables A.14 and A.15 in the appendix), the highest increase of output and exports is observed in Ukrainian sectors such as agriculture, food processing, textile and leather industry, forestry and petroleum industry. As all of these sectors except textiles produce under constant returns to scale, this confirms Ukraine's comparative disadvantage in the IRTS goods. The European expanding sectors with increased exports include chemical and mineral products, food processing, other manufacturing and textiles.

[29]The revenue share for sector $i$ is given by $c_{ir}Q_{ir}/\sum_j c_{ir}Q_{ir}$.

[30]In this sector we observe a strong decrease of number of existed and entered firms meaning that productivity growth is driven by an exit of unproductive firms.

Figure 4: Disaggregate results for Ukraine, change in %




## 7 Conclusion and policy implications

To analyze the establishment of the DCFTA between Ukraine and the EU we develop a GTAP 8.1 based multi-regional CGE model with three different setups. Besides a standard model specification with Armington assumption, we implement monopolistic competition and competitive selection of heterogenous firms suggested by Krugman [1980] and Melitz [2003]. Incorporating these developments in the new trade theory allows to capture trade growth in new varieties and changes of aggregate productivity due to reallocation of resources within an industry from less to more productive firms. As all of the standard CGE studies on the EU-Ukraine economic integration and trade liberalization leave these aspects out of consideration, we provide new insights into the possible outcomes of the new form of trade agreements.

Simulating trade liberalization between Ukraine and the EU by reduction of NTBs and barriers to efficient trade facilitation as well as tariff elimination, we find a relatively high increase of real GDP and a positive welfare impact for Ukraine (up to 12.31%). In comparison, the EU benefits less with the highest welfare gain of 0.05% as the share of European trade with Ukraine is quite low. The trade policy reform leads also to a rise of

imports and exports between the two trading partners. Thus, the effects are larger under the Melitz trade structure due to reallocation of resources to the most productive exporting firms. The results on factor remuneration indicate a deeper specialization of Ukraine in labor and resource-intensive goods whereas an opposite specialization is observed for the EU. Considering the other regions, there is a small trade diversion from ROW and CIS combined with a slight decrease of real GDP and welfare mainly for the CIS region specializing in the resource-intensive goods.

A comparison of the welfare results for Ukraine across the different model specifications shows that the impact is much higher under Armington structure than under Krugman or Melitz trade formulation. This result is inconsistent with the findings of Balistreri *et al.* [2011] who predict four times larger welfare gains from tariff reduction under Melitz specification. However, deep integration with the EU intensifies import competition in the increasing returns sectors, while inducing a movement of resources into Ukraine's traditional export sectors which produce under constant returns. Consistent with Balistreri *et al.* [2003] and Arkolakis *et al.* [2012] the gains from trade can be lower under an assumption of monopolistic competition if trade reduces the set of goods produced. This is our finding for Ukraine which may occur for the most of developing countries having the same specialization in labor and resource-intensive goods produced under constant returns to scale (see, e.g., [Akyüz, 2003, p. 48]). This means that traditional CGE models may overstate the overall gains from trade liberalization for developing countries.

However, our model does not include capital flows so EU firms supply Ukraine's markets on a cross-border bases. Allowing for capital flows might change the story if the EU firms were to engage in FDI, which would increase the number of EU varieties while increasing the demand for workers in Ukraine. Therefore, incorporation of the FDI flows is an important issue for further research.

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# 8 Appendix

Table A.8: Mapping of the GTAP regions

| Aggregate regions | GTAP 8.1 regions | |
|---|---|---|
| UKR | UKR | Ukraine |
| EU | AUT | Austria |
| | BEL | Belgium |
| | DNK | Denmark |
| | FIN | Finland |
| | FRA | France |
| | DEU | Germany |
| | GRC | Greece |
| | IRL | Ireland |
| | ITA | Italy |
| | LUX | Luxembourg |
| | NLD | Netherlands |
| | PRT | Portugal |
| | ESP | Spain |
| | SWE | Sweden |
| | GBR | United Kingdom |
| | CYP | Cyprus |
| | CZE | Czech Republic |
| | EST | Estonia |
| | HUN | Hungary |
| | LVA | Latvia |
| | LTU | Lithuania |
| | MLT | Malta |
| | POL | Poland |
| | SVK | Slovakia |
| | SVN | Slovenia |
| | BGR | Bulgaria |
| | ROU | Romania |
| | HRV | Croatia |
| CIS | XEE | Moldova Rep. of |
| | BLR | Belarus |
| | RUS | Russian Federation |
| | KAZ | Kazakhstan |
| | KGZ | Kyrgyzstan |
| | ARM | Armenia |
| | XSU | Rest of Former Soviet Union |
| | | -Tajikistan |
| | | -Turkmenistan |
| | | -Uzbekistan |
| | AZE | Azerbaijan |
| | GEO | Georgia |
| ROW | | All other GTAP regions |

Table A.9: Mapping of GTAP sectors

| Model specific sectors | | GTAP 8.1 sectors | |
|---|---|---|---|
| CRTS Sectors | | | |
| AGR | Agriculture and hunting | PDR | Paddy rice |
| | | WHT | Wheat |
| | | GRO | Cereal grains nec |
| | | V_F | Vegetables fruit nuts |
| | | OSD | Oil seeds |
| | | C_B | Sugar cane sugar beet |
| | | PFB | Plantbased fibers |
| | | OCR | Crops nec |
| | | CTL | Bovine cattle sheep and goats horses |
| | | OAP | Animal products nec |
| | | RMK | Raw milk |
| | | WOL | Wool silk worm cocoons |
| FRS | Forestry | FRS | Forestry |
| FSH | Fishing | FSH | Fishing |
| COL | Coal | COA | Coal |
| HDC | Production of hydrocarbons | OIL | Oil |
| | | GAS | Gas |
| OMN | Minerals nec | OMN | Minerals nec |
| FPI | Food-processing | CMT | Bovine meat products |
| | | OMT | Meat products nec |
| | | VOL | Vegetable oils and fats |
| | | MIL | Dairy products |
| | | PCR | Processed rice |
| | | SGR | Sugar |
| | | OFD | Food products nec |
| | | B_T | Beverages and tobacco products |
| OIL | Petroleum, coal products | P_C | Petroleum, coal products |
| MET | Metallurgy and metal processing | I_S | Ferrous metals |
| | | NFM | Metals nec |
| | | FMP | Metal products |
| ELE | Electricity | ELY | Electricity |
| GDT | Gas manufacture, distribution | GDT | Gas manufacture distribution |
| WTR | Water | WTR | Water |
| CNS | Construction | CNS | Construction |
| FNI | Financial services, insurance | OFI | Financial services nec |
| | | ISR | Insurance |
| ROS | Recreational and other services | ROS | Recreational and other services |
| OSG | Public services | OSG | Public administration, defense, education, health |
| IRTS Sectors | | | |
| TEX | Textiles and leather | TEX | Textiles |
| | | WAP | Wearing apparel |
| | | LEA | Leather products |
| CNM | Chemical and mineral products | CRP | Chemical rubber plastic products |
| | | NMM | Mineral products nec |
| OMF | Manufactures nec | OMF | Manufactures nec |
| WPP | Wood, paper products, publishing | LUM | Wood products |
| | | PPP | Paper products, publishing |
| MEQ | Manufacture of machinery and equipment | MVH | Motor vehicles and parts |
| | | OTN | Transport equipment nec |
| | | ELE | Electronic equipment |
| | | OME | Machinery and equipment nec |
| OBS | Business services nec | OBS | Business services nec |
| TRD | Trade | TRD | Trade |
| CMN | Communication | CMN | Communication |
| TRS | Transport | OTP | Transport nec |
| | | WTP | Water transport |
| | | ATP | Air transport |

Table A.10: Benchmark distortions for Ukraine, in %

| Sector | | Import tariffs* | NTBs | Barriers to efficient trade facilitation on Ukraine's exports to | | | Barriers to efficient trade facilitation on Ukraine's imports from | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | EU | CIS | ROW | EU | CIS | ROW |
| FRS | Forestry | 1.71 | 3.30 | 8.03 | 8.03 | 8.03 | 13.05 | 13.05 | 13.05 |
| FSH | Fishing | 5.00 | 3.30 | 5.05 | 5.86 | 4.16 | 7.87 | 4.94 | 7.91 |
| OIL | Petroleum, coal products | 1.63 | 19.40 | 15.96 | 15.96 | 15.96 | 25.93 | 25.93 | 25.93 |
| OMN | Minerals nec | 2.23 | | 7.20 | 7.20 | 7.20 | 11.70 | 11.72 | 11.70 |
| TEX | Textiles and leather | 8.06 | 19.40 | 4.92 | 5.64 | 4.99 | 9.70 | 11.47 | 8.73 |
| ELE | Electricity | 3.50 | 19.40 | | | | | | |
| OMF | Manufactures nec | 1.85 | 19.40 | 7.98 | 8.68 | 7.54 | 14.70 | 12.22 | 13.49 |
| COL | Coal | 0.00 | | | | | | | |
| GDT | Gas manufacture, distribution | | 19.40 | | | | | | |
| WTR | Water | | 19.40 | | | | | | |
| AGR | Agriculture and hunting | 5.63 | 3.30 | 17.57 | 18.77 | 16.51 | 24.48 | 30.92 | 27.11 |
| HDC | Production of hydrocarbons | 0.50 | 19.40 | | | | | | |
| FPI | Food-processing | 13.66 | 19.40 | 12.25 | 11.17 | 12.03 | 21.95 | 16.62 | 19.58 |
| WPP | Wood, paper products, publishing | 0.98 | 19.40 | 4.73 | 13.50 | 8.94 | 19.91 | 21.44 | 14.27 |
| CNM | Chemical and mineral products | 4.06 | 19.40 | 12.13 | 14.07 | 11.29 | 18.90 | 22.01 | 19.91 |
| MET | Metallurgy and metal processing | 1.93 | 19.40 | 14.85 | 15.38 | 15.55 | 16.56 | 21.88 | 17.26 |
| MEQ | Manufacture of machinery and equipment | 3.09 | 19.40 | 5.03 | 6.90 | 5.35 | 14.69 | 15.55 | 17.33 |

*Tariff rates on imports from the EU and ROW.

Table A.11: Benchmark distortions for the EU, in %

| Sector | | Import tariffs* | NTBs | Barriers to efficient trade facilitation on the EU's exports to | | | Barriers to efficient trade facilitation on the EU's imports from | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | EU | CIS | ROW | EU | CIS | ROW |
| FRS | Forestry | 0.51 | 27.00 | 4.65 | 4.69 | 5.40 | 6.75 | 4.99 | 5.35 |
| FSH | Fishing | 4.46 | 27.00 | 2.95 | 3.14 | 2.79 | 3.27 | 2.05 | 2.94 |
| OIL | Petroleum, coal products | 1.19 | 2.30 | 12.11 | 11.13 | 10.80 | 16.92 | 12.06 | 11.96 |
| OMN | Minerals nec | 0.21 | | 7.67 | 5.38 | 5.17 | 6.31 | 4.87 | 4.41 |
| TEX | Textiles and leather | 7.04 | 2.30 | 5.09 | 4.98 | 4.83 | 3.48 | 4.08 | 3.37 |
| ELE | Electricity | 0.00 | 2.30 | | | | | | |
| OMF | Manufactures nec | 0.09 | 2.30 | 6.41 | 5.79 | 5.53 | 5.02 | 3.70 | 4.17 |
| COL | Coal | | 2.30 | | | | | | |
| GDT | Gas manufacture, distribution | | 2.30 | | | | | | |
| WTR | Water | 0.00 | | | | | | | |
| AGR | Agriculture and hunting | 19.40 | 27.00 | 10.06 | 10.10 | 9.14 | 14.26 | 13.14 | 10.94 |
| HDC | Production of hydrocarbons | 0.00 | | | | | | | |
| FPI | Food-processing | 12.56 | 2.30 | 10.13 | 8.31 | 6.77 | 9.05 | 7.62 | 6.81 |
| WPP | Wood, paper products, publishing | 0.53 | 2.30 | 9.39 | 7.96 | 7.16 | 3.35 | 4.40 | 5.05 |
| CNM | Chemical and mineral products | 2.13 | 2.30 | 8.93 | 7.58 | 6.27 | 9.46 | 7.72 | 6.37 |
| MET | Metallurgy and metal processing | 1.38 | 2.30 | 7.87 | 7.03 | 8.28 | 12.29 | 9.49 | 7.82 |
| MEQ | Manufacture of machinery and equipment | 0.47 | 2.30 | 6.43 | 5.57 | 4.82 | 3.87 | 4.50 | 4.63 |

*Tariff rates on imports from Ukraine.

Table A.12: Benchmark trade shares for Ukraine and the EU, in %

| | The EU import shares from: | | | Ukrainian import shares from: | | |
|---|---|---|---|---|---|---|
| | CIS | ROW | UKR | CIS | EU | ROW |
| CRTS Sectors | | | | | | |
| AGR | 2.32 | 96.44 | 1.23 | 19.53 | 35.21 | 45.26 |
| CNS | 9.40 | 90.20 | 0.39 | 3.42 | 53.16 | 43.42 |
| COL | 18.13 | 80.91 | 0.97 | 99.38 | 0.03 | 0.59 |
| ELE | 16.31 | 73.09 | 10.60 | 6.54 | 60.29 | 33.17 |
| FNI | 0.84 | 99.09 | 0.08 | 0.37 | 52.14 | 47.50 |
| FPI | 1.97 | 97.04 | 0.99 | 19.67 | 40.18 | 40.15 |
| FRS | 34.98 | 61.89 | 3.13 | 70.31 | 11.61 | 18.08 |
| FSH | 0.37 | 99.61 | 0.02 | 0.43 | 44.22 | 55.36 |
| GDT | 63.25 | 34.77 | 1.98 | 5.26 | 11.02 | 83.72 |
| HDC | 30.57 | 69.41 | 0.01 | 99.48 | 0.01 | 0.51 |
| MET | 15.89 | 80.60 | 3.51 | 43.80 | 42.77 | 13.44 |
| OIL | 29.33 | 66.16 | 4.51 | 74.73 | 19.17 | 6.11 |
| OMN | 6.58 | 90.80 | 2.61 | 29.45 | 15.64 | 54.91 |
| OSG | 1.70 | 97.52 | 0.78 | 0.78 | 29.44 | 69.78 |
| ROS | 1.55 | 98.11 | 0.34 | 0.47 | 44.95 | 54.58 |
| WTR | 5.97 | 92.80 | 1.23 | 2.65 | 39.39 | 57.96 |
| IRTS sectors | | | | | | |
| CMN | 3.52 | 95.60 | 0.88 | 1.22 | 51.90 | 46.87 |
| CNM | 3.84 | 95.35 | 0.81 | 26.83 | 54.51 | 18.66 |
| MEQ | 0.43 | 99.35 | 0.22 | 18.37 | 60.09 | 21.53 |
| OBS | 2.79 | 96.87 | 0.34 | 0.94 | 58.75 | 40.31 |
| OMF | 2.08 | 97.65 | 0.27 | 3.25 | 53.66 | 43.09 |
| TEX | 1.30 | 97.69 | 1.01 | 6.47 | 53.32 | 40.21 |
| TRD | 1.70 | 97.74 | 0.56 | 1.21 | 46.98 | 51.81 |
| TRS | 4.65 | 94.30 | 1.05 | 1.99 | 43.28 | 54.73 |
| WPP | 6.41 | 92.47 | 1.12 | 19.68 | 72.74 | 7.58 |
| | The EU export shares to: | | | Ukrainian export shares to: | | |
| | CIS | ROW | UKR | CIS | EU | ROW |
| CRTS Sectors | | | | | | |
| AGR | 10.61 | 87.55 | 1.85 | 14.46 | 35.60 | 49.94 |
| CNS | 31.13 | 67.69 | 1.18 | 10.99 | 50.78 | 38.23 |
| COL | 6.83 | 92.88 | 0.29 | 7.90 | 67.80 | 24.29 |
| ELE | 22.83 | 75.78 | 1.39 | 25.56 | 61.83 | 12.61 |
| FNI | 3.52 | 95.93 | 0.55 | 1.70 | 41.48 | 56.82 |
| FPI | 8.72 | 90.20 | 1.09 | 59.23 | 18.84 | 21.93 |
| FRS | 3.50 | 96.26 | 0.24 | 1.17 | 51.81 | 47.02 |
| FSH | 2.88 | 96.66 | 0.46 | 12.20 | 37.75 | 50.05 |
| GDT | 3.54 | 96.28 | 0.18 | 0.78 | 58.13 | 41.09 |
| HDC | 0.02 | 99.97 | 0.02 | 0.06 | 37.21 | 62.73 |
| MET | 5.21 | 93.82 | 0.97 | 20.03 | 25.96 | 54.01 |
| OIL | 2.24 | 97.06 | 0.69 | 8.21 | 61.27 | 30.52 |
| OMN | 1.71 | 97.65 | 0.64 | 11.24 | 73.67 | 15.09 |
| OSG | 4.47 | 94.81 | 0.72 | 1.93 | 28.32 | 69.75 |
| ROS | 6.51 | 92.58 | 0.91 | 2.72 | 48.75 | 48.53 |
| WTR | 7.93 | 90.95 | 1.12 | 2.86 | 47.63 | 49.52 |
| IRTS sectors | | | | | | |
| CMN | 6.61 | 92.67 | 0.72 | 2.32 | 53.68 | 43.99 |
| CNM | 5.36 | 93.47 | 1.17 | 21.99 | 33.14 | 44.87 |
| MEQ | 5.47 | 93.57 | 0.96 | 49.88 | 19.37 | 30.74 |
| OBS | 5.82 | 93.58 | 0.59 | 2.14 | 51.42 | 46.44 |
| OMF | 4.05 | 95.19 | 0.76 | 8.09 | 56.75 | 35.16 |
| TEX | 7.32 | 90.55 | 2.13 | 5.80 | 78.74 | 15.46 |
| TRD | 4.91 | 94.43 | 0.66 | 2.76 | 47.73 | 49.51 |
| TRS | 4.35 | 95.00 | 0.65 | 1.94 | 45.04 | 53.02 |
| WPP | 8.17 | 90.03 | 1.80 | 45.84 | 41.59 | 12.57 |

Table A.13: Number of operating firms under Melitz trade formulation, change in %

| | S1.M | | | | S2.M | | | | S3.M | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UKR | EU | CIS | ROW | UKR | EU | CIS | ROW | UKR | EU | CIS | ROW |
| Number of Ukrainian firms operating in foreign and domestic markets | | | | | | | | | | | | |
| CMN | -0.50 | -0.92 | -1.08 | -1.00 | -0.17 | -2.90 | -3.37 | -3.05 | -0.22 | -9.89 | -10.49 | -10.08 |
| CNM | -20.12 | -6.22 | -16.26 | -16.54 | -68.44 | -45.09 | -60.53 | -61.00 | -95.71 | -89.38 | -94.14 | -94.25 |
| MEQ | -6.36 | 5.45 | 2.30 | 2.52 | -21.85 | 25.91 | 9.39 | 10.30 | -37.12 | 86.73 | 8.13 | 9.20 |
| OBS | 0.00 | -0.70 | -0.86 | -0.79 | -0.47 | -1.09 | -1.53 | -1.25 | -1.40 | -5.91 | -6.47 | -6.10 |
| OMF | -8.54 | -10.66 | -11.22 | -11.19 | -33.94 | -25.22 | -35.68 | -35.58 | -57.65 | -41.37 | -61.15 | -61.08 |
| TEX | -26.10 | 30.26 | -12.72 | -12.69 | -39.53 | 41.99 | -13.98 | -13.86 | -49.09 | 52.83 | -23.28 | -23.14 |
| TRD | -0.18 | -1.61 | -1.79 | -1.67 | 0.64 | -4.75 | -5.32 | -4.88 | 1.22 | -13.37 | -14.08 | -13.53 |
| TRS | -0.48 | -0.90 | -1.02 | -0.93 | -0.36 | -1.66 | -2.02 | -1.69 | -0.79 | -6.01 | -6.39 | -5.98 |
| WPP | -2.03 | 3.00 | 0.03 | 0.06 | -24.89 | 15.43 | 1.45 | 1.79 | -42.28 | 112.12 | 2.78 | 3.53 |
| Number of European firms operating in foreign and domestic markets | | | | | | | | | | | | |
| CMN | 0.42 | -0.01 | -0.17 | -0.09 | 2.81 | 0.00 | -0.49 | -0.16 | 10.74 | 0.01 | -0.66 | -0.21 |
| CNM | 20.34 | 0.00 | 0.27 | -0.07 | 60.16 | 0.03 | 1.03 | -0.17 | 83.72 | 0.07 | 1.74 | -0.22 |
| MEQ | 9.48 | -0.01 | -0.26 | -0.05 | 25.02 | -0.02 | -0.92 | -0.09 | 37.06 | -0.05 | -1.08 | -0.09 |
| OBS | 0.26 | 0.00 | -0.16 | -0.09 | 0.63 | 0.00 | -0.44 | -0.16 | 4.81 | 0.01 | -0.59 | -0.19 |
| OMF | 14.53 | -0.01 | -0.09 | -0.05 | 67.82 | -0.02 | -0.30 | -0.13 | 115.29 | -0.01 | -0.34 | -0.17 |
| TEX | 32.64 | -0.07 | -0.09 | -0.06 | 52.05 | -0.10 | -0.28 | -0.13 | 63.74 | -0.13 | -0.32 | -0.14 |
| TRD | 1.45 | 0.00 | -0.18 | -0.06 | 5.66 | 0.01 | -0.59 | -0.13 | 16.87 | 0.02 | -0.80 | -0.16 |
| TRS | 0.42 | 0.00 | -0.13 | -0.04 | 1.34 | 0.01 | -0.34 | -0.01 | 5.59 | 0.04 | -0.37 | 0.06 |
| WPP | 3.20 | 0.00 | -0.10 | -0.07 | 24.29 | -0.01 | -0.48 | -0.15 | 40.93 | -0.06 | -0.80 | -0.08 |

Table A.14: Disaggregate results for Ukraine, change in %

| | | S1.A | S1.K | S1.M | S2.A | S2.K | S2.M | S3.A | S3.K | S3.M |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Output | | | | |
| IRTS sectors | CMN | -0,43 | -0,33 | -0,23 | 0,22 | 0,58 | 0,72 | 0,21 | 0,75 | 0,43 |
| | CNM | -2.38 | -11.04 | -15.04 | -9.40 | -45.20 | -59.44 | -13.91 | -76.86 | -93.56 |
| | MEQ | -1.48 | -1.27 | -0.84 | -5.07 | -2.77 | -1.29 | -7.50 | -3.70 | -0.80 |
| | OBS | -0.74 | -0.36 | -0.19 | -1.93 | -0.16 | 0.28 | -3.86 | -1.25 | -1.23 |
| | OMF | -2.93 | -5.64 | -8.64 | -9.89 | -17.57 | -31.82 | -14.28 | -27.06 | -54.51 |
| | TEX | 6.10 | 9.21 | 9.91 | 6.18 | 11.60 | 13.01 | 7.17 | 14.11 | 16.18 |
| | TRD | 0.12 | 0.13 | 0.19 | 1.77 | 1.78 | 1.90 | 2.90 | 2.98 | 2.83 |
| | TRS | -0.63 | -0.30 | -0.13 | -1.85 | -0.04 | 0.32 | -3.77 | -1.23 | -1.16 |
| | WPP | -1.13 | -0.77 | -0.33 | -9.26 | -25.27 | -10.82 | -10.94 | -14.37 | -0.06 |
| CRTS sectors | AGR | 14.43 | 15.49 | 16.06 | 24.26 | 29.82 | 31.52 | 36.05 | 46.26 | 49.12 |
| | CNS | 0.02 | 0.24 | 0.19 | -0.80 | 0.14 | -0.14 | -1.39 | -0.09 | -0.57 |
| | COL | -0.04 | 0.16 | 0.25 | 1.88 | 2.99 | 3.11 | 4.98 | 6.63 | 6.92 |
| | ELE | 0.00 | -0.77 | -1.01 | 1.28 | -2.11 | -2.73 | 2.27 | -3.12 | -3.85 |
| | FNI | -0.07 | -0.21 | -0.16 | 0.74 | 0.29 | 0.39 | 1.04 | 0.27 | 0.47 |
| | FPI | 4.45 | 5.28 | 5.79 | 4.86 | 8.60 | 10.15 | 6.08 | 12.32 | 14.49 |
| | FRS | -1.34 | -0.13 | 0.26 | 3.79 | 8.82 | 10.35 | 5.10 | 13.79 | 15.52 |
| | FSH | 0.96 | 0.75 | 0.90 | 3.93 | 3.21 | 3.72 | 6.52 | 5.55 | 6.43 |
| | GDT | 0.04 | -0.83 | -0.99 | 2.68 | -0.88 | -1.40 | 4.91 | -0.93 | -1.36 |
| | HDC | -3.96 | -2.22 | -1.63 | -12.86 | -5.74 | -4.68 | -23.72 | -14.41 | -12.91 |
| | MET | -1.91 | 0.44 | 1.24 | -1.69 | 9.09 | 11.01 | -4.79 | 11.41 | 14.08 |
| | OIL | 0.53 | 1.07 | 1.30 | 3.82 | 6.56 | 7.06 | 9.33 | 13.69 | 14.46 |
| | OMN | -0.97 | 0.08 | 0.45 | -1.75 | 2.97 | 3.82 | -3.56 | 3.44 | 4.63 |
| | OSG | 0.36 | 0.23 | 0.25 | 1.25 | 0.81 | 0.85 | 1.88 | 1.08 | 1.23 |
| | ROS | -0.87 | -0.51 | -0.25 | -1.20 | 0.44 | 1.08 | -2.30 | 0.02 | 0.96 |
| | WTR | 0.04 | -0.37 | -0.38 | 1.86 | 0.28 | 0.24 | 3.35 | 0.73 | 0.83 |
| | | | | | | Exports | | | | |
| IRTS sectors | CMN | -2.17 | -1.09 | -0.65 | -9.07 | -2.21 | -1.85 | -16.50 | -7.01 | -8.54 |
| | CNM | -0.25 | -10.04 | -12.66 | -1.79 | -42.51 | -55.09 | -3.39 | -75.31 | -92.50 |
| | MEQ | 0.61 | 0.83 | 2.71 | 2.93 | 5.53 | 11.85 | 6.13 | 10.65 | 22.13 |
| | OBS | -1.79 | -0.96 | -0.46 | -6.50 | -1.56 | -0.34 | -12.24 | -5.62 | -5.28 |
| | OMF | -3.04 | -7.26 | -10.35 | -5.29 | -16.34 | -28.70 | -4.79 | -23.04 | -48.75 |
| | TEX | 14.95 | 18.50 | 25.31 | 19.02 | 25.71 | 35.94 | 23.08 | 31.92 | 44.81 |
| | TRD | -2.71 | -1.27 | -1.19 | -10.20 | -2.71 | -3.31 | -18.34 | -7.85 | -11.31 |
| | TRS | -1.42 | -0.98 | -0.63 | -5.14 | -1.48 | -0.82 | -9.91 | -5.20 | -5.37 |
| | WPP | -0.19 | 0.12 | 1.43 | 2.04 | -19.28 | 6.03 | 15.71 | 10.12 | 47.73 |
| CRTS sectors | AGR | 43.69 | 46.64 | 47.76 | 73.65 | 89.27 | 92.49 | 114.79 | 143.43 | 149.27 |
| | CNS | -1.29 | -0.47 | 0.35 | -2.63 | 1.08 | 3.58 | -7.11 | -1.43 | 2.28 |
| | COL | -1.99 | -0.66 | -0.15 | -7.44 | -1.97 | -0.77 | -15.23 | -7.39 | -5.94 |
| | ELE | -5.49 | -2.45 | -1.58 | -15.58 | -3.47 | -1.67 | -27.41 | -11.30 | -9.22 |
| | FNI | -4.03 | -1.67 | -1.02 | -12.56 | -3.31 | -1.80 | -21.57 | -8.62 | -7.02 |
| | FPI | 14.39 | 16.34 | 17.17 | 17.03 | 25.57 | 28.03 | 19.43 | 33.27 | 36.58 |
| | FRS | -2.42 | -0.43 | 0.14 | 6.14 | 15.40 | 16.83 | 7.67 | 22.09 | 23.83 |
| | FSH | 3.57 | 4.32 | 4.60 | 4.97 | 8.24 | 8.96 | 3.04 | 8.00 | 8.91 |
| | GDT | -5.26 | -2.41 | -1.52 | -14.70 | -3.13 | -1.19 | -26.07 | -10.56 | -8.28 |
| | HDC | -7.33 | -3.26 | -1.73 | -26.13 | -11.56 | -8.11 | -46.53 | -29.58 | -25.87 |
| | MET | -1.62 | 0.94 | 1.78 | 0.63 | 12.38 | 14.44 | -1.34 | 16.44 | 19.28 |
| | OIL | 1.76 | 2.65 | 3.01 | 12.61 | 16.99 | 17.94 | 32.27 | 40.01 | 41.57 |
| | OMN | -0.50 | 0.12 | 0.36 | -1.51 | 1.20 | 1.74 | -2.59 | 1.45 | 2.18 |
| | OSG | -3.05 | -0.89 | -0.19 | -10.11 | -1.51 | 0.21 | -18.30 | -5.98 | -4.04 |
| | ROS | -3.02 | -1.15 | -0.53 | -9.81 | -2.10 | -0.70 | -17.54 | -6.72 | -4.98 |
| | WTR | -5.44 | -2.43 | -1.52 | -15.53 | -3.52 | -1.59 | -27.30 | -11.34 | -9.04 |
| | | | | | | Imports | | | | |
| IRTS sectors | CMN | 1.67 | 0.93 | 0.71 | 9.90 | 3.54 | 3.66 | 18.67 | 8.77 | 10.95 |
| | CNM | 3.51 | 7.31 | 9.42 | 4.96 | 19.62 | 25.11 | 5.92 | 30.95 | 34.32 |
| | MEQ | 1.23 | 1.61 | 2.53 | -0.28 | 1.05 | 4.29 | -1.69 | 0.23 | 5.55 |
| | OBS | 0.92 | 0.78 | 0.55 | 4.27 | 2.01 | 1.45 | 7.79 | 4.86 | 5.00 |
| | OMF | 3.68 | 6.40 | 9.45 | 15.43 | 23.21 | 38.62 | 24.40 | 37.15 | 66.15 |
| | TEX | 7.23 | 6.99 | 10.51 | 9.99 | 9.47 | 14.70 | 12.69 | 11.96 | 18.35 |
| | TRD | 2.80 | 1.58 | 1.73 | 12.74 | 5.30 | 6.52 | 24.06 | 12.03 | 17.07 |
| | TRS | 0.64 | 0.78 | 0.69 | 3.32 | 2.20 | 2.10 | 6.17 | 5.04 | 5.64 |
| | WPP | 1.01 | 1.51 | 2.02 | 2.64 | 13.93 | 11.42 | 4.81 | 10.42 | 17.89 |
| CRTS sectors | AGR | 13.03 | 12.66 | 12.77 | 26.36 | 25.00 | 25.60 | 45.75 | 44.47 | 45.58 |
| | CNS | 0.36 | 0.43 | 0.15 | -0.34 | -0.09 | -1.07 | 0.11 | 0.25 | -1.30 |
| | COL | 1.07 | 0.64 | 0.52 | 6.19 | 4.61 | 4.20 | 14.50 | 11.76 | 11.37 |
| | ELE | 8.67 | 6.55 | 5.96 | 21.25 | 11.45 | 10.04 | 29.52 | 13.90 | 12.16 |
| | FNI | 1.24 | 0.38 | 0.26 | 5.00 | 1.56 | 1.26 | 8.68 | 3.25 | 3.02 |
| | FPI | 14.30 | 13.71 | 13.79 | 24.99 | 22.71 | 23.04 | 33.14 | 29.73 | 30.49 |
| | FRS | 2.00 | 1.56 | 1.57 | 7.23 | 4.06 | 5.37 | 13.71 | 10.71 | 12.12 |
| | FSH | 3.81 | 3.49 | 3.62 | 7.47 | 6.30 | 6.75 | 11.03 | 9.34 | 10.18 |
| | GDT | 2.23 | 0.21 | -0.28 | 10.73 | 1.91 | 0.65 | 19.34 | 4.99 | 3.62 |
| | HDC | -0.25 | -0.47 | -0.59 | 1.23 | 0.70 | 0.05 | 3.60 | 2.38 | 1.77 |
| | MET | 1.59 | 2.06 | 2.33 | 6.96 | 9.90 | 10.72 | 9.56 | 14.49 | 15.92 |
| | OIL | 1.24 | 1.49 | 1.61 | 6.37 | 7.83 | 8.03 | 12.46 | 14.71 | 15.03 |
| | OMN | -1.56 | 0.28 | 0.90 | -2.26 | 6.17 | 7.60 | -5.64 | 6.75 | 8.79 |
| | OSG | 1.47 | 0.61 | 0.42 | 5.02 | 1.55 | 1.05 | 8.92 | 3.37 | 2.91 |
| | ROS | 0.51 | 0.04 | 0.06 | 3.73 | 1.83 | 1.96 | 6.65 | 3.71 | 4.04 |
| | WTR | 2.33 | 0.71 | 0.36 | 12.65 | 5.46 | 4.68 | 20.97 | 9.47 | 8.63 |

Table A.15: Disaggregate results for the EU, change in %

| | | S1.A | S1.K | S1.M | S2.A | S2.K | S2.M | S3.A | S3.K | S3.M |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Output | | | | |
| IRTS sectors | CMN | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.04 | 0.04 | 0.04 |
| | CNM | 0.02 | 0.05 | 0.06 | 0.04 | 0.16 | 0.20 | 0.05 | 0.28 | 0.33 |
| | MEQ | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 |
| | OBS | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.03 | 0.04 | 0.04 |
| | OMF | 0.00 | 0.01 | 0.01 | 0.03 | 0.04 | 0.06 | 0.05 | 0.07 | 0.11 |
| | TEX | 0.01 | 0.01 | 0.01 | 0.03 | 0.03 | 0.03 | 0.05 | 0.04 | 0.05 |
| | TRD | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.02 | 0.03 | 0.04 | 0.04 |
| | TRS | 0.01 | 0.01 | 0.01 | 0.03 | 0.02 | 0.02 | 0.05 | 0.04 | 0.05 |
| | WPP | 0.01 | 0.01 | 0.01 | 0.02 | 0.07 | 0.03 | 0.00 | 0.04 | -0.01 |
| CRTS sectors | AGR | 0.01 | 0.00 | 0.00 | -0.08 | -0.12 | -0.12 | -0.21 | -0.28 | -0.29 |
| | CNS | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 |
| | COL | 0.01 | 0.00 | 0.00 | 0.02 | -0.02 | -0.02 | 0.03 | -0.02 | -0.02 |
| | ELE | 0.03 | 0.02 | 0.02 | 0.04 | 0.03 | 0.02 | 0.06 | 0.04 | 0.04 |
| | FNI | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 |
| | FPI | 0.09 | 0.09 | 0.09 | 0.11 | 0.11 | 0.11 | 0.13 | 0.12 | 0.12 |
| | FRS | 0.01 | 0.00 | 0.00 | -0.05 | -0.05 | -0.07 | -0.08 | -0.11 | -0.14 |
| | FSH | 0.03 | 0.03 | 0.03 | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 |
| | GDT | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.00 | 0.05 | 0.02 | 0.02 |
| | HDC | -0.09 | -0.10 | -0.10 | -0.16 | -0.23 | -0.24 | -0.21 | -0.33 | -0.35 |
| | MET | 0.02 | 0.01 | 0.00 | -0.06 | -0.15 | -0.15 | -0.09 | -0.24 | -0.25 |
| | OIL | 0.00 | -0.01 | -0.01 | -0.10 | -0.12 | -0.12 | -0.30 | -0.33 | -0.33 |
| | OMN | 0.02 | 0.02 | 0.02 | 0.01 | -0.01 | -0.01 | -0.01 | -0.03 | -0.02 |
| | OSG | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 |
| | ROS | 0.01 | 0.00 | 0.00 | 0.01 | 0.02 | 0.02 | 0.03 | 0.04 | 0.04 |
| | WTR | 0.02 | 0.01 | 0.01 | 0.02 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 |
| | | | | | | Exports | | | | |
| IRTS sectors | CMN | -0.03 | -0.05 | -0.08 | 0.00 | -0.09 | -0.14 | 0.06 | -0.07 | -0.12 |
| | CNM | 0.09 | 0.16 | 0.21 | 0.25 | 0.52 | 0.69 | 0.38 | 0.85 | 1.00 |
| | MEQ | 0.03 | 0.03 | 0.04 | 0.07 | 0.06 | 0.12 | 0.13 | 0.12 | 0.22 |
| | OBS | -0.04 | -0.05 | -0.08 | -0.04 | -0.10 | -0.15 | -0.02 | -0.10 | -0.15 |
| | OMF | 0.03 | 0.04 | 0.07 | 0.20 | 0.23 | 0.41 | 0.35 | 0.42 | 0.75 |
| | TEX | 0.41 | 0.41 | 0.64 | 0.66 | 0.62 | 0.99 | 0.86 | 0.79 | 1.23 |
| | TRD | -0.02 | -0.03 | -0.04 | 0.02 | -0.06 | -0.10 | 0.10 | -0.02 | -0.06 |
| | TRS | -0.02 | -0.02 | -0.03 | 0.00 | -0.02 | -0.02 | 0.07 | 0.06 | 0.08 |
| | WPP | 0.00 | 0.00 | 0.00 | 0.14 | 0.38 | 0.29 | 0.34 | 0.40 | 0.61 |
| CRTS sectors | AGR | 0.59 | 0.57 | 0.57 | 1.36 | 1.21 | 1.22 | 2.73 | 2.49 | 2.50 |
| | CNS | -0.03 | -0.03 | -0.04 | -0.06 | -0.08 | -0.10 | -0.02 | -0.06 | -0.10 |
| | COL | -0.04 | -0.04 | -0.04 | -0.03 | -0.05 | -0.05 | 0.02 | -0.01 | -0.01 |
| | ELE | 0.24 | 0.16 | 0.14 | 0.67 | 0.30 | 0.25 | 1.01 | 0.44 | 0.38 |
| | FNI | -0.04 | -0.04 | -0.04 | -0.03 | -0.07 | -0.06 | 0.00 | -0.07 | -0.06 |
| | FPI | 0.68 | 0.66 | 0.66 | 1.19 | 1.06 | 1.05 | 1.58 | 1.36 | 1.36 |
| | FRS | -0.03 | -0.04 | -0.03 | 0.05 | -0.01 | -0.02 | 0.18 | 0.08 | 0.09 |
| | FSH | 0.03 | 0.03 | 0.03 | 0.06 | 0.04 | 0.05 | 0.11 | 0.08 | 0.09 |
| | GDT | -0.07 | -0.10 | -0.10 | -0.03 | -0.18 | -0.19 | 0.05 | -0.18 | -0.19 |
| | HDC | -0.15 | -0.13 | -0.12 | -0.17 | -0.19 | -0.15 | -0.16 | -0.18 | -0.14 |
| | MET | 0.11 | 0.07 | 0.07 | 0.64 | 0.44 | 0.43 | 1.10 | 0.82 | 0.81 |
| | OIL | 0.05 | 0.05 | 0.06 | 0.39 | 0.39 | 0.39 | 0.81 | 0.80 | 0.81 |
| | OMN | 0.01 | 0.02 | 0.02 | 0.04 | 0.05 | 0.06 | 0.06 | 0.09 | 0.10 |
| | OSG | -0.03 | -0.05 | -0.04 | 0.00 | -0.08 | -0.08 | 0.06 | -0.07 | -0.07 |
| | ROS | -0.04 | -0.05 | -0.04 | -0.02 | -0.08 | -0.07 | 0.02 | -0.06 | -0.05 |
| | WTR | -0.05 | -0.07 | -0.07 | 0.22 | 0.04 | 0.04 | 0.38 | 0.10 | 0.10 |
| | | | | | | Imports | | | | |
| IRTS sectors | CMN | 0.04 | 0.05 | 0.08 | 0.03 | 0.10 | 0.15 | 0.00 | 0.11 | 0.16 |
| | CNM | 0.09 | 0.02 | 0.05 | 0.18 | -0.12 | -0.07 | 0.26 | -0.31 | -0.29 |
| | MEQ | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.12 | 0.12 | 0.14 | 0.24 |
| | OBS | 0.05 | 0.06 | 0.09 | 0.07 | 0.12 | 0.17 | 0.08 | 0.15 | 0.20 |
| | OMF | 0.02 | 0.02 | 0.02 | 0.06 | 0.05 | 0.07 | 0.09 | 0.06 | 0.07 |
| | TEX | 0.22 | 0.23 | 0.34 | 0.31 | 0.34 | 0.51 | 0.40 | 0.44 | 0.65 |
| | TRD | 0.02 | 0.03 | 0.05 | 0.02 | 0.08 | 0.11 | 0.01 | 0.09 | 0.12 |
| | TRS | 0.02 | 0.03 | 0.04 | 0.00 | 0.02 | 0.02 | -0.04 | -0.05 | -0.07 |
| | WPP | 0.06 | 0.07 | 0.11 | 0.18 | -0.04 | 0.32 | 0.60 | 0.54 | 1.30 |
| CRTS sectors | AGR | 0.81 | 0.83 | 0.84 | 1.65 | 1.86 | 1.90 | 2.80 | 3.23 | 3.30 |
| | CNS | 0.05 | 0.05 | 0.05 | 0.06 | 0.08 | 0.09 | 0.06 | 0.09 | 0.10 |
| | COL | 0.02 | 0.02 | 0.02 | 0.01 | 0.00 | -0.01 | -0.02 | -0.04 | -0.04 |
| | ELE | -0.38 | -0.14 | -0.08 | -1.13 | -0.13 | 0.00 | -2.12 | -0.76 | -0.61 |
| | FNI | 0.05 | 0.05 | 0.05 | 0.07 | 0.09 | 0.09 | 0.09 | 0.13 | 0.12 |
| | FPI | -0.14 | -0.12 | -0.12 | 0.11 | 0.23 | 0.25 | 0.42 | 0.65 | 0.68 |
| | FRS | 0.04 | 0.07 | 0.08 | 0.57 | 0.78 | 0.79 | 0.83 | 1.17 | 1.17 |
| | FSH | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| | GDT | 0.03 | 0.06 | 0.06 | 0.03 | 0.15 | 0.17 | -0.03 | 0.15 | 0.17 |
| | HDC | 0.02 | 0.01 | 0.01 | -0.05 | -0.08 | -0.09 | -0.18 | -0.22 | -0.24 |
| | MET | 0.00 | 0.06 | 0.08 | 0.82 | 1.22 | 1.27 | 1.36 | 2.05 | 2.14 |
| | OIL | 0.08 | 0.09 | 0.10 | 0.62 | 0.69 | 0.71 | 1.60 | 1.74 | 1.77 |
| | OMN | 0.02 | 0.02 | 0.02 | 0.00 | -0.02 | -0.01 | -0.02 | -0.05 | -0.05 |
| | OSG | 0.04 | 0.05 | 0.05 | 0.03 | 0.08 | 0.08 | 0.02 | 0.09 | 0.09 |
| | ROS | 0.05 | 0.05 | 0.04 | 0.06 | 0.09 | 0.09 | 0.06 | 0.12 | 0.11 |
| | WTR | 0.05 | 0.07 | 0.07 | 0.01 | 0.13 | 0.13 | -0.07 | 0.10 | 0.10 |