1 Introduction

The revolution in Ukraine, Russia's continued aggression in Eastern Ukraine, and the annexation of Crimea have drawn the world community's attention. Being in a situation of political and economic crises with high external and public debt, Ukraine receives urgent and necessary economic assistance from the US, the EU, as well as various international organizations such as the International Monetary Fund (IMF) and the World Bank. The EU aims to strengthen Ukraine by integrating it into its huge common market. The already signed and ratified Association Agreement/Deep and Comprehensive Free Trade Area (AA/DCFTA)[1] gives Ukraine a chance to increase its competitiveness on world markets, attract new investments and get better access to the European market.[2] However, a large number of reforms as well as economic modernization of Ukraine are needed for the implementation of this new type of agreement which involves more than just bilateral import tariff elimination. It additionally envisages the harmonization of Ukraine's regulations on competition policy, state aid, public procurement, sanitary and phyto-sanitary measures, technical regulations and service trade liberalization.

An analysis of the deep integration between Ukraine and the EU is needed to provide the parties with valuable information about the transitional impacts, especially after delaying the implementation of the agreement until 2016.[3] In this paper we conduct a comprehensive analysis of the DCFTA's potential effects. Therefore, we look not only at tariff and non-tariff measures (trade facilitation and non-tariff barriers), but also at the liberalization of barriers to FDI in business services in order to consider the full implications of the DCFTA. The last aspect is important as 77.6% of Ukrainian FDI inflows[4] are coming from the EU member countries and almost 54% of total FDI stock is located in service sectors such as financial activities, retail services and real estate.[5] As a central robust finding the DCFTA, with reductions in non-tariff barriers (including the barriers to FDI in services) and trade facilitation improvements, indicates relatively large welfare gains for Ukraine of more than 8%. The positive impact on the EU is small (up to 0.06%) whereas no measurable effect is found for the rest of the world region, but Russia and other Commonwealth of Independent States (CIS) countries experience minor welfare losses as a result of the DCFTA.

Our analysis is innovative in its approach as we analyze the DCFTA between Ukraine and the EU in the improved modeling framework combining new-new trade theory (i.e., Melitz [2003])

[1] The signature process of the AA/DCFTA was completed in June 2014; the Ukrainian Verkhovna Rada and the European Parliament ratified the agreement in September 2014. See, e.g., European Council [2014c], European Commission [2014b] for details (available at `http://europa.eu/index_en.htm`).

[2] The EU has temporarily removed customs duties on Ukrainian exports as an autonomous trade measure since April 2014. This unilateral transitional trade measure allows Ukraine to benefit from the advantages offered by the DCFTA even before its implementation in January 2016. 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/`.

[3] The implementation of the DCFTA was delayed under Russia's pressure until December 2015 while the autonomous trade measures of the EU were extended for this period. See, e.g., European Commission [2014a], European Parliament and the Council [2014] for details.

[4] The number is based on data for the first two quarters of 2014 provided by the State Statistics Service of Ukraine, available at `http://www.ukrstat.gov.ua/`.

[5] See Knuth *et al.* [2010, p. 9]. This is also supported by Kirchner *et al.* [2015, p. 6] and Adarov *et al.* [2015, p. 56-57] who additionally state that in contrast to business services the share of manufacturing is rather low (25.3% in 2013) illustrating a lack of export-oriented, efficiency-seeking FDI.

with explicit consideration of FDI in business services. Moreover, we aim to compare the results with the findings of Olekseyuk & Balistreri [2014] who focus on the implications of different trade structures (Armington [1969], Krugman [1980], Melitz [2003]). For this purpose we extend their multi-regional general-equilibrium simulation model allowing for the presence of multinational firms providing business services in Ukraine. This means that while in manufacturing foreign firms supply Ukrainian markets only on a cross-border basis, business services can be supplied by foreign firms both operating in Ukraine (FDI case) and abroad (cross-border supply). Therefore, we take not only the traditional gains from trade into account, but also: a.) the additional gains from new varieties due to monopolistic competition; b.) the aggregate productivity growth due to within industry reallocation of resources (according to the Melitz trade structure); c.) as well as productivity growth of the manufacturing sectors due to increased number of available business services.

The extension of the model, compared to Olekseyuk & Balistreri [2014], leads in all scenarios to higher welfare effects. However, the gains for Ukraine are still higher under the Armington structure in comparison to monopolistic competition. This deindustrialization impact, previously found by Olekseyuk & Balistreri [2014], arises due to a reallocation of resources into Ukraine's traditional export sectors producing under constant returns. Trade liberalization intensifies the production and exports of agriculture and other sectors in which Ukraine has a traditional comparative advantage, while the increasing returns sectors (including business services) shrink in the face of EU based import competition. Our result is consistent with the findings of Arkolakis *et al.* [2012], Balistreri *et al.* [2010] and Olekseyuk & Balistreri [2014]. They also show that the Armington specification can indicate larger gains if trade liberalization draws resources away from the increasing returns sectors producing under monopolistic competition as the number of available varieties declines. Though, incorporation of FDI and liberalization of the barriers to FDI mitigate the deindustrialization impact as the gap between the welfare results under Armington formulation and monopolistic competition decreases. The reason is the new entry of multinational firms in business services which leads to an increase of the number of available varieties within the country and, consequently, induces productivity growth of manufacturing sectors with improved access to business service inputs.

2 Literature review

The launch of negotiations on the AA/DCFTA between Ukraine and the EU in 2008 spurred economic research on this topic. Quantifying the impact of 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 (i.e., tariff reductions only) where the effects are small or even slightly negative.[6] Maliszewska *et al.* [2009] find some support by simulating different FTAs between the EU and five CIS countries: Armenia, Azerbaijan, Georgia, Ukraine and Russia.

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

Their results indicate 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 analyzed by Francois & Manchin [2009] in a multi-regional GTAP based model with a higher number of included CIS countries.[7] According to their results, a bilateral tariff reduction alone 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). Adding services liberalization and reduction of barriers to efficient trade facilitation (the DCFTA scenario), they find a smaller real income decrease for Ukraine of -0.4%. Focusing on the agricultural sectors of the GTAP7 dataset, von Cramon-Taubadel *et al.* [2010] find that a 50% reduction in 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.

Movchan & Giucci [2011] investigate a broader range of Ukraine's integration strategies. They compare the effects of different FTAs with the EU on the one hand and Ukraine's deeper integration within the customs union of Russia, Belarus and Kazakhstan on the other hand. Simulating the DCFTA with a 2.5% reduction of border dead-weight costs on trade in addition to 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 alternative implementation of a joint external tariff in case of the customs union would lead to a welfare loss up to 3.7%.

While some of the aforementioned studies[8] incorporate increasing returns to scale and large-group monopolistic competition in selected manufacturing and service sectors, Olekseyuk & Balistreri [2014] analyze the potential effects of the DCFTA assuming monopolistic competition among heterogeneous firms. Moreover, they compare the results across three models with alternative trade structures: a.) a standard specification of perfect competition based on the Armington [1969] assumption of regionally differentiated goods; b.) monopolistic competition among symmetric firms consistent with Krugman [1980]; and c.) a competitive selection model of heterogeneous firms consistent with Melitz [2003]. Their results show that the DCFTA, with reductions in non-tariff barriers and trade facilitation improvements, will cause relatively large welfare gains for Ukraine of more than 3%. Furthermore, across the structures the gains for Ukraine are largest under the Armington structure. This is attributed to a policy induced movement of resources into Ukraine's traditional export sectors which produce under constant returns. While there is little danger of deindustrialization dominating the overall welfare gains, they do observe substantially lower gains under monopolistic competition.

The review of previous research reveals that an explicit modeling of FDI as well as liberalization of barriers to FDI in business services remain out of scope of the aforementioned studies. According to Tarr [2013], it is important to have a modeling framework which allows for the analysis of this kind of liberalization due to the growing importance of services trade and FDI in services. Summarizing the results from different studies he finds that liberalization of barriers against FDI in services yields welfare gains several times larger than the usual estimates

[7] Francois & Manchin [2009] present detailed results for seven CIS counties: Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Russia and Ukraine.

[8] See Jensen *et al.* [2005], Maliszewska *et al.* [2009], Ecorys & CASE-Ukraine [2007], Francois & Manchin [2009], Movchan & Giucci [2011].

from traditional CGE models, which focus on goods trade. This occurs due to the fact that a reduction or elimination of FDI barriers in services sectors (e.g., telecommunication, banking, insurance, transportation and other business services) improves domestic firms' access to high-quality services and, consequently, leads to a reduction of costs of doing business, increases firms' productivity and improves the economy's competitiveness on world markets. The importance of FDI modeling is also supported by Christen *et al.* [2013], who broadly review the literature on market access in services. Comparing various approaches for the modeling of services liberalization, they also come to the conclusion that the reduction of barriers in services can generate much larger welfare effects than goods liberalization. Furthermore, they argue that an extension of CGE models to include FDI is crucial as it is a major channel for the international exchange of services.

Focusing on the modeling of FDI in business services with the assumption of large-group monopolistic competition (i.e., Krugman-based models with Dixit-Stiglitz structure), a lot of research has been done for many developing countries such as Russia, Kazakhstan, Armenia, Tunisia, Kenya, Tanzania and other East African countries. In particular, Konan & Maskus [2006] compare goods and services liberalization for Tunisia including liberalization of both cross-border services trade and establishment of domestic presence by FDI. They demonstrate that the gains from liberalization of services are more than three times larger compared to the ones from goods liberalization only. Furthermore, according to their results 75% of services liberalization gains may be achieved by the liberalization of foreign investment barriers. Rutherford & Tarr [2006] and Jensen *et al.* [2007] investigate the effects of Russia's WTO accession and show that the gains from liberalization of barriers against FDI in business services dominate as part of the overall gains from the WTO accession with shares of 85% and 72%, respectively. Balistreri *et al.* [2009] model services liberalization in Kenya and illustrate that the largest gains derive from liberalization of barriers that are non-discriminatory in their impacts between Kenyan and multinational service providers. For other countries Jensen & Tarr [2008], Jensen & Tarr [2010], Jensen *et al.* [2010], Balistreri *et al.* [2014] find similar results with the reductions of barriers to FDI contributing the main part of the overall effects from trade liberalization.[9] Only for Armenia Jensen & Tarr [2012] observe somewhat smaller gains due to (i) lower discriminatory barriers against multinational service providers and (ii) preferential liberalization according to the DCFTA with the EU.

Regarding Ukraine, Jensen *et al.* [2005] is the only study incorporating the FDI structure in services in a CGE model with increasing returns to scale and large-group monopolistic competition in some manufacturing sectors. They investigate the impact of Ukraine's WTO accession and show that the aggregate welfare gains are mainly driven by FDI reforms. They find a welfare increase of 2.3% from the reduction of barriers that discriminate against foreign services providers, whereas the average welfare effect amounts to 4.7%.

The impact of FDI is closely linked to the spillover theory. General spillover channels were first

[9] Balistreri *et al.* [2014] apply a multi-regional simulation model for East Africa and show that the gains from liberalization of FDI in services are dominant in the overall impact (compared to the effects from reduction of NTBs and barriers to efficient trade facilitation) only if countries have relatively high barriers against foreign service providers. This is found for Rwanda, Kenya and Uganda.

described by Findlay [1978] and Griliches [1979, 1992], who identify the introduction of superior technologies and organizational skills to the host economy as a key channel for FDI spillovers. Thereby, the technological gap between the host and home economy (Findlay [1978]) as well as the absorptive capacity in the host economy[10] play an important role. Empirical evidence suggests that FDI spillovers occur through vertical (between-sector) rather than through horizontal (within-sector) channels.[11] Havranek & Irsova [2011] provide a comprehensive meta-analysis of productivity spillovers from foreign affiliates to domestic firms for 47 countries. They find an evidence for backward (from FDI to local suppliers) and forward (from FDI to local buyers) vertical spillovers. In particular, their estimates suggest that a 10-percentage-point increase in foreign presence is associated with an increase in the productivity of domestic firms in supplier sectors of about 9%. Concerning vertical forward spillovers, Arnold *et al.* [2011] show for the Czech Republic that allowing foreign entry in services is the key channel through which services liberalization contributes to improved performance of manufacturing sectors. Furtheremore, Fernandes & Paunov [2012] provide a proof for increased total factor productivity of manufacturing sectors in Chile induced by a rise of FDI in services. Similar evidence exists for Ukraine. Using a firm-level dataset Shepotylo & Vakhitov [2012] show a strong positive impact on the productivity of Ukrainian firms from better access to services and from services liberalization. In particular, a standard deviation increase in services liberalization is associated with a 9% increase in total factor productivity. Though, FDI in business services may contribute to the competitiveness of Ukrainian firms through vertical forward linkages.

Given this literature review, no studies exist that combine the competitive selection of heterogeneous firms with the explicit modeling of FDI in business services. Incorporation of heterogeneous firms is also mentioned by Tarr [2013] and Jensen & Tarr [2012] as an important extension of the models with FDI structure. Therefore, we contribute to the literature by filling this gap in our analysis for the DCFTA between Ukraine and the EU.

3 Model description

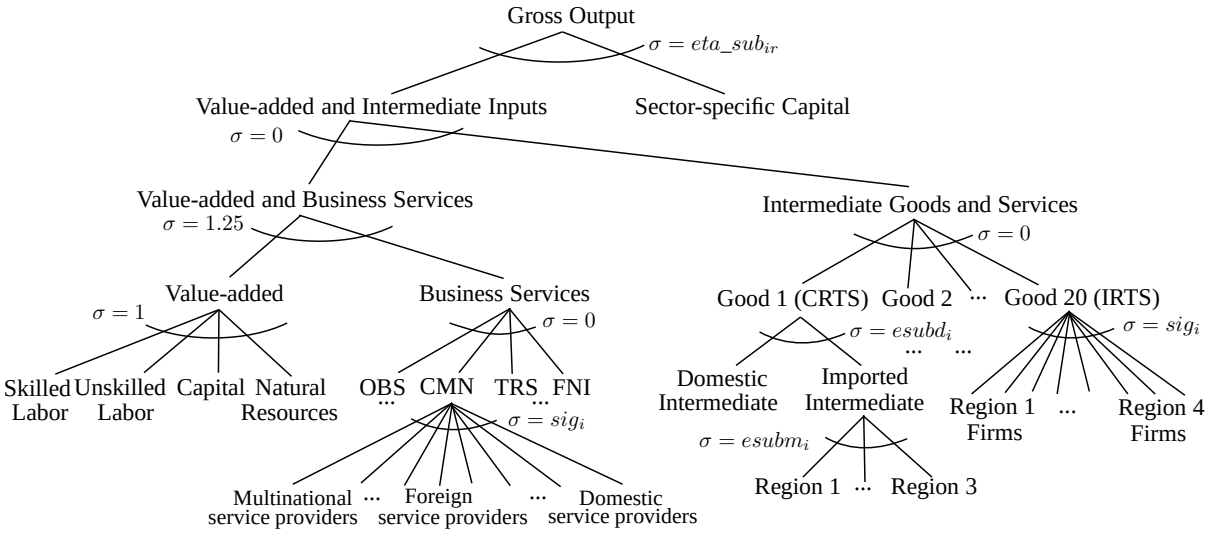
Our empirical multi-region model is directly developed from the model presented by Olekseyuk & Balistreri [2014]. The backbone of the modeling exercise consists of a typical CGE model with standard assumptions of perfect competition, Constant Returns to Scale (CRTS) and regional differentiation (Armington [1969]). Though, we allow for imperfect competition and Increasing Returns to Scale (IRTS) in some manufacturing sectors and business services. Figure 1 illustrates the production structure for each sector in every region of the model. It involves not only a combination of intermediate inputs and primary factors, but also a combination of business services and production factors at a lower CES nest. This is one of the key differences to the model developed by Olekseyuk & Balistreri [2014]. Following this approach we allow business services to substitute for the value-added with an elasticity of substitution of 1.25.[12] Such an

[10] See, e. g., Cohen & Levinthal [1989] or Mebratie & van Bergeijk P.A.G. [2013, p. 64] especially for developing and transitional countries.

[11] See, e. g., Javorcik [2004], Blalock & Gertler [2008], Kolasa [2008], Havranek & Irsova [2011].

[12] The value of 1.25 is adopted from Jensen & Tarr [2012], Jensen *et al.* [2010], Jensen *et al.* [2007], Jensen & Tarr [2010], Jensen & Tarr [2008], Balistreri *et al.* [2009] and Balistreri *et al.* [2014].

Figure 1: Production structure



extension of production structure was suggested by Markusen *et al.* [2005] and used in empirical studies such as Jensen *et al.* [2010], Jensen *et al.* [2007], Jensen & Tarr [2012], Balistreri *et al.* [2009] and Balistreri *et al.* [2014]. The intuition behind this extension is that firms can use services provided by, e.g., accounting or legal firms instead of hiring accountants or lawyers as employees (i.e., skilled labor as production factor).

Furthermore, we assume a Cobb-Douglas function over the mobile primary factors (skilled and unskilled labor, capital and natural resources) and a Leontief production function combining intermediate goods and services on the one hand with the factors of production and business services composite on the other hand. 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 of substitution eta_sub_{ir}, which is calibrated according to the specific elasticity of supply used for modeling of Melitz and Krugman based goods and services.[13]

There are two agents in each region of the model: 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 composite of domestic and foreign goods. In the CRTS formulation, this Armington aggregate is given by a nested CES function where consumers first allocate their expenditures among domestic and imported goods and then decide between foreign varieties from different regions (see the structure for good 1 in Figure 1). Allowing for imperfect competition and IRTS in some selected manufacturing sectors and business services, we differentiate between domestic and foreign products at the firm level. This requires an assumption of the same substitution elasticity between firms and products.[14] Thus, the composite of the firm level goods is modeled by a single level CES function with all domestic and imported varieties competing directly (see the structure for good 20 or for business services in Figure 1). General equilibrium is then defined by competition for all producers, balanced budgets for representative agents in each region, as well as by market

[13]This supply elasticity is used in the partial equilibrium models for Krugman and Melitz formulation.

[14]The inter-variety elasticity of substitution sig_i is equal to 3.8 which is consistent with the plant-level empirical analysis of Bernard *et al.* [2003].

clearance for all goods and factor markets.

Extending the initial model with explicit consideration of FDI in business services, we allow for the existence of two types of firms: (i) domestic firms producing in Ukraine for home and foreign markets and (ii) multinational firms producing in Ukraine for the local market with the FDI from other regions (EU, CIS, rest of the world).[15] Therefore, these FDI firms (or multinational firms) produce a specific variety in Ukraine, which is differentiated from domestic and other host county varieties (i.e., imported services). Thus, in these sectors we implement large-group monopolistic competition among symmetric firms producing under the same IRTS technology, which was suggested by Krugman [1980].[16] The costs of domestic firms are defined by the costs of Ukrainian primary factors and intermediate inputs. For FDI firms, the cost structure differs as, in addition to Ukrainian production factors and intermediates, they import specialized foreign inputs. Moreover, the barriers to FDI raise the costs of multinational firms and, consequently, affect their profitability and entry. A liberalization of such barriers induces foreign entry and leads to productivity gains due to increased number of available varieties (according to the Dixit & Stiglitz [1977] variety effect).[17]

Following Olekseyuk & Balistreri [2014], sectors with a high share of intra-industry trade (over 60%) are assumed to produce under IRTS technology. Moreover, for these sectors we implement monopolistic competition with competitive selection of heterogeneous firms according to Melitz [2003]. This allows us to capture the trade-policy induced changes in aggregate productivity due to a within industry reallocation of factors from less to more productive plants (including exit of the lowest productivity firms).[18]

4 Data sources and simulation scenarios

The model is calibrated to an aggregation of the GTAP 8.1 dataset. It includes the same sectors, primary factors of production and regions (see Table 1) as the model developed by Olekseyuk & Balistreri [2014].[19] To enable a comparison of results of two models with different structures, we use the same additional data for tariff rates, subsidies, taxes, NTBs and barriers to efficient trade facilitation.[20] For unilateral reduction of discriminatory barriers to FDI in four business services sectors, we calculate simple averages of the ad valorem equivalents (AVEs) provided by

[15] Due to data availability we implement this FDI structure only for Ukraine as the country of interest.

[16] A detailed specification of the Krugman model equations is provided in the appendix 8.1.

[17] Similar structures are implemented by Markusen *et al.* [2005], Jensen *et al.* [2007], Jensen *et al.* [2010], Jensen & Tarr [2012], Balistreri *et al.* [2009] and Balistreri *et al.* [2014].

[18] A detailed description of the model equations can be found in Olekseyuk & Balistreri [2014] and Balistreri & Rutherford [2013]. See also Balistreri *et al.* [2011] and Bernard *et al.* [2003] for the parametrization of the model and Balistreri *et al.* [2010], Balistreri & Rutherford [2012], Corcos *et al.* [2011], Costinot & Rodríguez-Clare [2014] for discussion of divergence in results across different model structures (e.g., Armington and Melitz) and their empirical relevance.

[19] See Tables A.10 and A.11 for detailed mapping of GTAP regions and sectors to our model.

[20] For NTBs we use the AVEs estimated by Kee *et al.* [2009]; for barriers to trade facilitation see Minor [2013], Hummels [2007], Hummels *et al.* [2007], Hummels & Schaur [2013]; detailed description of aggregation procedure is provided by Olekseyuk & Balistreri [2014].

Jafari & Tarr [2014] for eleven service sectors.[21] The values of all applied distortions for Ukraine and the EU are presented in Tables A.12 and A.13. For the modeling of multinational firms we need data on (i) shares of specialized imported inputs and (ii) shares of output of business service sectors captured by FDI firms. In this case we use the only available data estimated by Jensen *et al.* [2005] and Copenhagen Economics *et al.* [2005] before Ukraine's accession to the WTO.

Table 1: Scope of the model

CRTS sectors:	
AGR	Agriculture and hunting
CNS	Construction
COL	Coal
ELE	Electricity
FPI	Food-processing
FRS	Forestry
FSH	Fishing
GDT	Gas manufacture, distribution
HDC	Production of hydrocarbons
MET	Metallurgy and metal processing
OIL	Petroleum, coal products
OMN	Minerals nec[22]
OSG	Public services
ROS	Recreational and other services
WTR	Water
IRTS sectors (in case of Melitz structure):	
CNM	Chemical and mineral products
MEQ	Manufacture of machinery and equipment
OMF	Manufactures nec
TEX	Textiles and leather
TRD	Trade
WPP	Wood, paper products, publishing
Business services with IRTS and FDI (in case of Krugman structure):	
CMN	Communications
FNI	Financial services, insurance
OBS	Business services nec
TRS	Transport

Regions:	
UKR	Ukraine
EU	EU
CIS	CIS and Georgia
ROW	Rest of the world
Factors:	
lab	Unskilled labor
skl	Skilled labor
cap	Capital
res	Natural resources

In order to compare results with different model structures while analyzing the DCFTA between Ukraine and the EU, we conduct the same simulations as Olekseyuk & Balistreri [2014]. The first one (S1) includes only a bilateral elimination of import tariffs. In the second counterfactual simulation (S2) we additionally reduce the NTBs and barriers to efficient trade facilitation by 20%. 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). Extending the previous analysis we add a unilateral reduction of discriminatory barriers to FDI

[21] They provide tariff equivalents for the following sectors: accounting and legal services; air, rail, road and maritime transport; banking and insurance; fixed and mobile line; retail. All values except of retail sector are used in our calculations.

[22] OMN is modeled as a CRTS sector as it includes natural resources which are limited in each of the countries meaning that increasing returns to scale are not feasible. However, OMN does exhibit high degrees of intra-industry trade. This is a result of a diverse set of products contained in this catch-all "other minerals" sector in contrast to manufacturing sectors. Though, to check the model's sensitivity to our assumption that OMN is CRTS, we made a run with OMN as an IRTS sector. The welfare impact for Ukraine in S4.MK scenario is 8.24% when OMN is IRTS, relative to 8.14% in our central treatment (OMN is assumed to be a CRTS sector).

by 50% in the fourth scenario (S4).[23] As the deep and comprehensive integration with the EU involves the harmonization of Ukrainian legislation and polices, it will lead to a strong reduction of the barriers against European suppliers of business services.

Table 2: Scenarios

	Model structure		
Policy	Armington	Melitz	Melitz & Krugman
Tariffs	S1.A	S1.M	S1.MK
Tariffs + 20% NTB + 20% trade facilitation	S2.A	S2.M	S2.MK
Tariffs + 20% NTB + intra-EU trade facilitation	S3.A	S3.M	S3.MK
Tariffs + 20% NTB + intra-EU trade facilitation + 50% barriers to FDI	S4.A	S4.M	S4.MK

We run each simulation three times (see Table 2). The first run of each counterfactual simulation (S1.A, S2.A, S3.A and S4.A) provides the results under Armington trade formulation for all sectors. In the second run (S1.M, S2.M, S3.M and S4.M) we assume a Melitz structure with competitive selection of heterogeneous firms for the IRTS sectors except business services.[24] In addition, large-group monopolistic competition among symmetric firms producing under the same IRTS technology (Krugman structure) is assumed for business services[25] in the third run (S1.MK, S2.MK, S3.MK and S4.MK).

5 Results

According to the aggregate results of counterfactual experiments (see Table 3), the free trade area is welfare increasing for Ukraine and the EU. Real GDP increases by as much as 5.67% for Ukraine and 0.05% for the EU. Higher and broader reductions of barriers bring higher benefits for both trade partners. While the EU can gain from the policy reform only with a small rise of welfare of up to 0.06%, Ukraine's benefits are much higher with a welfare increase up to 11,73%.[26] Only in scenario S1.M and S1.MK Ukraine experiences a decline of welfare by a maximum of 0.13%. The reason for these negative results is the trade-induced net exit of firms and, therefore, a lower number of available varieties in the monopolistic competition models. This outcome is consistent with the findings of Arkolakis *et al.* [2012], Balistreri *et al.* [2010] and Olekseyuk & Balistreri [2014]. As trade liberalization happens only between Ukraine and the EU, other regions are negatively affected. 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 is affected more strongly with a welfare decrease between 0.01% and 0.11%. Comparing our results to the model without incorporated FDI structure (see Olekseyuk & Balistreri [2014]), we observe an increase in the welfare impact for Ukraine in all comparable scenarios ranging

[23] A bilateral liberalization is not simulated due to the lack of data concerning the FDI firms in the EU (shares of output captured by multinational firms and shares of specialized imported inputs).

[24] Melitz structure is incorporated for the following sectors: CNM, MEQ, OMF, TEX, TRD, WPP.

[25] Including CMN, FNI, OBS, TRS.

[26] Relatively weak trade links of the EU constitute the main reason for the difference in magnitude. Following Olekseyuk & Balistreri [2014] the import shares of the EU from Ukraine are very low with the maximum of 10.6%. The situation is opposite in Ukraine with import shares from the EU over 40% for the IRTS goods.

Table 3: Aggregate results, change in %

	S1.A	S1.M	S1.MK	S2.A	S2.M	S2.MK	S3.A	S3.M	S3.MK	S4.A	S4.M	S4.MK
Welfare (Hicksian welfare index)												
UKR	0.66	-0.02	-0.13	6.30	3.53	3.40	11.42	7.76	7.41	11.73	8.07	8.14
EU	0.00	0.00	0.00	0.01	0.03	0.03	0.03	0.05	0.05	0.03	0.05	0.06
CIS	-0.01	-0.01	-0.01	-0.05	-0.06	-0.05	-0.11	-0.11	-0.10	-0.11	-0.11	-0.10
ROW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Real GDP (in units of the private consumption composite)[27]												
UKR	0.32	-0.03	-0.10	3.03	1.61	1.53	5.49	3.59	3.38	5.67	3.77	3.79
EU	0.01	0.01	0.01	0.02	0.03	0.03	0.03	0.05	0.05	0.03	0.05	0.05
CIS	-0.01	-0.01	0.00	-0.03	-0.03	-0.02	-0.06	-0.06	-0.05	-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	0.00	0.00	0.00
Exports												
UKR	2.39	3.72	3.73	4.76	9.08	9.10	7.24	13.58	13.66	7.11	13.48	13.29
EU	0.07	0.09	0.09	0.19	0.26	0.25	0.32	0.43	0.43	0.31	0.42	0.41
CIS	-0.09	-0.12	-0.12	-0.26	-0.35	-0.35	-0.38	-0.53	-0.53	-0.38	-0.54	-0.54
ROW	-0.05	-0.06	-0.06	-0.10	-0.12	-0.12	-0.16	-0.20	-0.19	-0.16	-0.20	-0.20
Imports												
UKR	2.30	3.48	3.50	4.64	8.43	8.46	7.10	12.66	12.75	6.52	12.14	11.78
EU	0.06	0.08	0.08	0.17	0.23	0.23	0.29	0.39	0.39	0.29	0.39	0.38
CIS	-0.10	-0.12	-0.13	-0.34	-0.40	-0.40	-0.54	-0.65	-0.65	-0.55	-0.65	-0.66
ROW	-0.05	-0.06	-0.06	-0.10	-0.11	-0.11	-0.15	-0.18	-0.17	-0.15	-0.18	-0.18

from 0.06 to 0.33 percentage points. This highlights the importance of our improved model structure allowing multinational firms to increase their demand for Ukrainian primary factors of production and, therefore, indicating the higher welfare impact.

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 trade flows. These changes range between 2.30% and 13.66% for Ukraine. For the EU the effects are also positive, but much smaller in all simulations. The highest impacts on trade flows are observed under monopolistic competition as there is a reallocation of resources towards most productive exporting firms. Only in S4.MK the rise in exports and imports is somewhat lower than in S4.M. Assuming monopolistic competition in business services, some cross-border supply is replaced by the supply of new multinational firms entering the market due to reduced barriers to FDI. Concerning other regions, we detect a small diversion of trade from ROW and CIS which does not exceed 0.66% across the simulations.

Concerning factor earnings, Table 4 indicates an increase of remuneration for all Ukrainian production factors with the highest rise for unskilled labor and natural resources. This indicates a reallocation of production to the sectors producing with an intensive use of aforementioned production factors.[28] Somewhat opposite results arise for the EU: while factor returns for labor and capital rise slightly, the remuneration for provision of natural resources declines suggesting an opposite specialization of the EU. Concerning other regions, natural resources constitute the only primary factor which loses from trade liberalization in ROW and benefits in the CIS region. This demonstrates a deepening of the CIS specialization on resource-intensive goods, especially taking the reduced factor returns for all other production factors into account.

[27] All nominal measures for region r (e.g., GDP_r, factor earnings) are scaled by the true-cost-of-living index for region r.

[28] Similar specialization of Ukraine is found by Frey & Olekseyuk [2014] and Olekseyuk & Balistreri [2014].

Table 4: Factor earnings, change in %

	S1.A	S1.M	S1.MK	S2.A	S2.M	S2.MK	S3.A	S3.M	S3.MK	S4.A	S4.M	S4.MK
Unskilled labor												
UKR	2.07	1.52	1.45	5.70	3.64	3.56	9.21	6.42	6.22	9.49	6.70	7.11
EU	0.02	0.03	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.05	0.06	0.07
CIS	-0.02	-0.02	-0.02	-0.04	-0.07	-0.06	-0.07	-0.10	-0.09	-0.07	-0.10	-0.09
ROW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Skilled labor												
UKR	0.93	0.22	0.15	3.60	0.86	0.79	5.87	1.87	1.67	6.19	2.19	2.74
EU	0.02	0.02	0.02	0.03	0.04	0.04	0.05	0.07	0.07	0.05	0.07	0.07
CIS	-0.01	-0.01	-0.01	-0.03	-0.05	-0.04	-0.06	-0.08	-0.07	-0.06	-0.08	-0.07
ROW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Capital												
UKR	1.46	1.18	1.10	4.20	2.78	2.70	6.88	5.09	4.88	7.18	5.40	5.89
EU	0.02	0.02	0.02	0.03	0.04	0.04	0.04	0.06	0.06	0.04	0.06	0.06
CIS	-0.02	-0.02	-0.01	-0.06	-0.06	-0.05	-0.09	-0.09	-0.08	-0.09	-0.09	-0.08
ROW	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01	0.00	0.00
Natural resources												
UKR	-0.51	0.27	0.23	0.78	3.76	3.70	2.31	6.61	6.50	2.40	6.75	6.85
EU	-0.03	-0.04	-0.04	-0.06	-0.14	-0.13	-0.09	-0.20	-0.20	-0.09	-0.20	-0.20
CIS	0.03	0.01	0.01	0.15	0.08	0.08	0.24	0.13	0.14	0.24	0.13	0.13
ROW	0.00	-0.01	-0.01	-0.01	-0.05	-0.04	-0.02	-0.08	-0.07	-0.02	-0.08	-0.08

Table 5: Number of firms in business services, change in %

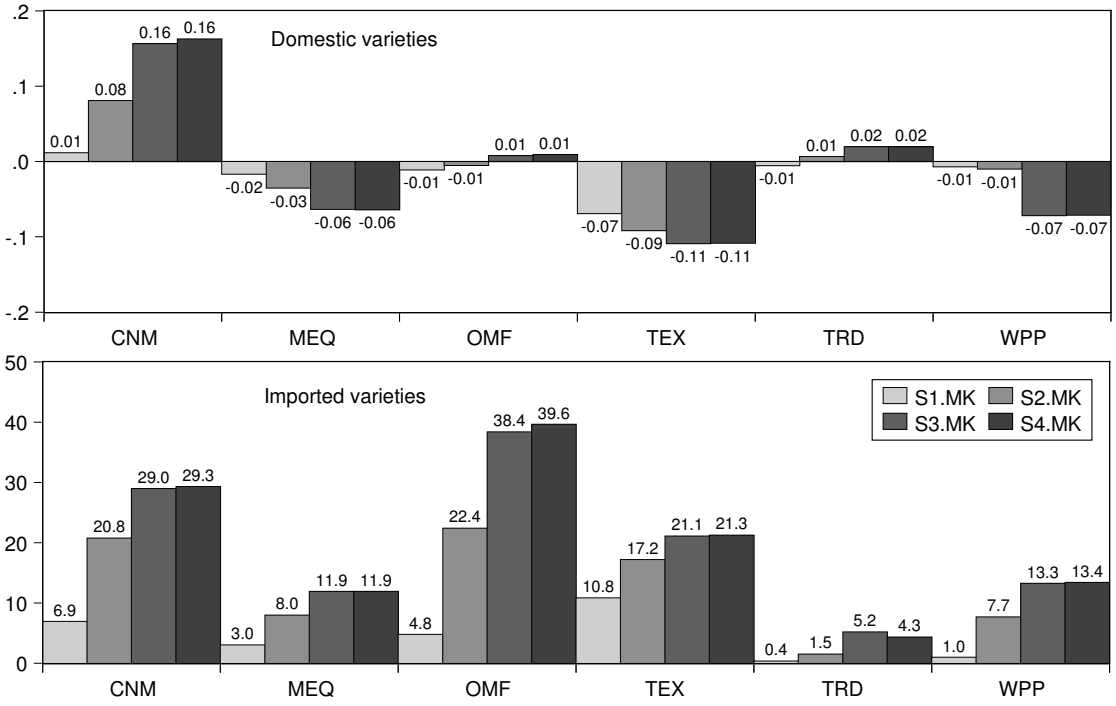
	Ukrainian firms				EU firms operating in Ukraine			
	S1.MK	S2.MK	S3.MK	S4.MK	S1.MK	S2.MK	S3.MK	S4.MK
CMN	-0.009	-0.006	-0.001	-0.001	-0.707	-0.151	0.023	1.350
FNI	-0.013	-0.017	-0.016	-0.018	-0.714	-1.008	-1.859	16.920
OBS	-0.006	-0.003	0.002	-0.002	-1.994	-1.980	-5.693	151.813
TRS	-0.001	0.016	0.049	0.047	-1.091	-0.883	-2.079	64.926

Table 6: Number of operating firms under Melitz structure, change in %

	S1.M	S1.MK	S2.M	S2.MK	S3.M	S3.MK	S4.M	S4.MK
Number of European firms operating in Ukraine								
CNM	20.69	20.52	61.15	60.97	84.97	84.62	85.27	85.54
MEQ	9.47	9.47	24.99	24.98	37.06	37.02	37.08	37.08
OMF	14.56	14.47	67.66	67.55	116.39	115.54	117.51	119.31
TEX	32.70	32.64	52.10	52.02	63.98	63.74	64.19	64.24
TRD	1.21	1.37	5.14	5.37	16.37	16.75	15.59	14.17
WPP	3.20	3.18	23.92	23.82	40.96	40.90	41.05	41.28
Number of Ukrainian firms operating in domestic market								
CNM	-20.78	-20.46	-70.00	-69.68	-97.54	-97.02	-98.04	-98.61
MEQ	-6.34	-6.35	-21.79	-21.81	-37.08	-37.10	-37.05	-37.03
OMF	-8.49	-8.50	-33.74	-33.76	-58.07	-57.79	-58.59	-59.78
TEX	-26.07	-26.10	-39.51	-39.54	-49.04	-49.10	-48.99	-48.99
TRD	-0.14	-0.18	0.71	0.65	1.36	1.22	1.51	1.65
WPP	-2.03	-2.02	-24.23	-24.10	-42.26	-42.25	-42.26	-42.24

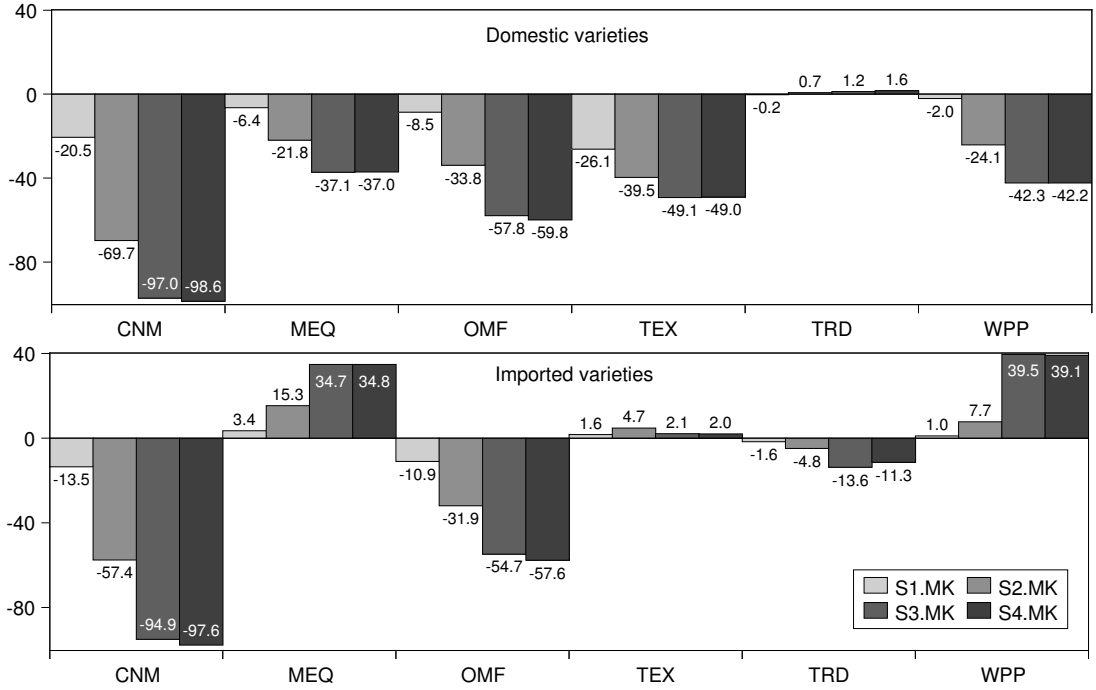
Comparing welfare results across different trade structures, we find the same result as Olekseyuk & Balistreri [2014] even with explicitly incorporated FDI structure. Ukraine's welfare effects are significantly higher under Armington structure than under monopolistic competition specifications. This occurs mainly due to the comparative disadvantage of Ukraine's IRTS goods and business services on the EU markets. Under the Krugman formulation for business services (see Table 5), policy reform induces exit of Ukrainian firms in all service sectors except transport (TRS). The number of European multinational firms operating in Ukraine also declines in the first three scenarios, which leads to a reduction of the set of services produced in Ukraine. Only in the last simulation (S4.MK) the liberalization of barriers to FDI causes a switch from cross-border supply to establishing a multinational firm, so the number of EU firms operating in Ukraine increases strongly. Considering the IRTS goods under Melitz trade structure, we also observe a noticeable decline in the number of Ukrainian firms operating in domestic market (see Table 6) for all IRTS sectors except trade (TRD). The same occurs for Ukrainian cross-border firms operating in foreign markets with the exception of machinery and equipment (MEQ) and the wood and paper industry (WPP). Thus, the number of European cross-border firms operating in Ukraine increases strongly which documents the EU's comparative advantage in the IRTS goods. This explains the contrary welfare effects for the EU which are higher under monopolistic competition than under the Armington structure.

Figure 2: Domestic and imported varieties in the EU, change in %



Considering the total number of varieties consumed under the Melitz trade structure (see Table 7), we find an increase for all IRTS sectors in the EU which occurs because of the higher number of imported varieties in all considered sectors (see Figure 2). For Ukraine the results of total number of consumed varieties are negative in all IRTS sectors due to the reduction of

Figure 3: Domestic and imported varieties in Ukraine, change in %



both domestic and imported varieties (see Figure 3).[29] However, simply counting the varieties to explain the welfare changes along the extensive margin can be misleading as varieties enter the expenditure system under different prices. To take this into account we calculate the so-called Feenstra ratio[30] and report the percentage change of this ratio at the bottom panel of Table 7. The results indicate no losses along the extensive margin for both trading partners.[31] This means that lost varieties in Ukraine represent low productivity goods with relatively high prices and low quantities, so that net impact is positive.

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

[29] Only manufacture of machinery and equipment (MEQ), textiles (TEX) and wood and paper industry (WPP) demonstrate an increase of imported varieties in Ukraine However, it is not enough to compensate for the losses of Ukrainian domestic varieties.

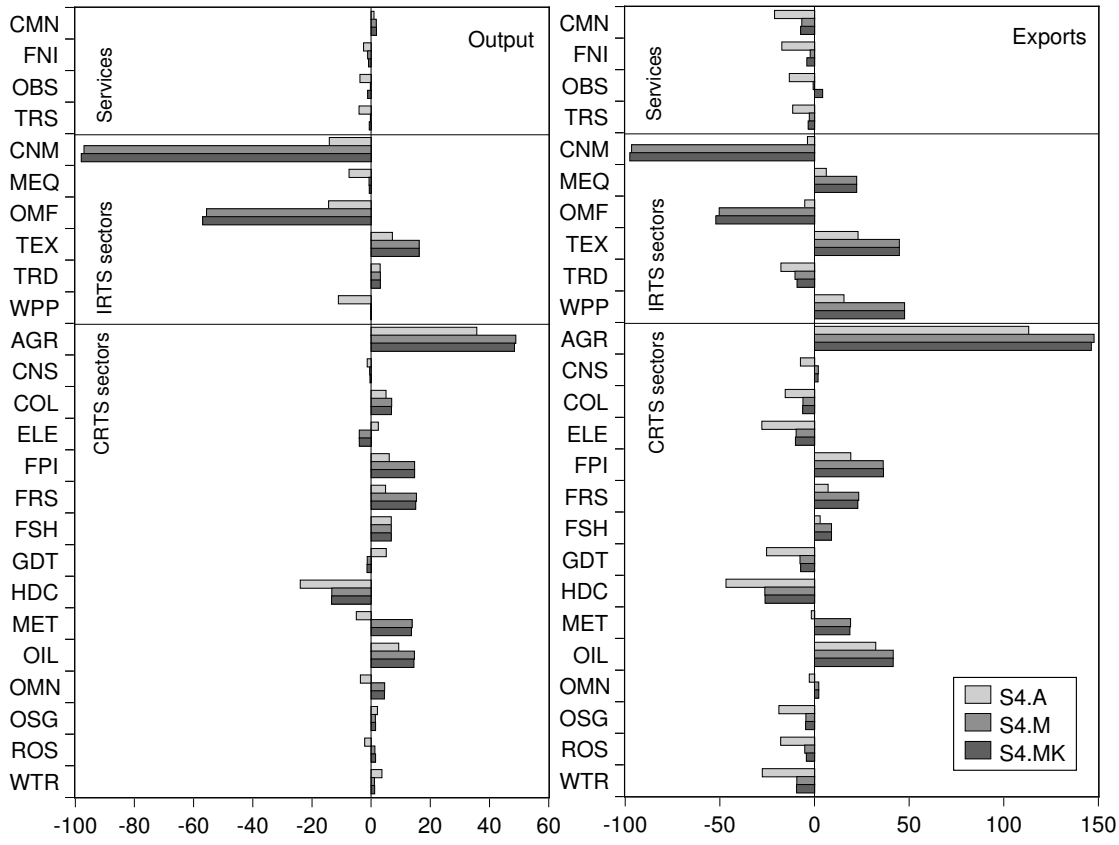
[30] Comparing equilibria t versus $t-1$, Feenstra [2010] shows that the variety gains can be measured by deviations in the following ratio from unity: $\left(\lambda_{hr}^{t}/\lambda_{hr}^{t-1}\right)^{-1/(\sigma_h-1)}$, where λ_{hr}^{z} is region-r's share of expenditures at equilibrium z on good-h varieties available in both equilibria to the total expenditures on good-h varieties at z.

[31] Only in S1 there are some losses in Ukrainian trade sector (TRD) form tariff reduction induced changes in the number of varieties.

Table 7: Consumed varieties and Feenstra ratio, change in %

Reported variable	IRTS sector	S1.M	S1.MK	S2.M	S2.MK	S3.M	S3.MK	S4.M	S4.MK
					Ukraine				
Total varieties consumed	CNM	-19.07	-18.72	-66.98	-66.61	-97.10	-96.48	-97.69	-98.36
	MEQ	-3.89	-3.91	-12.52	-12.54	-19.13	-19.15	-19.09	-19.07
	OMF	-9.12	-9.11	-33.28	-33.28	-57.36	-57.02	-57.94	-59.23
	TEX	-19.15	-19.17	-28.46	-28.47	-36.26	-36.29	-36.23	-36.24
	TRD	-0.46	-0.54	-0.59	-0.70	-2.29	-2.49	-1.99	-1.59
	WPP	-1.27	-1.26	-16.31	-16.15	-21.85	-21.82	-21.87	-21.89
Feenstra ratio	CNM	0.60	0.59	5.63	5.62	9.72	9.66	9.78	9.84
	MEQ	0.00	0.00	3.18	3.18	6.21	6.20	6.22	6.22
	OMF	0.13	0.11	3.70	3.68	6.85	6.77	6.92	6.98
	TEX	0.95	0.93	4.73	4.71	7.08	7.02	7.13	7.14
	TRD	-0.02	-0.03	0.34	0.32	0.77	0.73	0.80	0.83
	WPP	0.07	0.07	3.59	3.59	7.87	7.85	7.88	7.94
					EU				
Total varieties consumed	CNM	1.76	1.75	5.27	5.25	7.39	7.36	7.42	7.45
	MEQ	0.75	0.75	1.96	1.97	2.93	2.93	2.93	2.93
	OMF	1.19	1.18	5.60	5.59	9.67	9.60	9.76	9.92
	TEX	2.66	2.66	4.24	4.23	5.21	5.19	5.23	5.23
	TRD	0.07	0.09	0.36	0.38	1.28	1.31	1.21	1.10
	WPP	0.24	0.24	1.92	1.92	3.26	3.26	3.27	3.29
Feenstra ratio	CNM	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02
	MEQ	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
	OMF	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
	TEX	0.00	0.00	0.01	0.01	0.03	0.03	0.03	0.03
	TRD	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
	WPP	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02

Figure 4: Disaggregate results for Ukraine, change in %



6 Sensitivity analysis

To check the sensitivity of our results with respect to assumed values of the key elasticities and parameters, we execute a piecemeal sensitivity analysis. It shows how the results change when we vary the value of parameters one-by-one meaning that we run the model with central values for all parameters except the one under consideration. Table 8 illustrates the lower, central (i.e., initial) and upper values of parameters assumed for the sensitivity analysis. Hereby, we adopt a higher value for the resource supply elasticity in the EU than in other regions following Schiff *et al.* [2002] and Schiff & Wang [2006] who found that the elasticity of total factor productivity with respect to the North trade-related R&D (considering developed countries such as OECD member states) is much larger than one with respect to the South trade-related R&D (including developing countries only). The welfare results of our sensitivity analysis are reported in Tables A.16 and A.17 in the appendix. These results confirm the robustness of our findings as deviations from central values appear to be low.[32]

Table 8: Piecemeal sensitivity analysis: parameter values

	Parameter	lower	central	upper
esubd	Elasticity of substitution between imported and domestic goods (CRTS)	×0.5	×1	×1.5
esubm	Elasticity of substitution between imported goods from different regions (CRTS)	×0.5	×1	×1.5
sig	Inter-variety elasticity of substitution (IRTS)	2[a]	3.8	5.6
esubs	Elasticity of substitution between value-added and business services	0.625	1.25	1.875
esupply (*EU*)	Resource supply elasticity (IRTS) for the EU	5	10	15
esupply	Resource supply elasticity (IRTS PE)	0.5	2	3.5
a	Shape parameter for the Pareto distribution (Melitz)[b]	3.924	4.582	5.171

[a] Higher values for the lower bound of *sig* are used for Melitz and Krugman structure to avoid numerical instability.
[b] All assumed values for *a* are estimated by Balistreri *et al.* [2011].

7 Conclusions

To analyze the establishment of the DCFTA between Ukraine and the EU we develop an improved multi-regional general-equilibrium simulation model based on Olekseyuk & Balistreri [2014]. First, we apply a standard specification of manufacturing and services trade based on perfect competition and the Armington assumption of regionally differentiated goods. Second, we implement monopolistic competition with competitive selection of heterogeneous firms in several

[32] Only for Ukraine in scenario S1.M we observe a qualitative switch from negative to positive results with the lower value for *esubm* and *sig* as well as upper value for *esupply*, which happens for different reasons. For instance, lower substitutability between foreign goods from differen regions (*esubm*) leads to the lower increases in trade flows and number of available varieties decreases less, which allows for a small welfare increase. A rise of *esupply* causes an increase of the top nest elasticity of substitution between sector-specific capital and the rest of the inputs which leads to the slight welfare increase after tariff elimination.

IRTS sectors as proposed by Melitz [2003]. Third, we additionally consider Krugman [1980] style monopolistic competition in business services sectors allowing for the existence of multinational firms producing in Ukraine with FDI from other regions. These alternative structures allow us not only to evaluate trade growth in new varieties and changes of aggregate productivity due to the reallocation of resources across as well as within an industry (among more or less productive firms), but also to assess productivity growth of the manufacturing sectors due to increased access to business services. Therefore, we fill the gap in the literature by applying an innovative modeling approach incorporating both heterogeneous firms and explicit consideration of FDI in business services.

Simulating Ukraine's deep and comprehensive integration with the EU by a reduction of NTBs, barriers to efficient trade facilitation and to FDI in business services as well as tariff elimination, we find a large increase in real income and a substantial welfare impact for Ukraine (up to 11.73%). The EU benefits less with the highest welfare gain of 0.06% which can be explained by the low share of European trade with Ukraine. Trade liberalization leads to significant trade growth between the partners with the larger effects under the Melitz trade structure due to reallocation of resources to the most productive exporting firms. Consistent with Frey & Olekseyuk [2014] and Olekseyuk & Balistreri [2014], the results for factor earnings indicate a deeper specialization of Ukraine in labor and resource-intensive goods whereas an opposite specialization is observed for the EU. There is also limited trade diversion from ROW and CIS combined with a slight decrease in real GDP and welfare mainly for the CIS region, which is specialized in resource-intensive goods.

Comparing the welfare results for Ukraine across the different model specifications we observe the same deindustrialization impact as Olekseyuk & Balistreri [2014]. Even with the higher welfare effects in all scenarios of the extended model, the gains for Ukraine are still substantially higher under the Armington structure in comparison to monopolistic competition. Thus, Ukraine's deeper 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 (e.g., agriculture, food processing). Therefore, the set of available varieties decreases which leads to lower gains under the assumption of monopolistic competition. This finding is also consistent with the theoretic work of Arkolakis *et al.* [2012] and Balistreri *et al.* [2010].

Though, our results demonstrate that incorporation of FDI structure is important as it allows for the consideration of multinational firms producing in the destination country using its primary factors. Moreover, liberalization of barriers to FDI (S4.MK) is an important part of the DCFTA as it causes new entries of multinational firms in business services and, consequently, increases the supply and number of available varieties within the country. This induces productivity growth of manufacturing sectors due to additional varieties of business services and, therefore, mitigates the deindustrialization impact found by Olekseyuk & Balistreri [2014] as the gap between the welfare results under Armington formulation and monopolistic competition decreases.

We caution, however, that our results indicate a lower bound of potential effects for a couple of reasons. First, we simulate a unilateral reduction of barriers to FDI in business services. Including

a reduction of the EU barriers to FDI in business services would drive the results up as Ukrainian firms would enter the EU market.[33] Second, we simulate a reduction of discriminatory barriers only. An additional reduction of non-discriminatory barriers[34] to FDI, which apply against both domestic and foreign service suppliers, would lead to entry of new service providers in Ukraine and, therefore, increase the effects from the policy reform. Third, we do not account for potential export spillovers from FDI. Positive spillover effects from FDI firms on domestic firms' decision to export as well as on their export propensity would additionally increase the gains for Ukraine.[35] Thus, a more detailed investigation is necessary to obtain a more realistic overall impact of the DCFTA.

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[33] According to data for the first two quarters of 2014 provided by the State Statistics Service of Ukraine (available at `http://www.ukrstat.gov.ua/`), 93.5% of Ukrainian FDI outflows are directed to the EU member countries. A reduction of European barriers to FDI will, therefore, increase the Ukrainian outflows.

[34] This is expected as the DCFTA agreement provides for the right of establishment in services and integration of Ukraine into the internal market of the EU in telecommunications, financial services, maritime services and postal and courier services once Ukraine effectively implements the EU acquis in these sectors (see, e.g., Hoekman *et al.* [2014]).

[35] The export spillovers from FDI have been found by a number of previous studies, e. g., Greenaway *et al.* [2004] and Kneller & Pisu [2007] for the UK, Sun [2009, 2010] for China.

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8 Appendix

8.1 Mathematical structure of the model for business services

In terms of notation $k \in K \subset I$ indicate a business service sector producing under large-group monopolistic competition (Krugman formulation), $r \in R$ and $s \in R$[36] indicate a region. All equations of the partial equilibrium (PE) model are listed in Table A.9 together with associated variables.

Table A.9: Equations of the partial equilibrium model

Equation description	Associated variable		Equation number
Demand by sector	P_{kr}:	Composite commodity price	(1)
Composite price index	Q_{ks}:	Aggregate quantity	(2)
Firm-level demand	p_{krs} and p^M_{krs}:	Firm-level price	(3)
Firm-level price	q_{krs} and q^M_{krs}:	Firm output	(4) and (5)
Free entry (zero profit)	N_{kr} and N^M_{kr}:	Entered firms	(6) and (7)
Composite-input market	c_{krs}:	Unit cost index	(8)

Producers face the same regional demand (Q_{kr}) for the sectoral composite service (including imported and domestic varieties) which is determined in the general equilibrium (GE). The aggregate demand equation for business services is given by:

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

where $\eta \geq 0$[37] is the price elasticity of demand, P_{kr} is a composite price of service 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 at the last GE solution point.

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 (i.e., cross-border and domestic firms). For multinational firms this firm-level price is defined by p^M_{krs}, where the firm produces in s due to FDI from r. Taking the two different types of service providers into account, the Dixit-Stiglitz price index for a composite business service k in region s is given by:

$$P_{ks} = \left[\sum_r \lambda_{krs} N_{kr} p_{krs}^{1-\sigma_k} + \sum_r \lambda^M_{krs} N^M_{krs} (p^M_{krs})^{1-\sigma_k} \right]^{\frac{1}{1-\sigma_k}}, \tag{2}$$

where $\sigma_k > 1$ is the elasticity of substitution, λ_{krs} indicates the bilateral preference weights and N_{kr} is the number of active domestic and cross-border firms in region r. λ^M_{krs} and N^M_{krs} denote the same variables as λ_{krs} and N_{kr}, but for multinational firms producing in s with the FDI from r. The corresponding bilateral firm-level demand for domestic and cross-border firms q_{krs} (e.g., services supplied to region s by a firm from r) is defined by:

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

[36] Index ss is also used to indicate a destination region, but other than s which is already used in the equation.
[37] The price elasticity of demand is assumed to be equal 0.75.

This equation applies also to the firm-level demand of the FDI firms q^M_{krs} with the bilateral preference weights λ^M_{krs} and $r \neq s$.

Assuming large-group monopolistic competition we allow firms to have some 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. Firms maximize their profits by setting a price with an optimal markup over marginal cost:

- For domestic and cross-border firms:
$$p_{krs} = \frac{c_{krr}\tau_{krs}(1+t_{krs})}{1-\frac{1}{\sigma_k}}, \tag{4}$$

- For FDI firms:
$$p^M_{krs}\Big|_{r\neq s} = \frac{c_{krs}\tau_{kss}(1+t_{kss})}{1-\frac{1}{\sigma_k}}, \tag{5}$$

where t_{krs} (or t_{kss}) indicates a composite tax rate (includes tariffs and subsidies) and c_{krs} (or c_{krr}) is a composite input unit cost, so that $c_{krr}\tau_{krs}$ (or $c_{krs}\tau_{kss}$) constitute the marginal cost of delivering product k from region r to s (or within s) under the iceberg cost assumption.

As the firms incur a fixed cost f[38] in addition to marginal cost, zero profit condition indicates that the number of firms (a complementary variable) will adjust such that nominal fixed cost payments equal profits. Again, there are two zero profit conditions in the PE model: one for service providers producing domestically for home and foreign markets and one for multinational firms producing in the host county. For domestic and cross-border firms, the costs in the home country r and profits from all destination markets s are relevant, therefore, the equation is given by:

$$c_{krr}f_{kr} = \sum_s \frac{p_{krs}q_{krs}}{\sigma_k(1+t_{krs})}. \tag{6}$$

For FDI firms, both the cost payments and profits in the host country s are relevant. Thus, we take the costs of operation on the r to s link ($c_{krs}f_{krs}, r \neq s$) into account and zero profit condition is given by:

$$c_{krs}f_{krs} = \frac{p_{krs}q_{krs}}{\sigma_k(1+t_{krs})}. \tag{7}$$

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

$$(\bar{Y}_{krr} + \bar{Y}_{krs}\Big|_{r\neq s})\left(\frac{c_{krs}}{\bar{c}_{krs}}\right)^{\mu} = N_{kr}(f_{kr} + \sum_{ss}\tau_{kr,ss}q_{kr,ss})\Big|_{r=s} + N^M_{krs}(f_{krs} + \tau_{kss}q^M_{krs})\Big|_{r\neq s}. \tag{8}$$

The left-hand side represents the total input supply Y_{krs} considering both types of firms. The supply elasticity $\mu \geq 0$[39] is determined in the GE model and recentered at the last GE solution for each iteration. The right-hand side constitutes the total demand for composite inputs where

[38] Fixed cost is measured in composite input units as well as the iceberg trade cost τ_{krs}.
[39] This supply elasticity is taken into account by calibrating the top nest elasticity eta_sub_{ir}.

τ_{krs} is considered as a real cost of delivering q_{krs} units to region s.

This PE model as well as the PE model for Melitz goods, which incorporate the industrial organization in selected sectors, are connected to the constant-returns GE model using the decomposition algorithm[40] described by Balistreri & Rutherford [2013]. Therefore, we solve the industrial organization models in isolation from aggregate income changes. This 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.

Table A.10: Mapping of the GTAP regions

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

[40]This technique is also used by Balistreri *et al.* [2011], Balistreri *et al.* [2014] and Olekseyuk & Balistreri [2014].

Table A.11: 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
OSG	Public services	OSG	Public administration, defense, education, health
ROS	Recreational and other services	ROS	Recreational and other services
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
TRD	Trade	TRD	Trade
Business services with IRTS and FDI			
OBS	Business services nec	OBS	Business services nec
CMN	Communication	CMN	Communication
TRS	Transport	OTP	Transport nec
		WTP	Water transport
		ATP	Air transport
FNI	Financial services, insurance	OFI	Financial services nec
		ISR	Insurance

Table A.12: Applied distortions for Ukraine, in %

Sector		Import tariffs[a]	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
		AVEs of barriers to FDI in business services[b]							
FNI	Financial services, insurance	16.00							
CMN	Communication	1.00							
TRS	Transport	22.00							
OBS	Business services nec	22.00							

[a]Tariff rates on imports from the EU and ROW.
[b]Simple averages of initial AVEs provided by Jafari & Tarr [2014] are converted to the percentage of domestic price.
Source: Authors' calculations based on the Law of Ukraine "About the Customs Tariff of Ukraine," Kee *et al.* [2009], Minor [2013], World Bank's Doing Business dataset for 2012 and Jafari & Tarr [2014].

Table A.13: Applied distortions for the EU, in %

Sector		Import tariffs[a]	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

[a]Tariff rates on imports from Ukraine.
Source: Authors' calculations based on GTAP, Kee *et al.* [2009], Minor [2013] and World Bank's Doing Business dataset for 2012.

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

		S1.A	S1.M	S1.MK	S2.A	S2.M	S2.MK	S3.A	S3.M	S3.MK	S4.A	S4.M	S4.MK
							Output						
Services	CMN	-0.35	-0.18	-0.15	0.57	1.07	1.04	0.85	1.61	1.50	0.89	1.68	1.78
	FNI	-0.73	-0.47	-0.32	-1.12	-0.14	0.07	-2.18	-0.80	-0.41	-2.55	-1.19	-0.83
	OBS	-0.75	-0.09	-0.14	-1.94	0.47	0.42	-3.87	-0.40	-0.56	-3.75	-0.28	-1.14
	TRS	-0.78	-0.06	-0.20	-2.11	0.54	0.39	-4.16	-0.37	-0.81	-4.05	-0.22	-0.61
IRTS	CNM	-2.41	-15.87	-15.47	-9.44	-61.57	-61.13	-13.94	-96.33	-95.54	-14.11	-97.08	-97.93
	MEQ	-1.47	-0.81	-0.83	-5.02	-1.19	-1.22	-7.41	-0.77	-0.79	-7.43	-0.72	-0.66
	OMF	-2.94	-8.58	-8.59	-9.90	-31.59	-31.61	-14.27	-55.02	-54.68	-14.33	-55.62	-56.94
	TEX	6.09	9.92	9.91	6.17	13.04	13.03	7.17	16.15	16.15	7.14	16.15	16.16
	TRD	0.12	0.23	0.19	1.75	1.96	1.91	2.87	2.92	2.82	2.94	3.02	3.07
	WPP	-1.15	-0.31	-0.31	-9.29	-9.90	-9.72	-10.96	-0.07	-0.03	-11.08	-0.10	-0.13
CRTS	AGR	14.39	16.07	16.06	24.17	31.58	31.59	35.88	49.02	49.15	35.62	48.81	48.40
	CNS	0.03	0.21	0.19	-0.77	-0.11	-0.13	-1.34	-0.54	-0.58	-1.29	-0.48	-0.39
	COL	-0.05	0.25	0.23	1.86	3.11	3.09	4.97	6.89	6.86	4.96	6.90	6.80
	ELE	0.01	-1.04	-1.05	1.30	-2.84	-2.85	2.32	-4.02	-4.05	2.39	-3.99	-4.03
	FPI	4.44	5.83	5.79	4.85	10.25	10.21	6.08	14.54	14.47	6.07	14.60	14.65
	FRS	-1.38	0.26	0.28	3.73	10.44	10.47	5.01	15.43	15.55	4.80	15.26	14.99
	FSH	0.99	0.96	0.89	3.98	3.78	3.70	6.61	6.58	6.39	6.76	6.75	6.77
	GDT	0.04	-1.00	-1.03	2.68	-1.49	-1.53	4.90	-1.40	-1.52	5.02	-1.31	-1.37
	HDC	-4.00	-1.68	-1.63	-12.87	-4.68	-4.64	-23.72	-13.12	-12.95	-23.93	-13.28	-13.39
	MET	-1.94	1.25	1.26	-1.69	11.16	11.16	-4.76	13.98	14.12	-5.03	13.82	13.54
	OIL	0.50	1.32	1.30	3.78	7.12	7.09	9.27	14.53	14.50	9.23	14.53	14.42
	OMN	-0.99	0.45	0.45	-1.75	3.89	3.89	-3.54	4.59	4.64	-3.65	4.53	4.45
	OSG	0.38	0.28	0.25	1.29	0.87	0.84	1.94	1.28	1.21	2.03	1.37	1.47
	ROS	-0.88	-0.21	-0.26	-1.21	1.14	1.09	-2.31	1.03	0.90	-2.19	1.20	1.47
	WTR	0.06	-0.35	-0.39	1.91	0.24	0.19	3.43	0.90	0.75	3.59	1.04	1.12
							Exports						
Services	CMN	-3.02	-0.05	-0.72	-11.89	-1.14	-1.42	-21.13	-6.89	-7.34	-21.06	-6.70	-7.22
	FNI	-2.66	0.32	-0.67	-10.40	0.31	-1.11	-18.71	-4.20	-6.78	-17.18	-2.19	-4.06
	OBS	-2.43	-0.05	-0.53	-8.47	0.23	-0.27	-15.59	-3.61	-5.10	-13.26	-0.62	4.20
	TRS	-1.68	-0.01	-0.33	-6.18	0.01	-0.35	-11.78	-3.13	-4.15	-11.43	-2.65	-3.26
IRTS	CNM	-0.28	-13.57	-13.13	-1.83	-57.49	-57.00	-3.43	-95.73	-94.81	-3.64	-96.60	-97.60
	MEQ	0.62	2.75	2.73	2.98	11.96	11.93	6.23	22.16	22.15	6.20	22.21	22.29
	OMF	-3.08	-10.32	-10.27	-5.34	-28.41	-28.39	-4.85	-49.50	-48.98	-5.09	-50.34	-52.10
	TEX	14.94	25.31	25.31	19.00	35.97	35.97	23.07	44.75	44.79	22.99	44.73	44.74
	TRD	-2.59	-0.95	-1.13	-9.88	-2.84	-3.08	-17.85	-10.91	-11.28	-17.69	-10.25	-9.14
	WPP	-0.20	1.43	1.44	2.02	7.24	7.49	15.71	47.68	47.76	15.52	47.60	47.50
CRTS	AGR	43.52	47.64	47.77	73.30	92.50	92.68	114.15	148.63	149.41	113.08	147.63	146.25
	CNS	-1.34	0.32	0.35	-2.70	3.60	3.63	-7.21	2.15	2.26	-7.40	2.02	1.90
	COL	-2.01	-0.12	-0.11	-7.45	-0.67	-0.66	-15.24	-5.96	-5.89	-15.38	-6.05	-6.14
	ELE	-5.56	-1.60	-1.56	-15.65	-1.53	-1.49	-27.48	-9.37	-9.16	-27.80	-9.62	-10.01
	FPI	14.33	17.15	17.17	16.95	28.13	28.16	19.33	36.42	36.56	19.11	36.32	36.38
	FRS	-2.48	0.12	0.17	6.02	16.91	16.97	7.51	23.65	23.90	7.11	23.32	22.80
	FSH	3.56	4.61	4.61	4.96	9.01	9.01	3.03	8.88	8.90	2.98	8.89	8.98
	GDT	-5.07	-1.32	-1.45	-14.22	-0.77	-0.94	-25.36	-7.91	-8.14	-25.23	-7.58	-7.28
	HDC	-7.36	-1.74	-1.67	-26.12	-7.89	-7.83	-46.49	-25.98	-25.71	-46.75	-26.17	-26.06
	MET	-1.65	1.79	1.81	0.62	14.60	14.60	-1.30	19.17	19.32	-1.60	18.99	18.67
	OIL	1.76	3.04	3.03	12.64	18.03	18.02	32.35	41.58	41.59	32.27	41.58	41.58
	OMN	-0.51	0.37	0.37	-1.51	1.79	1.78	-2.59	2.17	2.19	-2.64	2.16	2.17
	OSG	-3.13	-0.22	-0.18	-10.22	0.27	0.32	-18.44	-4.23	-4.03	-18.71	-4.44	-4.62
	ROS	-3.12	-0.54	-0.56	-9.97	-0.64	-0.65	-17.76	-5.18	-5.13	-17.76	-5.05	-4.29
	WTR	-5.47	-1.51	-1.49	-15.52	-1.42	-1.42	-27.25	-9.13	-9.00	-27.47	-9.26	-9.37
							Imports						
Services	CMN	2.81	0.10	0.98	14.53	3.31	3.60	27.84	10.43	10.83	27.30	9.87	10.35
	FNI	1.59	-0.63	0.57	8.85	0.18	1.94	16.74	3.44	6.96	11.19	-1.63	1.49
	OBS	1.82	0.27	0.85	7.22	1.09	1.70	13.40	4.10	6.07	1.84	-6.96	-21.69
	TRS	0.98	0.15	0.46	4.86	1.52	1.89	9.20	4.16	5.37	4.82	-0.08	1.30
IRTS	CNM	3.51	9.70	9.54	4.97	25.76	25.61	5.93	34.96	34.71	5.97	35.20	35.44
	MEQ	1.23	2.54	2.53	-0.28	4.31	4.29	-1.68	5.57	5.54	-1.66	5.60	5.63
	OMF	3.72	9.50	9.40	15.51	38.51	38.41	24.53	66.93	66.28	24.85	67.82	69.27
	TEX	7.25	10.57	10.51	10.03	14.76	14.69	12.77	18.50	18.32	12.92	18.67	18.74
	TRD	2.66	1.51	1.66	12.30	6.07	6.29	23.27	16.62	17.00	23.09	15.85	14.45
	WPP	1.00	2.04	2.02	2.62	11.13	11.04	4.77	17.95	17.90	4.85	18.05	18.27
CRTS	AGR	13.08	12.87	12.77	26.48	25.71	25.60	45.95	45.84	45.54	46.27	46.17	46.47
	CNS	0.39	0.19	0.16	-0.28	-1.05	-1.08	0.21	-1.23	-1.30	0.32	-1.12	-0.98
	COL	1.07	0.50	0.48	6.19	4.16	4.12	14.50	11.37	11.28	14.61	11.45	11.44
	ELE	8.71	5.93	5.90	21.32	9.85	9.83	29.64	12.03	11.89	29.96	12.21	12.37
	FPI	14.35	13.88	13.78	25.08	23.13	23.01	33.29	30.78	30.47	33.57	31.05	31.11
	FRS	2.02	1.59	1.55	7.28	5.47	5.44	13.80	12.21	12.08	13.98	12.39	12.64
	FSH	3.84	3.68	3.61	7.53	6.81	6.73	11.12	10.35	10.13	11.30	10.52	10.53
	GDT	2.14	-0.38	-0.35	10.47	0.39	0.43	18.86	3.42	3.40	18.90	3.36	3.17
	HDC	-0.27	-0.64	-0.63	1.20	-0.06	-0.06	3.58	1.59	1.61	3.54	1.55	1.36
	MET	1.58	2.35	2.33	6.97	10.78	10.76	9.60	15.91	15.91	9.57	15.92	15.94
	OIL	1.21	1.62	1.60	6.29	8.07	8.04	12.33	15.11	15.06	12.32	15.12	14.98
	OMN	-1.58	0.90	0.91	-2.25	7.70	7.70	-5.60	8.67	8.79	-5.82	8.54	8.31
	OSG	1.51	0.46	0.41	5.11	1.06	1.01	9.06	3.04	2.88	9.29	3.22	3.41
	ROS	0.55	0.12	0.06	3.82	2.01	1.95	6.79	4.24	4.05	6.94	4.38	4.28
	WTR	2.37	0.39	0.33	12.70	4.62	4.56	21.05	8.74	8.52	21.38	8.97	9.14

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

		S1.A	S1.M	S1.MK	S2.A	S2.M	S2.MK	S3.A	S3.M	S3.MK	S4.A	S4.M	S4.MK
							Output						
Services	CMN	0.01	0.01	0.01	0.02	0.02	0.02	0.04	0.04	0.05	0.03	0.04	0.04
	FNI	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.03	0.03	0.02	0.03	0.03
	OBS	0.01	0.01	0.01	0.02	0.03	0.03	0.03	0.05	0.05	0.03	0.05	0.04
	TRS	0.01	0.00	0.00	0.02	0.01	0.01	0.03	0.03	0.02	0.03	0.02	0.02
IRTS	CNM	0.02	0.07	0.06	0.04	0.23	0.23	0.05	0.38	0.37	0.05	0.38	0.38
	MEQ	0.01	0.00	0.00	0.01	-0.01	-0.01	0.01	-0.01	-0.01	0.01	-0.01	-0.01
	OMF	0.00	0.01	0.01	0.03	0.05	0.05	0.05	0.11	0.12	0.05	0.12	0.12
	TEX	0.02	0.01	0.01	0.04	0.03	0.03	0.05	0.05	0.05	0.06	0.05	0.05
	TRD	0.00	0.00	0.00	0.02	0.02	0.02	0.03	0.04	0.05	0.03	0.04	0.04
	WPP	0.01	0.01	0.01	0.02	0.03	0.03	0.01	-0.01	-0.01	0.01	-0.01	-0.01
CRTS	AGR	0.01	0.00	0.00	-0.08	-0.13	-0.13	-0.21	-0.30	-0.30	-0.20	-0.30	-0.29
	CNS	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.03
	COL	0.01	0.00	0.00	0.02	-0.02	-0.02	0.03	-0.03	-0.03	0.03	-0.03	-0.03
	ELE	0.03	0.02	0.02	0.04	0.04	0.04	0.07	0.06	0.06	0.07	0.06	0.06
	FPI	0.09	0.09	0.09	0.11	0.11	0.11	0.13	0.11	0.11	0.13	0.11	0.11
	FRS	0.01	0.00	0.00	-0.05	-0.07	-0.07	-0.09	-0.15	-0.15	-0.08	-0.15	-0.14
	FSH	0.03	0.03	0.03	0.05	0.04	0.04	0.06	0.05	0.06	0.06	0.06	0.06
	GDT	0.01	0.01	0.01	0.02	0.01	0.01	0.05	0.03	0.03	0.05	0.03	0.03
	HDC	-0.09	-0.12	-0.11	-0.16	-0.30	-0.30	-0.22	-0.44	-0.44	-0.22	-0.44	-0.44
	MET	0.02	0.00	0.00	-0.06	-0.17	-0.17	-0.09	-0.28	-0.28	-0.09	-0.28	-0.27
	OIL	0.00	0.00	-0.01	-0.10	-0.12	-0.12	-0.29	-0.32	-0.32	-0.29	-0.32	-0.32
	OMN	0.02	0.02	0.02	0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	OSG	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.04	0.05	0.05
	ROS	0.00	0.01	0.00	0.02	0.02	0.02	0.03	0.04	0.04	0.03	0.04	0.04
	WTR	0.02	0.02	0.01	0.02	0.03	0.03	0.03	0.05	0.05	0.03	0.05	0.05
							Exports						
Services	CMN	-0.06	-0.08	-0.09	-0.06	-0.18	-0.19	-0.02	-0.21	-0.22	-0.02	-0.21	-0.23
	FNI	-0.06	-0.08	-0.10	-0.07	-0.19	-0.21	-0.03	-0.23	-0.25	-0.07	-0.26	-0.28
	OBS	-0.06	-0.07	-0.08	-0.06	-0.17	-0.19	-0.02	-0.20	-0.22	-0.12	-0.29	-0.39
	TRS	-0.03	-0.04	-0.04	0.02	-0.05	-0.03	0.13	0.03	0.09	0.08	-0.03	0.06
IRTS	CNM	0.10	0.27	0.27	0.26	0.90	0.89	0.39	1.34	1.33	0.39	1.35	1.35
	MEQ	0.03	0.03	0.03	0.07	0.07	0.07	0.13	0.16	0.16	0.13	0.15	0.15
	OMF	0.02	0.05	0.05	0.20	0.41	0.41	0.36	0.79	0.79	0.36	0.80	0.81
	TEX	0.41	0.64	0.65	0.68	0.98	0.98	0.88	1.22	1.22	0.89	1.23	1.23
	TRD	-0.02	-0.07	-0.07	0.02	-0.17	-0.17	0.10	-0.15	-0.14	0.10	-0.16	-0.17
	WPP	0.00	-0.03	-0.03	0.13	0.24	0.24	0.32	0.47	0.47	0.32	0.47	0.48
CRTS	AGR	0.60	0.56	0.56	1.36	1.16	1.17	2.72	2.42	2.42	2.73	2.43	2.45
	CNS	-0.03	-0.04	-0.04	-0.06	-0.13	-0.13	-0.03	-0.14	-0.14	-0.03	-0.14	-0.14
	COL	-0.04	-0.05	-0.05	-0.04	-0.10	-0.10	0.01	-0.08	-0.08	0.01	-0.08	-0.08
	ELE	0.24	0.13	0.13	0.67	0.18	0.19	1.00	0.29	0.28	1.01	0.29	0.30
	FPI	0.68	0.65	0.65	1.19	1.01	1.01	1.57	1.29	1.29	1.58	1.30	1.30
	FRS	-0.03	-0.04	-0.04	0.04	-0.08	-0.07	0.17	0.00	0.00	0.17	0.00	0.00
	FSH	0.03	0.03	0.03	0.06	0.03	0.03	0.11	0.07	0.07	0.11	0.07	0.07
	GDT	-0.07	-0.12	-0.11	-0.04	-0.28	-0.28	0.03	-0.32	-0.32	0.03	-0.33	-0.33
	HDC	-0.15	-0.15	-0.14	-0.19	-0.27	-0.26	-0.19	-0.33	-0.33	-0.19	-0.33	-0.33
	MET	0.12	0.05	0.06	0.64	0.36	0.36	1.08	0.71	0.71	1.09	0.71	0.72
	OIL	0.05	0.05	0.05	0.39	0.37	0.37	0.80	0.78	0.78	0.80	0.78	0.77
	OMN	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.06	0.07	0.07
	OSG	-0.03	-0.05	-0.05	-0.01	-0.13	-0.13	0.05	-0.14	-0.14	0.05	-0.14	-0.14
	ROS	-0.04	-0.05	-0.05	-0.03	-0.11	-0.11	0.01	-0.12	-0.12	0.01	-0.12	-0.13
	WTR	-0.04	-0.09	-0.08	0.21	-0.03	-0.03	0.36	-0.01	-0.02	0.37	-0.01	-0.01
							Imports						
Services	CMN	0.04	0.06	0.07	0.01	0.14	0.15	-0.03	0.15	0.17	-0.03	0.16	0.17
	FNI	0.06	0.06	0.08	0.09	0.14	0.18	0.11	0.20	0.24	0.11	0.20	0.25
	OBS	0.05	0.06	0.07	0.07	0.15	0.16	0.08	0.19	0.21	0.09	0.21	0.25
	TRS	0.02	0.03	0.03	-0.02	0.04	0.02	-0.10	-0.01	-0.08	-0.10	0.00	-0.07
IRTS	CNM	0.08	-0.02	-0.02	0.16	-0.35	-0.35	0.24	-0.75	-0.74	0.24	-0.76	-0.77
	MEQ	0.03	0.07	0.06	0.07	0.16	0.16	0.13	0.29	0.30	0.13	0.30	0.30
	OMF	0.03	0.04	0.04	0.05	0.06	0.05	0.08	0.02	0.03	0.08	0.02	0.02
	TEX	0.21	0.33	0.33	0.30	0.50	0.50	0.38	0.65	0.65	0.38	0.65	0.65
	TRD	0.03	0.07	0.07	0.03	0.18	0.18	0.01	0.21	0.21	0.01	0.21	0.22
	WPP	0.07	0.13	0.13	0.18	0.37	0.37	0.63	1.45	1.45	0.62	1.45	1.45
CRTS	AGR	0.80	0.85	0.85	1.65	1.93	1.93	2.80	3.35	3.37	2.78	3.33	3.31
	CNS	0.05	0.05	0.05	0.07	0.10	0.10	0.06	0.13	0.13	0.06	0.13	0.13
	COL	0.02	0.02	0.02	0.01	0.01	0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	ELE	-0.39	-0.07	-0.07	-1.13	0.08	0.08	-2.11	-0.52	-0.50	-2.14	-0.55	-0.58
	FPI	-0.14	-0.11	-0.11	0.11	0.29	0.29	0.43	0.74	0.75	0.43	0.74	0.75
	FRS	0.04	0.08	0.08	0.57	0.83	0.83	0.83	1.22	1.23	0.82	1.21	1.20
	FSH	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.03	0.03
	GDT	0.03	0.08	0.07	0.04	0.22	0.22	-0.02	0.25	0.24	-0.02	0.25	0.25
	HDC	0.02	0.01	0.01	-0.04	-0.07	-0.07	-0.17	-0.20	-0.20	-0.16	-0.20	-0.20
	MET	0.00	0.09	0.09	0.83	1.33	1.32	1.38	2.22	2.22	1.36	2.21	2.20
	OIL	0.08	0.10	0.10	0.63	0.73	0.73	1.62	1.80	1.80	1.62	1.80	1.80
	OMN	0.02	0.02	0.02	0.01	0.00	0.00	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01
	OSG	0.04	0.05	0.05	0.04	0.11	0.11	0.03	0.14	0.15	0.03	0.14	0.14
	ROS	0.04	0.05	0.05	0.06	0.13	0.12	0.07	0.17	0.17	0.07	0.17	0.18
	WTR	0.04	0.08	0.07	0.02	0.19	0.18	-0.05	0.19	0.20	-0.05	0.19	0.20

Table A.16: Piecemeal sensitivity analysis: welfare results for Ukraine, change in %

Parameter	lower	central	upper	lower	central	upper	lower	central	upper
		S1.A			S1.M			S1.MK	
esubd	0.76	0.66	0.57	-0.02	-0.02	-0.00	-0.15	-0.13	-0.11
esubm	0.31	0.66	0.86	0.02	-0.02	-0.10	-0.03	-0.13	-0.30
sig	0.79	0.66	0.58	0.06	-0.02	-0.07	-0.10	-0.13	-0.15
esubs	0.66	0.66	0.66	-0.02	-0.02	-0.02	-0.13	-0.13	-0.13
esupply (*EU*)	0.67	0.66	0.65	-0.01	-0.02	-0.02	-0.12	-0.13	-0.14
esupply	0.70	0.66	0.63	-0.03	-0.02	0.01	-0.10	-0.13	-0.13
a	0.66	0.66	0.66	-0.02	-0.02	-0.02	-0.13	-0.13	-0.13
		S2.A			S2.M			S2.MK	
esubd	6.59	6.30	6.06	3.48	3.53	3.58	3.34	3.40	3.46
esubm	5.19	6.30	7.20	3.48	3.53	3.16	3.48	3.40	2.83
sig	6.60	6.30	6.23	3.43	3.53	3.60	3.31	3.40	3.51
esubs	6.30	6.30	6.30	3.53	3.53	3.53	3.40	3.40	3.40
esupply (*EU*)	6.32	6.30	6.29	3.54	3.53	3.52	3.41	3.40	3.40
esupply	6.37	6.30	6.27	3.49	3.53	3.57	3.42	3.40	3.41
a	6.30	6.30	6.30	3.53	3.53	3.53	3.40	3.40	3.40
		S3.A			S3.M			S3.MK	
esubd	11.85	11.42	11.07	7.84	7.76	7.72	7.40	7.41	7.43
esubm	9.42	11.42	13.40	7.53	7.76	8.91	7.40	7.41	7.84
sig	11.55	11.42	11.68	7.44	7.76	7.95	7.14	7.41	7.73
esubs	11.42	11.42	11.42	7.67	7.76	7.67	7.34	7.41	7.34
esupply (*EU*)	11.45	11.42	11.41	7.69	7.76	7.67	7.35	7.41	7.33
esupply	11.54	11.42	11.37	7.59	7.76	7.80	7.40	7.41	7.37
a	11.42	11.42	11.42	7.67	7.76	7.67	7.34	7.41	7.34
		S4.A			S4.M			S4.MK	
esubd	12.17	11.73	11.38	8.17	8.07	8.00	8.20	8.14	8.08
esubm	9.77	11.73	13.69	7.80	8.07	9.23	8.04	8.14	8.57
sig	11.87	11.73	12.00	7.77	8.07	8.21	8.08	8.14	8.37
esubs	11.73	11.73	11.73	7.99	8.07	7.99	8.08	8.14	8.08
esupply (*EU*)	11.67	11.73	11.77	7.90	8.07	8.03	7.67	8.14	8.40
esupply	11.87	11.73	11.68	7.89	8.07	8.12	8.31	8.14	7.46
a	11.73	11.73	11.73	7.99	8.07	7.99	8.08	8.14	8.08

Table A.17: Piecemeal sensitivity analysis: welfare results for the EU, change in %

Parameter	lower	central	upper	lower	central	upper	lower	central	upper
		S1.A			S1.M			S1.MK	
esubd	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
esubm	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
sig	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
esubs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
esupply (*EU*)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
esupply	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S2.A			S2.M			S2.MK	
esubd	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.03	0.03
esubm	0.01	0.01	0.01	0.02	0.03	0.04	0.02	0.03	0.04
sig	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.03	0.03
esubs	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.03	0.03
esupply (*EU*)	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.03	0.03
esupply	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.03	0.03
a	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.03	0.03
		S3.A			S3.M			S3.MK	
esubd	0.03	0.03	0.03	0.05	0.05	0.05	0.05	0.06	0.06
esubm	0.03	0.03	0.03	0.04	0.05	0.06	0.04	0.06	0.07
sig	0.02	0.03	0.03	0.06	0.05	0.05	0.06	0.06	0.05
esubs	0.03	0.03	0.03	0.05	0.05	0.05	0.06	0.06	0.06
esupply (*EU*)	0.03	0.03	0.03	0.05	0.05	0.05	0.05	0.06	0.06
esupply	0.03	0.03	0.03	0.06	0.05	0.05	0.06	0.06	0.05
a	0.03	0.03	0.03	0.05	0.05	0.05	0.06	0.06	0.06
		S4.A			S4.M			S4.MK	
esubd	0.03	0.03	0.03	0.05	0.05	0.06	0.05	0.06	0.06
esubm	0.03	0.03	0.03	0.04	0.05	0.06	0.04	0.06	0.07
sig	0.02	0.03	0.03	0.06	0.05	0.05	0.06	0.06	0.05
esubs	0.03	0.03	0.03	0.05	0.05	0.05	0.06	0.06	0.06
esupply (*EU*)	0.03	0.03	0.03	0.05	0.05	0.05	0.05	0.06	0.06
esupply	0.03	0.03	0.03	0.06	0.05	0.05	0.06	0.06	0.06
a	0.03	0.03	0.03	0.05	0.05	0.05	0.06	0.06	0.06