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Modeling the Effects of Free Trade Agreements between the EU and Canada, USA and Moldova/Georgia/Armenia on the Austrian Economy: Model Simulations for Trade Policy Analysis

Joseph Francois and Olga Pindyuk

Abstract

This study examines the economic impact on Austria of three possible new EU free trade agreements: (1) an EU-US agreement; (2) an EU-Canada agreement; and (3) an EUArmenia/Georgia/Moldova agreement. This is done with a computational model of the global economy. The trade agreements are modeled as a mix of preferential tariff reductions and reductions in non-tariff measures that affect both goods and services. The primary impact follows from NTM reduction rather than tariff reductions. Of the three agreements, a potential agreement with the US is by far the most important. This follows from the size of the US economy. The US accounts for roughly one-quarter of extra-EU Austrian exports. Overall, the combined impact of the FTAs studied is positive. Most of the impact follows from investment response. Productivity gains from NTM reduction mean a combination of increased national income, higher wages, and employment, and increased capital stocks for the Austrian economy.

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Joseph Francois and
Olga Pindyuk

FIW – Research Centre International Economics

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Rahlgasse 3
A-1060 Vienna

Telefon: (+43-1) 533 66 10
Fax: (+43-1) 533 66 10-50

E-Mail: wiiw@wiiw.ac.at
Website: www.wiiw.ac.at

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Abstract

This study examines the economic impact on Austria of three possible new EU free trade agreements: (1) an EU-US agreement; (2) an EU-Canada agreement; and (3) an EU-Armenia/Georgia/Moldova agreement. This is done with a computational model of the global economy. The trade agreements are modeled as a mix of preferential tariff reductions and reductions in non-tariff measures that affect both goods and services. The primary impact follows from NTM reduction rather than tariff reductions. Of the three agreements, a potential agreement with the US is by far the most important. This follows from the size of the US economy. The US accounts for roughly one-quarter of extra-EU Austrian exports. Overall, the combined impact of the FTAs studied is positive. Most of the impact follows from investment response. Productivity gains from NTM reduction mean a combination of increased national income, higher wages, and employment, and increased capital stocks for the Austrian economy.

1. Introduction

The European Union is pursuing bi-lateral trade and investment agreements with Canada, and jointly with Armenia, Georgia and Moldova. An agreement with Canada means the EU will have agreements with two of the three members of the North American Free Trade Agreement (NAFTA). There has also been informal discussion of a possible agreement with the United States, the third and primary pillar of NAFTA. However no formal negotiations are underway. The potential impacts of a EU-US agreement are substantial. This is because the EU and US are, respectively, each other's most important trading partners.

This study examines the economic impact on Austria of three new EU free trade agreements: (1) an EU-US agreement; (2) an EU-Canada agreement; and (3) an EU-Armenia/Georgia/Moldova agreement. The study explores the possible effects of reducing not only tariffs, but also non-tariff barriers, known as non-tariff measures or NTMs. With low tariffs between OECD countries, NTMs such as regulatory barriers have emerged as a major barrier to gains from trade and investment. The emphasis placed here on NTMs also means we identify employment and investment effects following from increased productivity when regulatory and administrative burdens of NTMs are reduced.

The report is organized as follows. In Section 2 we provide a brief discussion of economic background. This includes directions of trade, and the value added composition of trade. This is followed, in Section 3, by a discussion of the policy landscape. Section 4 provides a brief overview of the modeling framework itself. The modeling is done with a computational model of the global economy that includes Austria, the EU, the United States, Canada, Armenia, Georgia, and Moldova. The trade agreements are modeled as a mix of tariff reductions and reductions in non-tariff measures (NTMs). Section 5 provides results of the modeling exercise, while we conclude in Section 6.

2. Economic context

The majority of Austria's exports are destined for the EU Single Market. From Table 1 below, 68.7 percent (or roughly EUR 91 billion)[1] of Austrian exports of goods and services on a gross value basis are destined for other EU Member States. However, another 7.2 percent (EUR 9.6 billion) are destined for the United States. When we focus on extra-EU exports, the United States accounts for 23 percent of Austrian exports. Exports to Canada are much smaller – EUR 850 mln in 2007 together, Canada and the United Stated account for 25 percent of extra-EU exports, and 7.8 percent of total exports. Armenia, Georgia and Moldova together account for only about 0.1 % of Austrian exports (roughly EUR 180 mln)

Table 1

Export Percent Shares, 2007

	EU	USA	Canada	Georgia, Moldova Armenia
gross exports				
Austria	68.720	7.197	0.641	0.098
EU26	63.340	8.050	0.885	0.077
extra-EU gross exports				
Austria		23.009	2.048	0.196
EU26		21.959	2.413	0.197
exports on a value added basis				
Austria	68.473	6.566	0.613	0.062
E26	61.676	8.435	0.936	0.587
share of GDP exported (value added)				
Austria	22.238	2.133	0.199	0.020
E26	14.815	1.953	0.217	0.014

Source: own calculations from model database

To put the value in perspective, France accounts for 3.4 percent of Austrian goods and services exports, Britain accounts for 3.5 percent, Italy accounts for 7.5 percent, and Germany accounts for 29.9 percent. This means that the NAFTA economies, collectively, are more important for Austria than France and Britain combined as a trading partner, though substantially less than Germany. For Germany, the US is comparable to France, Italy, or Britain (all between 7 and 8.5 percent of German exports), and twice as important as China. In contrast, Georgia and Moldova, while of political importance, are substantially smaller as trading partners, and an FTA with them is not likely to have substantive effects on the Austrian economy. Table 1 also reports trade shares on a value added basis. These estimates are based on the Austrian (and European) value added content of exports by sector, along with the composition of bilateral exports. On this basis, the US is somewhat less important for Austria, but more important for the European Union as a whole. For Austria, this means that exports to the United States tend to be more finished, incorporating imported inputs,

[1] Trade data in this paper on are used from the model database.

whereas Austrian exports to other (primarily European) markets are more likely to be intermediate inputs with higher Austrian content.[2]

The relative export shares mean that, in the exercise that follows, the agreement with the US will dominate, in terms of economic impact on Austria. This follows through for macroeconomic impact, industrial output effects, and changes in employment.

Table 2 provides breakdown of Austrian exports by sectors. The country turns out to have quite different export structures with various trading partners. Chemicals and metals account for higher shares in Austrian exports to the rest of the EU, than in its exports to the US or Canada. In the country's exports to the US it is motor vehicles that account for the biggest share (34.4%) – in contrast to exports to the EU, where motor vehicles account for only 12.8%. Insurance services are another sector, exports share of which is much higher in trade with the US, than in trade with the EU (4.2% versus 0.4%).

Table 2

Sector structure of Austrian exports by partner in 2007, %

	EU	USA	Canada	Georgia	Moldova	Armenia
Agr forestry fisheries	0.8	0.0	0.0	0.3	0.1	0.5
Other primary sectors	0.2	0.1	0.3	0.0	0.0	0.0
Processed foods	5.0	4.9	3.2	16.6	4.9	1.0
Textiles and clothing	3.3	1.1	1.3	0.5	1.1	0.4
Wood products	4.5	0.7	4.9	1.4	1.8	0.3
Paper pulp publishing	3.5	1.2	2.1	3.9	9.0	0.9
Chemicals	10.1	7.9	5.6	19.2	10.1	3.1
Metals and metal products	12.4	6.2	10.5	5.5	3.0	83.7
Electrical machinery	3.3	1.7	6.3	0.9	5.0	0.1
Motor vehicles	12.8	34.4	13.8	1.8	8.9	0.4
Other transport equipment	1.6	2.4	6.5	7.6	1.9	0.0
Other machinery	16.9	14.7	24.4	24.9	28.0	2.4
Other goods	3.5	3.6	4.0	2.5	11.1	0.5
Transport	6.1	6.7	5.9	6.9	6.2	3.2
Finance	0.6	0.5	0.8	0.2	0.2	0.1
Insurance	0.4	4.2	0.8	1.8	0.3	0.4
Business services	7.4	3.3	5.5	1.9	3.1	1.0
Communications	1.1	1.3	0.7	0.6	1.5	0.4
Construction	0.5	0.1	0.1	0.3	0.3	0.1
Personal services	1.2	0.5	1.2	0.8	0.9	0.5
Other services	4.7	4.2	2.0	2.4	2.6	1.2
Total	100.00	100.00	100.00	100.00	100.00	100.00

Source: model database.

[2] While beyond the scope of this study, there will also be Austrian indirect exports. For example, to the extent Austria supplies value added that is included in German motor vehicle exports to the United States, we are undercounting total (direct and cross-border indirect) exports. However, these effects are then captured in the computational model used later in this report.

Exports to Canada, as well as exports to Georgia and Moldova, are dominated by other machinery (again the export shares are much higher than in trade with the EU). The second biggest exporting sector in trade with Canada is motor vehicles. Chemicals and processed foods account for quite significant shares of Austrian exports to Georgia. Exports to Armenia are concentrated mainly in metals and metal products (83.7% of total exports to this country).

In Table 3 we present the sectorial breakdown of Austrian imports by partners. Imports structures resemble closely the exports ones, suggesting likely presence of intra-industry trade in many sectors (in particular motor vehicles, which again account for the highest shares in imports from Canada and the US). Other machinery is most important in imports from Canada, Georgia, and Moldova.

Table 3

Sector structure of Austrian imports by partner, %

	EU	USA	Canada	Georgia	Moldova	Armenia
Agr forestry fisheries	0.9	0.0	0.0	0.3	0.1	0.6
Other primary sectors	0.3	0.2	0.3	0.0	0.0	0.0
Processed foods	5.1	5.1	3.8	18.4	5.4	1.2
Textiles and clothing	3.4	1.2	1.4	0.5	1.1	0.4
Wood products	4.6	0.8	5.2	1.5	1.9	0.3
Paper pulp publishing	3.6	1.3	2.2	4.0	9.8	1.0
Chemicals	10.1	8.0	5.6	18.6	9.7	3.1
Metals and metal products	12.5	6.4	10.8	5.6	3.0	83.1
Electrical machinery	3.3	1.7	6.2	0.9	4.7	0.1
Motor vehicles	12.8	34.3	13.8	1.8	8.9	0.4
Other transport equipment	1.6	2.4	6.2	7.3	1.8	0.0
Other machinery	16.9	14.8	24.2	24.5	27.3	2.5
Other goods	3.5	3.7	4.1	2.6	12.5	0.5
Transport	6.0	6.5	5.6	6.5	5.6	3.2
Finance	0.5	0.5	0.7	0.2	0.1	0.1
Insurance	0.4	4.1	0.8	1.8	0.3	0.4
Business services	7.3	3.2	5.2	1.8	2.8	1.0
Communications	1.1	1.2	0.7	0.6	1.4	0.4
Construction	0.5	0.1	0.1	0.2	0.3	0.1
Personal services	1.2	0.5	1.2	0.8	0.8	0.5
Other services	4.6	4.1	1.9	2.2	2.4	1.1
Total	100.00	100.00	100.00	100.00	100.00	100.00

Source: model database.

While direct exports are informative when exploring trade linkages, ultimately it is the linkages between trade and value added (labor, investment, land and natural resources) that establish a link between trade and the pattern of national income and labor market conditions. To highlight this issue, we estimate several measures of the sector intensity of Austrian exports. This includes the direct contribution of sectors to Austrian exports measured in terms of the value added content, as well as indirect shares. Indirect shares are measured in two ways. The first involves forward linkages, where we look at value added within

a sector that is embodied, through downstream or forward linkages, in final exports in other sectors. The second involves backward linkages, where we look at value added from upstream sectors that is embodied, through intermediate linkages, in final exports within a particular sector.

The forward linkages form of export value added tells us what sectors actually contribute value added to final exports, while the second tells us what sectors serve as a mechanism for exporting value added. An example of forward linkages is engineering services embodied in machinery exports. The engineering services are not exported directly, but are embodied in machinery exports. Backward linkages include, for example, the various sources of value added (engineering, metals, transport) included in machinery exports. In the first case we are looking at the sources of value added by sector that feed final exports. In the second case we are looking at how much value added from various sectors is included in final exports in a given sector. The formal definitions are presented in Box 1 below.

Box 1

The Value Added in Exports

We measure the value added contained in exports as follows. First, we calculate direct cost shares linked to demand for intermediate inputs:

$$\theta_{z,i} = \frac{e_{z,i}}{\sum_j e_{j,i}} \times 100$$

Direct value added in exports:

$$\alpha_z = v_z x_z$$

Total (direct and indirect) value added in exports based on forward linkages:

$$F_z = \alpha_z + \sum_{i \neq z} .01 \times \theta_{z,i} v_z x_i$$

Total (direct and indirect) value added in exports based on backward linkages:

$$B_z = \alpha_z + \sum_{i \neq z} .01 \times \theta_{i,z} v_i x_z$$

where: $e_{i,j}$ represents expenditure in sector j on inputs indexed by i, including both value added or primary inputs (capital, labor, land) and intermediate inputs; v_j represents expenditure on primary inputs as a share of total costs of production in sector j; and x_j represents the gross value of exports from sector j.

Tables 4 and 5 contain data on value added of Austrian exports by sector. Table 4 draws comparison between export value of sectors in gross value terms and value added terms. Gross value of exports overstates their share in GDP by as much as 142% if measured directly and by 51% if accounting for forward linkages of sectors in the economy. The main message that stands out is that sectors, which are dominant in terms of gross export values, are less so if we concentrate on value added instead. This is especially true for motor vehicles, which are integrated into global production networks – direct value added of the

sector's exports accounts for less than 25% of exports' gross value. Accounting for forward linkages of the sector adds only 1 p.p. to the share of value added in gross exports value. Other transport equipment exports are characterized by the second lowest share of value added in gross exports value. Services, on the contrary, tend to be exported to a large extent indirectly – shares of total value added in gross exports value (accounting for backward linkages) exceed 100% in all the services sectors apart from transports.

Table 4

Austria's trade linkages and value added, values in 2007

	A gross value: direct exports, USD mn	B value added: direct exports, % of gross value	C value added: direct exports & forward linkages, % of gross value	D value added: direct exports & backward linkages, % of gross value
Agr forestry fisheries	1207.84	50.7	222.8	75.1
Other primary sectors	370.44	46.3	180.0	73.8
Processed foods	8497.67	36.8	46.1	72.0
Textiles and clothing	5728.1	38.6	45.4	60.9
Wood products	7414.27	33.8	47.5	64.5
Paper pulp publishing	6260.21	38.1	64.4	70.7
Chemicals	18368.23	36.9	44.8	61.4
Metals and metal products	20223.67	38.6	53.1	59.8
Electrical machinery	6158.22	39.4	40.3	56.1
Motor vehicles	22918.84	24.2	25.3	37.2
Other transport equipment	3319.24	30.6	32.5	51.1
Other machinery	32823.35	39.0	46.1	59.9
Other goods	6913.66	31.4	76.4	54.4
Transport	11593.55	66.7	89.8	127.4
Finance	1089.43	34.9	204.6	82.8
Insurance	1871.67	53.0	83.3	87.2
Business services	13316.02	66.2	160.0	89.2
Communications	1923.8	45.2	119.1	76.5
Construction	1392.69	55.0	198.6	75.6
Personal services	1999.69	60.9	102.4	84.6
Other services	8606.1	57.0	141.1	81.8
Total	181996.7	41.3	66.4	66.4

Source: model database.

In Table 4, the gross value of exports is greater than the value added contained in those sectors. For example, for motor vehicles and parts, we have $22.9 billion in exports (column A), of which 37.2 percent (column D) is Austrian value added. We also see that much of this is from other sectors, as value added from motor vehicles (column B) is 24.2 percent of gross export values, whereas total Austrian value added was 37.2 percent (column D). The remaining 13 percent represents value added from upstream suppliers to the motor vehicles and parts sector. Focusing on business services, most exports are indirect, meaning they are embodied in exports by other downstream sectors. From the table, value added in column C as a percent of gross exports was 160 percent. This means value

added embodied on exports by other sectors far exceeded the gross value of direct exports of business services.

Table 5 compares exports structures in gross value and value added terms. Accounting for forward intermediate linkages in the economy shows that export shares of business services and other services are much higher than judging by gross value structure (by as much as 10.3 p.p. and 5.3 p.p. respectively). At the same time, motor vehicles, other machinery and chemicals appear to play a less important role in exports – their shares in total exports value added are 4.8%, 12.5%, and 6.8% respectively, as compared with 12.6%, 18.0%, and 10.1% respective shares in gross exports value.

The backward linkages data show us what sectors serve as a mechanism for actual exports of value added. Here the role of other machinery becomes more important again – the sector accounts for 16.3% of exported value added. Other sectors, which serve as value added exporting channels are transports, chemicals, business services, and chemicals. It is noteworthy, that business services stand out as a sector with significant both forward and backward intermediate linkages, suggesting their pivotal role in the structure of the economy.

Table 5

Austria's trade linkages and value added, structure in 2007, %

	gross value: direct exports	**value added: direct exports**	**value added: direct exports & forward linkages**	**value added: direct exports & backward linkages**
Agr forestry fisheries	0.66	0.81	2.23	0.75
Other primary sectors	0.20	0.23	0.55	0.23
Processed foods	4.67	4.15	3.24	5.06
Textiles and clothing	3.15	2.94	2.15	2.88
Wood products	4.07	3.33	2.91	3.95
Paper pulp publishing	3.44	3.17	3.33	3.66
Chemicals	10.09	9.02	6.81	9.32
Metals and metal products	11.11	10.39	8.88	10.00
Electrical machinery	3.38	3.22	2.05	2.86
Motor vehicles	12.59	7.37	4.80	7.06
Other transport equipment	1.82	1.35	0.89	1.40
Other machinery	18.04	17.00	12.51	16.27
Other goods	3.80	2.89	4.37	3.11
Transport	6.37	10.28	8.61	12.22
Finance	0.60	0.51	1.84	0.75
Insurance	1.03	1.32	1.29	1.35
Business services	7.32	11.71	17.62	9.82
Communications	1.06	1.16	1.89	1.22
Construction	0.77	1.02	2.29	0.87
Personal services	1.10	1.62	1.69	1.40
Other services	4.73	6.52	10.04	5.82
Total	100.00	100.00	100.00	100.00

Source: model database.

3. Policy Landscape and Scenarios

While there has been significant progress in lowering barriers to international trade linked to tariffs, the policy relevance of non-tariff measures (NTMs) has increased. The reason for the greater attention to NTMs is three-fold. First, as the level of tariffs has decreased, the relative importance of NTMs has increased. In addition, during this time, significant progress has been made in terms of quantifying the effects of NTMs, leading to a better understanding of the costs these barriers impose on the cost of doing business. And finally, there is some evidence of NTMs being used as substitution for the tariffs that have been reduced.

Amongst the literature on NTMs are a number of OECD studies, i.e. OECD (2000) on technical standards and conformity, OECD (2001) on sanitary, phytosanitary and technical barriers to trade, OECD (2005) on Customs fees and charges on imports, OECD (2006) on the review of different methods for assessing NTMs and the OECD (2009) on assessments in agro-food trade.[3] More recently, literature aimed more directly at providing estimates of the impact of barriers includes the ECORYS (2009) study on NTMs on EU-US Trade and Investment, the joint EU-Government of Canada (2010) study, and the Copenhagen Economics (2009) study on EU-Japan trade. The EU-US and EU-Japan studies both make use of a recent business survey originating in the Ecorys study. The Copenhagen Economics-led study supplemented these with direct questions on cost impacts, similar to some of the OECD studies on cost impacts of regulatory differences.

Table 6

Export barrier reductions if FTAs are implemented, Percent of value of traded goods/services

	Tariffs	NTMs goods	NTMs services
US-EU			
US barriers	1.714	5.936	2.641
EU barriers	3.397	6.232	2.081
Canada-US			
CA barriers	4.297	5.575	7.277
EU barriers	3.128	6.232	2.081
Moldova/Georgia/Armenia-EU			
Georgia barriers	6.631	16.549	9.765
Moldova barriers	2.989	16.549	9.765
Armenia barriers	4.175	16.549	9.765
EU barriers	0.957	6.232	2.081

Source: model database (ECORYS 2009, and EU and Canadian government (2009). And Dee et al (2011). GEO,MDV,ARM NTMs are from FSU estimates.

[3] The literature on NTMs is surveyed by Anderson and van Wincoop (2004) in the case of goods, and Francois and Hoekman (2010) in the case of services.

The EC NTM project led by ECORYS (2009) had the stated goal of trying to "shed light on the existence of nontariff measures (NTMs) and regulatory divergence at the sector level of EU-US trade." The basis for the estimation in the study comes from an extensive business survey incorporating firms originating in the EU, US and third countries, operating in the EU and/or US. (The survey is further described below). The results from the survey were incorporated in a set of econometric models to estimate current levels of NTBs impacting US-EU trade. The use of a gravity model allowed for calculation of ad valorem equivalents of NTBs. These were then used as basis for further analysis using a Computable General Equilibrium (CGE) model aiming to estimate potential effects of lowering current levels on NTBs. Dee et al (2011) extend the set of NTM estimates from the survey data, in a study of the labour market impact of NTMs in the G20.

Table 7

EU, US, and Canadian NTM reductions if FTAs are implemented

	USA	Canada	EU27
NTMs for goods, percent reduction	10.5		
Processed foods	2.8	7.0	8.4
Textiles and clothing	0.0	2.8	3.0
Wood products	0.0	0.0	5.4
Paper pulp publishing	3.3	0.0	3.4
Chemicals	7.5	3.7	3.7
Metals and metal products	6.5	7.5	5.8
Electrical machinery	12.3	7.0	5.4
Motor vehicles and parts	10.1	12.3	12.5
Other transport equipment	6.3	9.4	7.8
Other machinery	5.9	5.9	6.9
average goods	10.5	5.6	6.2
NTMs for services, percent reduction			
Transport	4.2	6.2	3.6
Finance	12.2	8.1	9.6
Insurance	13.1	5.0	15.0
Business services	10.1	7.5	6.2
Communications	8.8	6.6	7.2
Construction	11.0	8.6	3.1
Personal services	10.1	7.5	6.2
Other services	2.1	8.6	7.5
average services	9.0	7.3	7.3

Source: model database (ECORYS 2009, and EU and Canadian government (2009). And Dee et al (2011).

Reflecting the rise in the relative importance of NTMs over tariffs, the most recent set of bilateral and regional trade agreements has emphasized non-tariff measures. This includes not only EU centered agreements (such as ongoing EU-Canada negotiations) but the negotiations surrounding the Trans-Pacific Partnership as well. Table 6 above summarizes the main elements of the trade agreements modeled in this study. Tariff reductions in the

policy experiments are based on actual applied tariffs as reported by the WTO and UNCTAD. Non-tariff barrier estimates are based on recent studies of NTMs.[4] These are reported in Table 6 as reductions in barriers comparable to trade cost reductions (as a percent of the value of traded goods and services).

Further detail on the reductions in trade costs in the modeling exercise are provided in Table 7 above, for the US, EU, and Canada. These are based on a combination of elements following from the original ECORYS (2009) and joint EU-Canada (2009) study. The first is a rough estimate that of barriers in place roughly half are "actionable," meaning they can actually be addressed in negotiations. A second point is that roughly half of those barriers that are actionable relate to increased trade costs, and half to barriers. We model a reduction of 50% in actionable barriers to trade.[5]

As can be seen from Table 7, the biggest decline in NTMs is envisaged on the side of the US, both for services and goods. On average, NTMs for goods are expected to be cut relatively more than the ones for services in the case of the US. Canada and the EU, on the contrary, are likely to decrease barriers to services to a larger extent, than to goods, In terms of sectors the US are expected to introduce the biggest reductions to NTMs in finance and insurance services, and in electrical machinery and motor vehicles in manufacturing. Canada is likely to liberalize the most its construction and other services trade, and trade in motor vehicles and other transport equipment. NTMs for motor vehicles, processed food, and other transport equipment will be decreased the most in the EU's manufacturing as well; in services, it is insurance and finance which should face the highest NTMs reduction

[4] This includes ECORYS (2009) and Dee et al (2011).

[5] Based on Dee et al (2011), we use estimates for the FSU states, following from estimates for Russia, for the average barrier estimates in Table 6 for Georgia, Moldova, and Armenia.

4. Policy Modeling Framework

Our policy assessment uses a computable general equilibrium model (CGE) of global world trade. CGE models help answering what-if questions by simulating the price, income and substitution effects in equilibrium on markets under different assumptions. Here, the economic outcomes of the "baseline" scenario with no policy effects as compared to the scenario with a tariff and quota free trade for developing countries are evaluated. The “baseline” for the model is the equilibrium before the policy change, and the ‘scenario’ is the equilibrium after the policy change. The effect of the policy change can then be quantified as the difference between the two. The model runs on the GTAP database, version 8, and is benchmarked to 2007. The model itself is based on Francois, van Meijl and van Tongeren (2005) and Dee et al (2011). The sectoring and regional aggregations for the model are summarized in Table 8 below.

Table 8

Sectors and regions

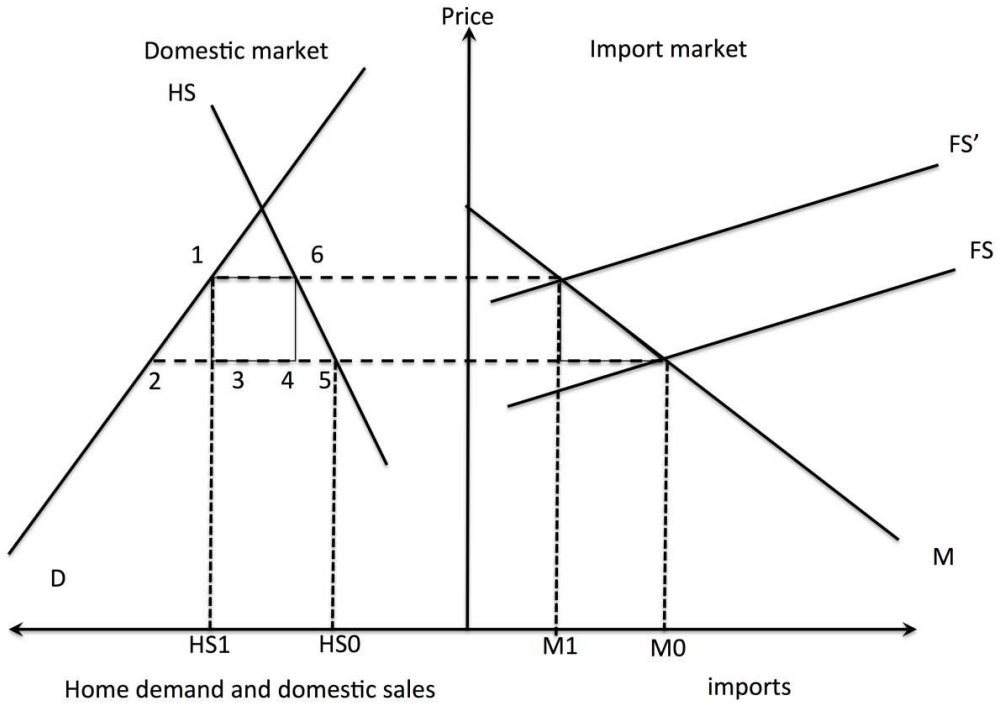
Regions	**Sectors**
Austria	Agr forestry fisheries
Other EU	Other primary sectors
United States	Processed foods
Canada	Textiles and clothing
Mexico	Wood products
Georgia	Paper pulp publishing
Moldova	Chemicals
Armenia	Metals and metal products
Rest of world	Electrical machinery
	Motor vehicles
	Other transport equipment
	Other machinery
	Other goods
	Transport
	Finance
	Insurance
	Business services
	Communications
	Construction
	Personal services
	Other services

The policy experiments involve tariff and NTM reductions as summarized in Table 6. The model includes investment effects (i.e. changes in investment levels following changes in economic policy). It also includes a long-run labor market closure linking employment levels to productivity and wages (Dee et al 2011).

As noted in the ECORYS (2009) study, focusing on the total existing level of barriers to trade can be misleading. This is because estimated cost impacts include barriers that cannot be reduced. Based on comparison of barriers affecting intra-EU trade, relative to extra-EU trade, a rough rule of thumb is that half of total estimated barriers can actually be reduced through negotiations. This means, for example, that the 5.9 percent barrier reductions in Table 6 by the US in the context of a EU-US agreement follow from removing half of barriers leading to total trade costs of 11.8 percent.

Figure 1

Discriminatory Market Access Barriers



Information on the extent to which policies affect prices and costs is important for accurate modeling of policy reforms, including whether policies create ”rents” as opposed to being resource-using (generating ”waste”), and the identity (ownership) of the entities and groups to whom any rents accrue. This is a well-known issue that can have a major bearing on the magnitude of the welfare impacts of policies and policy reforms. For example, if a policy generates rents for domestic groups and liberalization results in a share of these rents accruing to foreign entrants, the result may be lower national welfare. Figures 1 and 2 illustrate these concepts. We focus on distinctions between rent and cost generating barriers, and between discriminatory and non-discriminatory market access barriers. In Figure 1, the left panel illustrates domestic demand (the line D) and home supply (the line HS) for goods or services affected by NMTs. The gap between these at a given price defines the import demand function M that is mapped in the right panel. The foreign supply line (FS) closes the system. In the figure, we have imposed a trade barrier that raises the price for imported

goods or services, represented as a shift in the FS line to FS'. The result is higher prices. The welfare impact depends on the nature of the barrier. If it is a barrier that generates rents, then we have a net consumer (or downstream industry) loss equal to area (1-2-5-6), and revenues or rents equal to area (1-3-4-6). What is critical is the incidence of the rents. If they accrue to foreigners, then the full area (1-3-4-6) is lost from the perspective of the importer, and the NTMs generate a welfare loss equal to (1-2-5-6). Similarly, if the barriers actually raise the cost of foreign delivery, the full rent area is again foregone. In either case, the national welfare/income effect is approximated by area (1-2-5-6). Things get more complicated when part of area (1-3-4-6) represents higher costs (dead-weight losses) and part represents rents. Indeed, recent work supported by the EC (ECORYS 2009) has been focused explicitly on this distinction, and the results of this analysis feed into the estimated reported in this study. In the estimates below, we distinguish between cost and rent generation under NTMs on the basis of ECORYS (2009), assuming 2/3 of rents accrue to importer interests, and 1/3 to exporter interests.

5. Estimated Effects

Our analysis of the impact of each trade agreement on Austria is based on the application of a multi-sector, multi-region computational model (known as a computable general equilibrium or CGE model), as discussed briefly in Section 3.

5.1 Overall Effects

Overall results from the policy experiments are summarized in Table 9 below. From Table 9, the greatest impact follows from an EU-US agreement. This is not surprising, given the relative size of the economies involved. Critically, the lowering of NTMs leads to increased labor productivity, higher wages, and a combined 0.6 percent increase in employment. The reason for the strong boost in labor productivity (and so wages and employment) follows from the nature of NTMs. While they involve a share (roughly half) accruing as rents linked to barriers, roughly half of the price impact of NTMs follows from increased costs. From Table 6, this means that a 5.9 percent US barrier reduction for NTMs affecting goods, this implies a roughly 2.45 percent cost reduction (productivity gain) linked to reductions in regulatory and procedural barriers that raise costs.

Overall, the combined impact of the FTAs studied is positive. If implemented collectively, we estimate a 2.0 percent long-run gain to Austrian GDP. Much of this follows from investment response. Static gains are roughly 0.4 percent of GDP. The remaining 1.6 percent follows from increased levels of investment in Austria (a 3.76 percent increase as reported in Table 7). The investment follows from increased productivity, particularly as NTMs for goods are reduced.

Table 9

Summary of Impacts on Austria

	EU-US agreement	**EU-Canada agreement**	**EU-Armenia-Georgia-Moldova agreement**
Summary, effects on Austria			
National income, million dollars	5,568	684	95
National income, percent	1.744	0.215	0.030
Less skilled labor			
change in employment, percent	0.528	0.065	0.010
change in wages, percent	1.059	0.131	0.019
More skilled labor			
change in employment, percent	0.511	0.064	0.009
change in wages, percent	1.025	0.129	0.019
Change in capital stock, percent	3.761	0.481	0.067

Source: model estimates

The productivity gains from NTM reduction mean a combination of increased wages, employment, and capital stocks for the Austrian economy, overall. This follows from reductions in resource costs linked to regulatory burdens, differences in product standards, and increased input costs linked to NTMs.

5.2 Output, employment and trade effects by sector

Table 10 summarizes estimated changes in output by sector. The greatest increases in output are in motor vehicles (reflecting US barrier reductions in Table 7 above), followed by a broad increase in service sector production (averaging around 2.5 percent across service sectors).

Table 10

Estimated Changes in Output, percent

	total	US agreement	Canadian agreement	Georgia, Moldova, Armenia
Agr forestry fisheries	1.049	0.927	0.091	0.030
Other primary sectors	0.672	0.580	0.085	0.007
Processed foods	2.460	2.003	0.388	0.070
Textiles and clothing	3.409	3.018	0.383	0.007
Wood products	1.136	0.972	0.137	0.027
Paper pulp publishing	1.456	1.207	0.197	0.052
Chemicals	0.264	0.196	0.053	0.016
Metals and metal products	1.544	1.442	0.093	0.009
Electrical machinery	1.406	0.918	0.474	0.015
Motor vehicles	12.668	11.910	0.737	0.021
Other transport equipment	-0.835	-1.319	0.164	0.321
Other machinery	1.991	1.631	0.312	0.048
Other goods	-0.648	-0.561	-0.076	-0.011
Transport	0.602	0.520	0.077	0.006
Finance	1.938	1.761	0.146	0.030
Insurance	2.218	2.073	0.117	0.028
Business services	2.812	2.436	0.332	0.045
Communications	2.122	1.852	0.235	0.035
Construction	3.828	3.339	0.430	0.060
Personal services	1.827	1.573	0.223	0.031
Other services	1.737	1.519	0.192	0.026

Source: model-based estimates

Not surprisingly, and reflecting the pattern of results in Table 9, the greatest impact follows from the US-EU trade agreement. This is in line with distribution of investment effects (recall the 3.8 percent increase in capital stock in Table 9), which underpins a broad increase in industrial output as well across most sectors. The exceptions are “other transport equipment” and “other goods.” With expansion of those sectors that benefit most from lib-

eralization, there will be sectors that lose out as resources are pulled away to expanding sectors best in position to gain from changes in marker access.

Following from changes in output, Tables 11 and 12 report estimates of percent changes in employment by sector. Relative rankings map closely to changes in output by sector. The motor vehicles and parts sector sees the greatest increase in percent terms (over 9 percent for both more and less skilled workers). However, in terms of sign, we see more sectors where jobs are lost. This includes chemicals, wood and paper, and other transport equipment. In these sectors, we see increased capital intensity, partly in response to rising wages. Referring back to Table 9, overall employment and wage levels go up. Wages rise because of increased productivity gains (linked to falling costs as regulatory barriers are reduced). As such, there is an incentive in all sectors for a shift toward capital intensity. Indeed this shift, in general equilibrium, reinforces and supports the ability of the economy to provide more overall employment, and at higher wages, under the policy experiments.

Table 11

Changes in Employment by Sector, percent
More Skilled Workers

	total	US agreement	Canadian agreement	Georgia, Moldova, Armenia
Agr forestry fisheries	0.907	0.805	0.072	0.030
Other primary sectors	0.579	0.497	0.077	0.005
Processed foods	1.069	0.801	0.222	0.046
Textiles and clothing	1.698	1.524	0.190	-0.016
Wood products	-0.384	-0.350	-0.036	0.002
Paper pulp publishing	-0.226	-0.252	0.004	0.023
Chemicals	-1.043	-0.940	-0.097	-0.006
Metals and metal products	0.317	0.367	-0.041	-0.009
Electrical machinery	0.294	-0.032	0.329	-0.002
Motor vehicles	9.782	9.312	0.478	-0.008
Other transport equipment	-1.803	-2.127	0.038	0.285
Other machinery	0.728	0.538	0.163	0.027
Other goods	-1.947	-1.693	-0.223	-0.031
Transport	-1.339	-1.170	-0.144	-0.024
Finance	0.571	0.565	-0.003	0.009
Insurance	0.753	0.786	-0.039	0.005
Business services	0.253	0.207	0.041	0.004
Communications	0.283	0.249	0.028	0.006
Construction	1.790	1.563	0.200	0.028
Personal services	0.568	0.478	0.079	0.011
Other services	0.664	0.584	0.071	0.009

Source: model-based estimates

Table 12

Changes in Employment by Sector, percent
Less Skilled Workers

	total	US agreement	Canadian agreement	Georgia, Moldova, Armenia
Agr forestry fisheries	0.899	0.798	0.072	0.030
Other primary sectors	0.572	0.491	0.077	0.005
Processed foods	1.035	0.770	0.220	0.045
Textiles and clothing	1.661	1.490	0.187	-0.017
Wood products	-0.420	-0.384	-0.038	0.001
Paper pulp publishing	-0.262	-0.286	0.002	0.022
Chemicals	-1.079	-0.973	-0.099	-0.007
Metals and metal products	0.280	0.333	-0.043	-0.010
Electrical machinery	0.257	-0.066	0.326	-0.003
Motor vehicles	9.742	9.275	0.475	-0.008
Other transport equipment	-1.839	-2.160	0.036	0.285
Other machinery	0.691	0.504	0.161	0.027
Other goods	-1.983	-1.726	-0.225	-0.032
Transport	-1.385	-1.213	-0.147	-0.025
Finance	0.534	0.531	-0.006	0.008
Insurance	0.716	0.752	-0.041	0.005
Business services	0.216	0.174	0.039	0.004
Communications	0.246	0.215	0.026	0.005
Construction	1.749	1.526	0.197	0.027
Personal services	0.531	0.444	0.077	0.010
Other services	0.624	0.547	0.068	0.008

Source: model-based estimates

Tables 13 and 14 show changes in Austrian bilateral exports and imports brought about by the FTAs. The highest increase of exports in relative terms takes place in the country's trade with Georgia, followed by exports to Moldova and Armenia. In the sectorial breakdown, it is other transport equipment and processed food, which account for the fastest growth. In value terms, however, exports boost is relatively modest – about USD 169 million to the three countries jointly.

Growth of exports to the US and Canada turns out to be quite impressive as well – by 44% and 50% respectively (or by USD 5.7 billion and USD 586 million respectively). Exports growth is concentrated in machinery and motor vehicles sectors. There is also quite rapid increase of exports of financial and insurance services taking place.

Overall, exports to the EU practically does not change as a result of FTAs adoption, however, some reallocation of exports between sectors occurs. In particular, there is decline in exports of other transport equipment, other goods and electrical machinery, which is compensated by rise in exports of business services, communications, and other services sectors.

Table 13

Changes in Austrian exports by partner, percent

	EU	USA	Canada	Georgia	Moldova	Armenia
Agr forestry fisheries	-0.3	5.1	-1.8	4.6	71.5	3.2
Other primary sectors	-0.8	0.0	1.3	0.0	0.0	85.9
Processed foods	0.2	44.4	131.0	197.6	243.0	179.7
Textiles and clothing	1.2	116.6	116.1	50.7	75.8	75.0
Wood products	0.7	5.5	9.0	45.6	71.5	41.7
Paper pulp publishing	0.8	0.8	0.2	20.7	87.4	24.9
Chemicals	-1.9	30.6	33.0	28.7	31.7	36.7
Metals and metal products	-1.5	56.9	63.0	57.1	73.5	70.1
Electrical machinery	-1.9	57.0	66.2	65.7	31.1	75.0
Motor vehicles	0.3	64.4	88.0	105.9	3.8	137.2
Other transport equipment	-12.1	80.3	60.3	282.7	421.6	403.8
Other machinery	-1.8	51.1	51.8	51.7	68.0	62.9
Other goods	-3.2	6.0	7.4	-2.3	62.4	36.2
Transport	-0.4	7.9	12.6	5.3	16.2	9.0
Finance	0.8	23.3	20.7	26.5	67.6	50.2
Insurance	1.2	11.4	12.8	13.6	38.8	25.0
Business services	3.1	6.7	21.5	19.8	35.1	19.3
Communications	1.9	3.3	17.6	22.3	42.9	29.1
Construction	1.4	3.7	21.0	12.0	18.4	12.0
Personal services	0.8	2.3	17.0	19.1	30.9	15.1
Other services	0.5	0.4	-0.3	-5.3	9.2	-3.6
Total	-0.6	43.7	50.3	81.1	66.8	65.4

Source: model-based estimates

Table 14

Changes in Austrian imports by partner, percent

	EU	USA	Canada	Georgia	Moldova	Armenia
Agr forestry fisheries	1.6	22.2	124.8	3.0	-4.3	16.0
Other primary sectors	0.2	-0.3	-0.5	0.0	0.0	-2.3
Processed foods	1.3	165.6	112.8	71.9	73.3	68.6
Textiles and clothing	1.3	112.9	108.1	37.7	76.1	203.0
Wood products	0.9	71.9	67.6	51.2	68.0	63.1
Paper pulp publishing	1.5	20.0	21.4	30.8	37.0	33.0
Chemicals	0.7	43.8	46.1	33.8	53.5	27.9
Metals and metal products	2.3	85.4	79.5	60.1	74.2	73.6
Electrical machinery	0.2	58.5	61.0	76.1	130.8	119.5
Motor vehicles	1.1	141.4	127.8	103.9	140.0	153.3
Other transport equipment	-9.9	76.0	82.7	78.6	135.3	95.1
Other machinery	1.3	83.0	91.3	89.0	138.2	114.8
Other goods	3.5	15.5	19.2	13.9	10.7	15.4
Transport	0.5	12.5	13.4	22.1	10.6	19.1
Finance	1.5	12.9	14.5	25.2	8.3	19.3
Insurance	1.2	8.9	10.4	19.9	4.8	15.0
Business services	0.4	5.6	7.1	18.8	2.8	13.2
Communications	0.9	3.9	5.0	14.6	0.5	12.4
Construction	3.5	7.9	9.0	18.0	12.2	17.8
Personal services	1.9	5.4	6.5	13.5	3.4	13.5
Other services	1.8	1.8	3.0	10.6	-2.5	9.3
Total	1.1	85.3	71.9	58.2	77.9	69.1

Source: model-based estimates

As can be seen from Table 14, changes in imports are rather symmetrical to the exports ones. There is double-digit imports growth from all the trading partners, the EU signs FTAs with. The highest growth rate is estimated for the imports from the US – 85%, in value terms it means around USD 25 billion surge, which is 5 times higher than increase in Austrian exports to that country. The fastest import growth is recorded in processed food, motor vehicles, and textiles and clothing.

Imports increase from other four countries also significantly surpasses that of exports in value terms. For imports from Canada increase amounts to USD 2.1 billion, while for joint imports from Armenia, Georgia, and Moldova, the value is around USD 430 million.

It is noteworthy, that imports from the rest of the EU also slightly increase as a result of the FTAs (by 1.1%), which implies that trade diversion effects are rather minor.

5.3 Tariffs vs NTMs

We next turn to the relative importance of tariffs and NTMs in the overall impact of policy experiments. To do this, we have provided a breakdown in Table 15 below. In the Table, we have broken down the overall income effects in Table 8 into the relative contributions of tariff and NTM reductions.

Table 15

Contributions of tariff and NTM reductions to national income effects, million dollars

	EU-US agreement	**EU-Canada agreement**	**EU-Georgia Moldova, Armenia agreement**
Tariffs	289	176	12
Goods NTMs	4,875	442	5
Services NTMs	403	66	5

Source: model-based estimates

From Table 13, the dominant element in all three sets of agreements is NTMs affecting trade in goods. There are several reasons for this. One is simply that most trade involves goods. This is shown in Figure 3, for the case of the United States. On a gross value basis (nominal value of Austrian exports), 80 percent of Austrian exports to the US are goods. On a value added basis (Austrian value added contained in exports) goods account for 65 percent of the total. Another reason is that a greater share of NTMs is “actionable” for goods than for services. From ECORYS (2009) roughly 50 percent of goods NTMs were identified as actionable, while 30% of services NTMs were identified as actionable. Finally, from the discussion around Table 1, Austria has strong ties to EU Member States (especially Germany) where again it is goods trade that benefits most in the NTM scenarios.

Figure 2

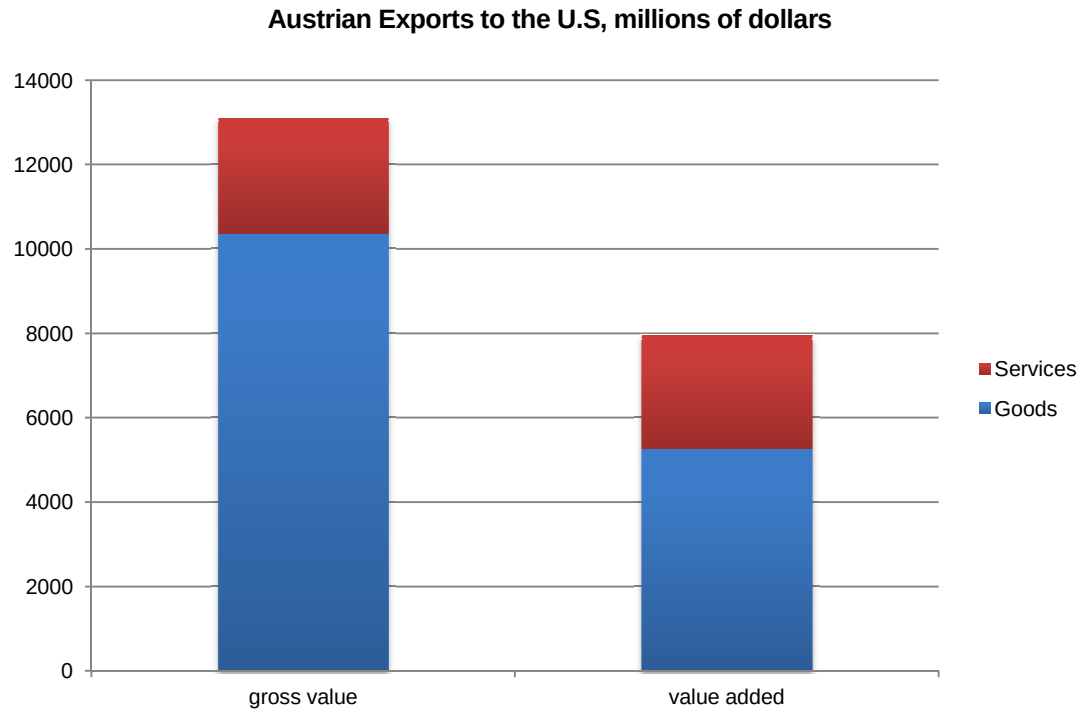


Table 16

Contributions of tariff and NTM reductions to Austrian exports value change, percent

	Total	Canada			USA			Armenia-Georgia-Moldova		
		Tariffs	NTM goods	NTM services	Tariffs	NTM goods	NTM services	Tariffs	NTM goods	NTM services
Agr forestry fisheries	0.05	0.26	0.05	0.01	-0.36	-0.02	0.1	0	0	0
Other primary sectors	-0.23	0	0.07	0.02	-0.23	-0.25	0.16	0	-0.02	0
Processed foods	4.51	0.52	0.2	0.02	-0.09	3.41	0.12	0.13	0.21	0
Textiles and clothing	4.21	0.3	0.17	0.03	2.02	1.47	0.19	0	0.02	0
Wood products	0.83	0.17	0.06	0.03	-0.19	0.56	0.17	0	0.03	0
Paper pulp publishing	0.73	0.08	0.06	0.02	-0.2	0.54	0.13	0.04	0.05	0
Chemicals	0.6	0.05	0.05	0.01	0.18	0.22	0.07	0	0.03	0
Metals and metal products	2.02	0.06	0.04	0.01	0.08	1.38	0.11	0	0.33	0
Electrical machinery	1.62	0.04	0.53	0.02	-0.08	0.98	0.11	0	0.02	0
Motor vehicles	13.29	0.22	0.59	0.01	1.2	11.07	0.16	0	0.03	0
Other transport equipment	2.34	-0.13	0.82	0.01	-0.26	1.35	0.12	0	0.43	0
Other machinery	2.4	0.11	0.29	0.03	0.12	1.63	0.17	0.01	0.05	0
Other goods	-1.8	0.01	-0.13	-0.03	0.37	-1.85	-0.13	0.04	-0.09	0
Transport	0.94	0.07	0.06	0.05	-0.01	0.39	0.38	0	0	0.01
Finance	2.34	0.05	0.09	0.23	-0.1	0.73	1.31	0	0.02	0.01
Insurance	3.9	0	0.05	0.09	-0.01	0.83	2.92	0	0.02	0.02
Business services	2.59	0.13	0.22	0.12	-0.14	1.89	0.28	0	0.07	0.01
Communications	1.77	0.09	0.14	0.1	-0.1	1.19	0.29	0	0.04	0.03
Construction	0.82	0.05	0.09	0.05	-0.21	0.64	0.18	0	0.01	0.01
Personal services	0.89	0.08	0.09	0.14	-0.17	0.56	0.15	0	0.02	0.02
Other services	0.46	0.06	0.06	0.02	-0.16	0.35	0.11	0	0.01	0

Source: model-based estimates

In Table 16, we present the effects of different components of the FTAs on Austrian exports. The country's exports grow in all the sectors apart from other primary sectors and other goods, the increase being most visible in motor vehicles (13.3%), processed food (4.5%), and textile and clothing (4.2%). The bulk of the effect comes from decrease of NTMs in trade with the US. In particular, NTMs liberalization contributed 11.1 p.p. to growth of Austrian motor vehicles exports. The impact of tariffs decrease on Austrian exports was noticeable primarily in textiles and motor vehicles exports to the USA.

FTA with Canada has little (less than 1%) impact on Austrian exports, the biggest increase taking place in exports of motor vehicles (0.8%), other transport equipment (0.7%), and electrical machinery (0.6%) – mainly due to NTMs contribution.

In Table 17 we present potential effects of three FTAs' components on Austrian imports. The highest increase takes place in motor vehicles (7%), other transport equipment (5.9%), other goods (5%), and construction (4.4%). As in the case of exports, the FTA with US is driving the results, primarily because of a decrease in NTMs with respect to the US merchandise imports. FTAs with Armenia, Georgia, and Moldova do not cause significant impact on overall Austrian imports.

Table 17

Contributions of tariff and NTM reductions to Austrian imports value change, percent

	Total	**Canada**			**USA**			**Armenia-Georgia-Moldova**		
		Tariffs	NTM goods	NTM services	Tariffs	NTM goods	NTM services	Tariffs	NTM goods	NTM services
Agr forestry fisheries	3.26	0.53	0.17	0.03	0.11	2.14	0.17	0.02	0.07	0
Other primary sectors	0.6	0.05	0.07	0.01	-0.05	0.46	0.05	0	0.01	0
Processed foods	2.65	0.08	0.14	0.01	0.4	1.67	0.11	0.07	0.15	0
Textiles and clothing	2.24	0.12	0.15	0.02	0.32	1.45	0.13	0.01	0.05	0
Wood products	1.95	0.18	0.23	0.02	0.01	1.32	0.13	0.01	0.05	0
Paper pulp publishing	1.99	0.08	0.15	0.01	0.07	1.47	0.13	0.01	0.05	0
Chemicals	2.72	0.11	0.19	0.02	0.25	1.91	0.16	0.01	0.06	0
Metals and metal products	3.32	0.11	0.23	0.03	0.18	2.42	0.18	0.01	0.17	0
Electrical machinery	2.77	0.12	0.29	0.03	0	2.04	0.21	0.01	0.08	0
Motor vehicles	6.96	0.18	0.34	0.02	0.65	5.52	0.19	0	0.06	0
Other transport equipment	5.93	0.2	0.55	0.03	0.59	4.18	0.23	0.01	0.13	0
Other machinery	4.09	0.14	0.3	0.03	0.24	3.1	0.19	0.01	0.08	0
Other goods	4.99	0.2	0.34	0.06	0.31	3.55	0.36	0.02	0.14	0.01
Transport	3.1	0.13	0.18	0.1	0.1	1.72	0.8	0.01	0.06	0.01
Finance	2.82	0.12	0.14	0.34	0.04	1.49	0.62	0.01	0.06	0.01
Insurance	3.29	0.13	0.11	0.47	0.03	1.33	1.17	0.01	0.05	0.01
Business services	0.73	0.05	0.03	0.05	0.05	0.31	0.22	0	0.01	0
Communications	1.62	0.1	0.1	0.09	0.01	0.92	0.35	0.01	0.03	0.01
Construction	4.36	0.19	0.3	0.04	0.11	3	0.59	0.01	0.11	0.01
Personal services	2.44	0.11	0.15	0.09	0.07	1.7	0.25	0.01	0.06	0
Other services	2.34	0.11	0.17	0.01	0.07	1.76	0.13	0.01	0.07	0

Source: model-based estimates

6. Conclusions

This paper has examined the possible impact of trade agreements with the US, Canada, and Georgia/Moldova/Armenia on the Austrian economy. Of these, the US agreement dominates in terms of likely effects. Taken together, agreements with both the US and Canada may bring substantial benefits to the Austrian economy. North America and Europe are each other's most important trading partners. In the case of Austria, effects follow from both direct trade (improved market access) and strong linkages to other parts of the EU, who in turn would also benefit from improved market access.

In this study, we have emphasized non-tariff barriers (NTMs) alongside tariffs. This has involved including estimates of NTMs in the CGE model, and allowing for a split between rent and cost-generating NTMs. The NTM reductions, especially for goods, are found to be the most important part of the agreement for Austria. Reductions in such trade barriers, with savings in real resources, imply gains in Austrian labour productivity, and a consequent positive investment and exports response.

For the Austrian economy, the primary gains are linked to deeper integration with North America. A possible agreement with the United States offers the most gains, in terms of wages, employment, and national income. A combined agreement with the US and Canada offers even more, with national income gains of close to 2 percent of GDP. However, for the most part these gains follow not from tariffs, but rather from reductions in non-tariff measures. As these reflect differences in rules and regulations, as well as deliberate regulatory burdens placed on foreign firms, negotiations in this area are likely to be quite difficult, with uncertain outcomes.

In contrast to FTAs with North America, agreements with Georgia, Moldova, and Armenia have almost no effect on the Austrian economy. As such, the imperative for such agreements from an Austrian perspective lies in the geo-political benefits.

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Annex 1 sector mappings

Table A1

Mapping of Model Sectors to GTAP

No.	GTAP Sector	Model Sector	No.	GTAP Sector	Model Sector
1	pdr	Agr forestry fisheries	30	lum	Wood products
2	wht	Agr forestry fisheries	31	ppp	Paper pulp publishing
3	gro	Agr forestry fisheries	32	p_c	Chemicals
4	v_f	Agr forestry fisheries	33	crp	Chemicals
5	osd	Agr forestry fisheries	34	nmm	Other goods
6	c_b	Agr forestry fisheries	35	i_s	Metals and metal products
7	pfb	Agr forestry fisheries	36	nfm	Metals and metal products
8	ocr	Agr forestry fisheries	37	fmp	Metals and metal products
9	ctl	Agr forestry fisheries	38	mvh	Motor vehicles
10	oap	Agr forestry fisheries	39	otn	Other transport equipment
11	rmk	Agr forestry fisheries	40	ele	Electrical machinery
12	wol	Agr forestry fisheries	41	ome	Other machinery
13	frs	Agr forestry fisheries	42	omf	Other goods
14	fsh	Agr forestry fisheries	43	ely	Other services
15	coa	Other primary sectors	44	gdt	Other services
16	oil	Other primary sectors	45	wtr	Other services
17	gas	Other primary sectors	46	cns	Construction
18	omn	Other primary sectors	47	trd	Other services
19	cmt	Processed foods	48	otp	Transport
20	omt	Processed foods	49	wtp	Transport
21	vol	Processed foods	50	atp	Transport
22	mil	Processed foods	51	cmn	Communications
23	pcr	Processed foods	52	ofi	Finance
24	sgr	Processed foods	53	isr	Insurance
25	ofd	Processed foods	54	obs	Business services
26	b_t	Processed foods	55	ros	Other services
27	tex	Textiles and clothing	56	osg	Other services
28	wap	Textiles and clothing	57	dwe	Other services
29	lea	Textiles and clothing			

Table A2

Mapping of Model Sectors to ISIC rev 3.1

Model Sector	ISIC Sectors
Agr forestry fisheries	ISIC 01-05
Other primary sectors	ISIC 10-14
Processed foods	ISIC 15-16
Textiles and clothing	ISIC 17-19
Wood products	ISIC 20
Paper pulp publishing	ISIC 21-22
Chemicals	ISIC 24-25
Metals and metal products	ISIC 27-28
Electrical machinery	ISIC 30-32
Motor vehicles	ISIC 34
Other transport equipment	ISIC 35
Other machinery	ISIC 29,31,33
Other goods	ISIC 15-37, remaining
Transport	ISIC 61-63
Finance	ISIC 65,67
Insurance	ISIC 66
Business services	ISIC 70-74
Communications	ISIC 64
Construction	ISIC 45
Personal services	ISIC 91-93
Other services	ISIC 40,41,50,51,52,75,80,85,90

Annex 2 CGE model technical overview

In the computational model, the "whole" economy, for the relevant aggregation of economic agents, is modelled simultaneously. This means that the entire economy is classified into production and consumption sectors. These sectors are then modelled collectively. Production sectors are explicitly linked together in value-added chains from primary goods, through higher stages of processing, to the final assembly of consumption goods for households and governments. These links span borders as well as industries. The link between sectors is both direct, such as the input of steel into the production of transport equipment, and also indirect, as with the link between chemicals and agriculture through the production of fertilizers and pesticides. Sectors are also linked through their competition for resources in primary factor markets (capital, labour, and land). The data structure of the model follows the GTAP database structure, and basic models of this class are implemented in either GEMPACK or GAMS (Hertel 1997, Hertel et al 1997, Rutherford and Paltsev 2000). We work here with a GEMPACK implementation.

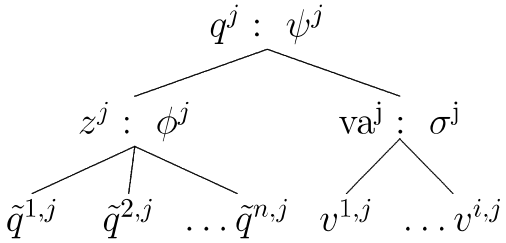
Production

We start here with a representative production technology using a basic, constant returns to scale specification. Where we have scale economies, this serves as the cost structure for composite input bundles. Assume that output q^j in sector j can be produced with a combination of intermediate inputs z^j and value added services (capital, labour, land, etc.) va^j. This is formalized in equation 1. Assuming homothetic cost functions and separability, we can define the cost of a representative bundle of intermediate inputs z^j for the firm producing q^j and similarly the cost of a representative bundle va^j of value added services. These are shown in equations 2 and 3. They depend on the vector of composite goods prices $\tilde{P}$ and primary factor prices ω. Unit costs for q then depend on the mix of technology and prices embodied in equations 1,2,3. We represent this in equation 4, which defines unit cost ς^j. In the absence of taxes, in competitive sectors ς^j represents both marginal cost and price. On the other hand, with imperfect competition on the output side (discussed explicitly later) ς^j can be viewed as measuring the marginal cost side of the optimal markup equation, with markups driving a wedge between ς^j and P^j.

To combine production technologies with data, we need to move from general to specific functional forms. We employ a nested CES function, with a CES representation of value added activities va^j, a CES representation of a composite intermediate z^j made up of intermediate inputs, and an upper CES nest that then combines these to yield the final good q^j. Our set-up is illustrated in Figure 2 below, on the assumption we have i primary factors v, as well as n production sectors that can be represented in terms of composite goods $\tilde{q}$ as defined below.

Figure 3

representative nested production technology



These composites may (or may not, depending on the goods involved) be used as intermediate inputs. In Figure 2, we have also shown the CES substitution elasticity for intermediate inputs ϕ, the substitution elasticity for value added σ, and the substitution elasticity for our "upper nest" aggregation of value added and intermediates, ψ. In the absence of taxes, total value added *Y* will be the sum of primary factor income, as in equation 5.

Given our assumption of CES technologies, we can represent value added in sector *j* as a function of primary inputs and the elasticity of substitution in value added σ^j. This yields equation 6, and its associated CES price index shown in equation 7. Similarly, we can specify the CES price index for composite intermediates, as in equation 7. This gives us equation 8, where the coefficient ϕ^j is the elasticity of substitution between intermediate inputs. This is assumed to be Leontief (i.e. ϕ^j = 0). Finally, following Figure 2, we will also specify an aggregation function for value added and intermediate inputs, in terms of its CES price index. This is shown as equation 9. From the first order conditions for minimizing the cost of production, we can map the allocation of primary factors to the level of value added across sectors. This is formalized in equation 10. We can also specify the total demand for composite intermediate goods across sectors $\tilde{q}^{\mathrm{int},i}$ as a function of the producer price of composite input price P_{z^j} in each sector, the scale of intermediate demand across sectors z^j, and prices of composite goods $\tilde{P}_i$. This is shown in equation 11. With the upper nest CES for goods we can also map value added va^j and intermediate demand z^j in terms of equations 7 and 8, output q^j and the elasticity of substitution ψ^j between inputs and value added. This yields equations 12 and 13, where the terms γ are the CES weights (similar to those in equation 6) while ψ^j is the upper nest elasticity of substitution in the production function.

We also model some sectors as being characterized by large group monopolistic competition. In reduced form, this can be represented by an industry level scale economy that reflects variety effects. We define the price of output at industry level as in equation 14. In this case, ς^j is defined by equation 9 and represents the price of a bundle of inputs, and equation 14 follows directly from average cost pricing, homothetic cost functions, and Dixit-Stiglitz type monopolistic competition. (See Francois and Roland-Holst 1997, Francois 1998, and Francois, van Meijl, and van Tongeren 2005 for explicit derivations.)

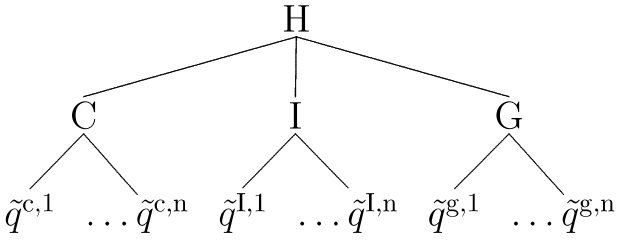
Together, equations 1 through 14 map out the production side of the economy. For an open economy, given resources, technology (represented by technical coefficients in the CES functional forms), and prices for foreign and domestic goods and services, we can determine factor incomes, national income, and the structure of production. We close this system by discussion of the demand side of the economy, and basic open economy aspects, in the next sections.

Final Demand

In the system we have spelled out so far, we have mapped the basic, national structure of production. We close the system with a demand specification for a representative household. This involves allocation of regional income by the household to composite consumption H, which is separated over private consumption C, public consumption G, and investment I. Each of these components of H involves consumption of composite goods and services $\tilde{q}$ indexed by sector j. This is illustrated in Figure 3 below. Where we assume fixed expenditure shares (i.e. with H taking a Cobb-Douglas functional form), then we also have a fixed savings rate. Otherwise, given the equilibrium allocation of household income to consumption and investment, we will denote these expenditure shares by θ. We maintain a fixed-share allocation between public and private consumption.

Figure 4

representative household demand



We assume a well-defined CES utility function for personal consumption defined over goods $\tilde{q}$. From the first order conditions for utility maximization, we can then derive the price of utility from private consumption P_U as a function of prices $\tilde{P}$, as in equation 15. The corresponding expenditure function is then $U = U^c P_U$ where $U^c$is the level of utility from private consumption. Taking national income as our budget constraint, then combining equation 5 with the expenditure function yields equation 16. From 16, we can define U^c from the expenditure function and income, as in equation 17. Consumption quantities, in terms of composite goods, can be recovered from equation 17, as shown in equation 18. Like private consumption, the public sector is also modelled with a CES demand function over public sector consumption. This implies equations 19-22. For investment demand, in the short run, we assume a fixed savings rate. In the long-run, the model can alternatively incorporate a fixed savings rate, or a rate that adjusts to meet steady state conditions in a basic Ramsey structure with constant relative risk aversion (CRRA) preferences. We em-

ploy the CRRA version here. (Francois, McDonald and Nordstrom 1996, 1997). With fixed savings, and assuming a Leontief composite of investment goods that make up the regional investment good, investment demand is defined by equation 23. With CRRA preferences, steady-state conditions implies equation 24 as well, related to the price of capital ω_k. Where 24 holds, the additional equation allows us to make the savings rate coefficient θ^I endogenous. In equation 24 ρ is the rate of time discount and δ is the rate of depreciation. With a short-run or static closure, investment demand means we apply equation 23. With a long-run closure, we also apply equation 25. When we impose CRRA preferences in the long-run, we then employ all three equations on the model 23-25, and savings rates are endogenous. With a fixed savings rate, we drop equation 24 and make θ^I exogenous.

Cross-border linkages and taxes

Finally, individual countries, as described by equations 1-25 above, are linked through cross border trade and investment flows. With either monopolistic competition or Armington preferences, we can define a CES composite good $\tilde{q}$ in terms of foreign and domestic goods. The price index for this composite good is defined by equation 26. Given equation 26 and the envelope theorem, we can define domestic absorption D as in equation 27, where *h* indexes home prices and quantities. The difference between production q_j and domestic absorption D_j in equilibrium will be imports (where a negative value denotes exports), as in equation 28. Across all countries indexed by *r*, we also have a global balanced trade requirement, shown in equation 29. Similarly, balancing the global capital account also requires equations 30 and 31 (where we now index source *r* and home destination *h*).

The basic system outlined above provides the core production and demand structure of each region, as well as the basic requirements for bilateral import demand, global market clearing for traded goods and services, and global capital account balancing. Within this basic structure, we also introduce taxes, transport services, iceberg (deadweight) non-tariff barriers, and rent-generating non-tariff barriers. These drive a wedge between the ex-factory price originating in country *r* and the landed prices in country *h* inclusive of duties and transport costs. Taxes and rent-generating trade costs mean that *Y* is also inclusive of tax revenues and rents. In the short-run we fix *B*, while in the long-run this is endogenous (such that the distribution of relative global returns is maintained). All of this adds additional complexity to the system outlined above, but the core structure remains the same.

Table A3

Mathematical summary of the CGE model

(1) $q^j = f^j\left(z^j, \mathrm{va^j}\right)$

(2) $P_z = g\left(\tilde{P}\right)$

(3) $P_{\mathrm{va}} = h\left(\omega\right)$

(4) $\zeta_j = c\left(P_z, P_{\mathrm{va}}\right)$

(5) $Y = \sum_i \omega_i v_i$

(6) $\mathrm{va}_j = \left[\sum_i \alpha_{ij} v_{ij}^{\frac{\sigma^j - 1}{\sigma^j}}\right]^{\frac{1}{\sigma^j - 1}}$

(7) $P_{v^j} = \left[\sum_i \alpha_{ij}^{\sigma^j} \omega_i^{1-\sigma^j}\right]^{\frac{1}{1-\sigma^j}}$

(8) $P_{z^j} = \left[\sum_i \beta_{ij}^{\phi^j} \tilde{P}_i^{1-\phi^j}\right]^{\frac{1}{1-\phi^j}}$

(9) $P_j = \left(\gamma_{vj}^{\psi^j} P_{\mathrm{va}^j}^{1-\psi^j} + \gamma_{zj}^{\psi^j} P_{z^j}^{1-\psi^j}\right)^{\frac{1}{1-\psi^j}}$

(10) $v_i \geq \sum_j \mathrm{va}^j \left(\frac{\alpha_{vj}}{\omega_i}\right)^{\sigma^j} P_{\mathrm{va}^j}$

(11) $\tilde{q}^{\mathrm{int,i}} = \sum_j z^j \left(\frac{\beta_{ij}}{\tilde{P}_i}\right)^{\phi^j} P_{z^j}$

(12) $\mathrm{va}^j = q^j \left(\frac{\gamma_{vi}}{P_{v^j}}\right)^{\psi^j} P_j$

(13) $\bar{z}^j = q^j \left(\frac{\gamma_{zi}}{P_{z^j}}\right)^{\psi^j} P_j$

(14) $P_j = q_j^{\psi} \left(\gamma_{vj}^{\psi^j} P_{\mathrm{va}^j}^{1-\psi^j} + \gamma_{zj}^{\psi^j} P_{z^j}^{1-\psi^j}\right)^{\frac{1}{1-\psi^j}}$
where $1 > \psi > 0$

(15) $P_{U^c} = \left(\sum_{i=1}^{n} \alpha_{c,i}^{\eta^c} \tilde{P}_i^{1-\eta^c}\right)^{\frac{1}{1-\eta^c}}$
where $0 < \frac{\eta^c - 1}{\eta^c} < 1$

(16) $U^c \left(\sum_{i=1}^{n} \alpha_{c,i}^{\eta^c} \tilde{P}_i^{1-\eta^c}\right)^{\frac{1}{1-\eta^c}} = Y\theta^c$

(17) $U^c = \left(\sum_{i=1}^{n} \alpha_{c,i}^{\eta^c} \tilde{P}_i^{1-\eta^c}\right)^{\frac{1}{\eta^c - 1}} Y\theta^c$

(18) $\tilde{q}^{c,i} = U^c P_{U^c}^{\eta^c} \alpha_{c,i}^{\eta^c} \tilde{P}_i^{-\eta^c}$

(19) $P_{U^g} = \left(\sum_{i=1}^{n} \alpha_{g,i}^{\eta^g} \tilde{P}_i^{1-\eta^g}\right)^{\frac{1}{1-\eta^g}}$
where $0 < \frac{\eta^g - 1}{\eta^g} < 1$

(20) $U^g \left(\sum_{i=1}^{n} \alpha_{g,i}^{\eta^g} \tilde{P}_i^{1-\eta^g}\right)^{\frac{1}{1-\eta^g}} = Y\theta^g$

(21) $U^g = \left(\sum_{i=1}^{n} \alpha_{g,i}^{\eta^g} \tilde{P}_i^{1-\eta^g}\right)^{\frac{1}{\eta^g - 1}} Y\theta^g$

(22) $\tilde{q}^{g,i} = U^c P_{U^c}^{\eta^g} \alpha_{g,i}^{\eta^g} \tilde{P}_i^{-\eta^g}$

(23) $\left(\sum_{j=1}^{n} \alpha_{I,j} \tilde{P}_j\right) = Y\theta^I$

(24) $\omega_k = P^c\left(\rho + \delta\right)$

(25) $dK/K = dI/I$

(26) $\tilde{P}_j = \left(\sum_{r=1}^{R} b_{r,j}^{s^j} P_{r,j}^{1-s^j}\right)^{\frac{1}{1-s^j}}$
where $0 < \frac{s^j - 1}{s^j} < 1$

(27) $D_j = \left(\tilde{q}^{\mathrm{c,j}} + \tilde{q}^{\mathrm{I,j}} + \tilde{q}^{\mathrm{g,j}} + \tilde{q}^{\mathrm{int,i}}\right) \tilde{P}_j^s b_{h,j}^s P_{h,j}^{-s}$

(28) $M_j = D_j - q_j$

(29) $\left(\sum_{r=1}^{rr} M_{r,j}\right) = 0$

(30) $\left(\sum_j \sum_{r \neq h} P_{r,j} M_{r,h,j}\right) = B_h$

(31) $\left(\sum_r B_r\right) = 0$