4

The Welfare Effects of Integration

Having prepared the estimates of fragmentation, we now proceed to consider their welfare implications. For eight of the nine countries, we seek to compare real incomes in the world as it is with one in which barriers are eliminated. (Unfortunately, data problems prevent us from analyzing Belgium separately.) To quantify these effects, we use a global general equilibrium model based on one developed by Glenn Harrison, Thomas F. Rutherford, and David Tarr.[1] The model has considerable country and sectoral detail, with 16 regions and 33 sectors (box 4.1).[2] The model also allows for both increasing returns to scale and dynamic adjustment of the capital stock. In this chapter we first report our results and then describe the model and our methodology.

Welfare Analysis

We conducted three types of simulations of the effects of eliminating fragmentation: unilateral removal of barriers in each of the eight countries to all other countries worldwide; multilateral worldwide removal by all eight countries at once; and a preferential trade agreement in which all

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[1] The model is based on the computer code provided by Harrison, Rutherford, and Tarr. Their code is available for public access at the web.badm.sc.edu/glenn/ur_pub.htm and was used in their 1995, 1996, and 1997 articles.

[2] The underlying data come from version 5 (1997) of the Global Trade Analysis Project (GTAP) database. See www.gtap.org for a description and documentation.

Box 4.1 Sectors and regions included in general equilibrium model

Sectors

Fruits, nuts, vegetables
Other crops
Other agriculture
Live animals
Other animal products
Fish
Coal, gas, oil
Other minerals
Bovine cattle, sheep, goat, and horse products
Other meat products
Vegetable oils and fats
Dairy products
Processed rice
Sugar
Other food products
Beverages and tobacco products
Textiles
Wearing apparel
Leather goods
Lumber and wood products
Pulp, paper products, publishing
Coal and petroleum products
Chemicals, plastics, and rubber
Nonmetallic mineral products
Primary ferrous metals
Nonferrous metals
Fabricated metal products
Motor vehicles and parts
Electronic equipment
Machinery and equipment
Other manufacturing products
Trade and transport services
Other services

Regions

Australia
Japan
Korea
China
Rest of Asia
Canada
United States
Brazil
Rest of Latin America
Germany
Italy
Netherlands
United Kingdom
Rest of Europe
Middle East
Rest of world

Notes: **Boldface** indicates sectors for which protection measures were inserted. *Italics* indicate sectors assumed to have increasing returns to scale.

eight countries simultaneously remove barriers against each other but not against the rest of the world. We focus on changes in equivalent variation (which, given the model structure, are the same as changes in real consumption) as a percentage of GDP. Thus our estimates can be compared with those obtained for deadweight losses in other models.

Here we report and discuss the point estimate predictions for overall welfare changes. The appendix presents confidence intervals for these estimates. Table 4.1 shows the principal results. The table reports the permanent, annual effect of trade opening on consumption once the capital stock has changed to its new equilibrium. Put another way, the table reports the welfare costs, borne at home and abroad, of all protection in the eight countries separately and as a group. The top panel reports these gains as percentages of GDP, and the bottom panel in billions of 1997 US dollars.

All in all, the measured effects are large. Removing trade barriers that are as comprehensive as those we have identified indicates significant benefits from ending fragmentation. As the top panel of table 4.1 shows, each of the countries except the United States would get an annual boost of 1 percent or more to GDP from its own unilateral opening (indicated by the cells in the table on the diagonal). Multilateral opening by all eight would bring even larger gains of at least 3 percent of GDP for all countries except Germany and the United States, and global GDP would rise by 2.1 percent.

Two main forces drive the gains for any given country: the amount of its initial protection and the share of trade in its GDP. The relatively low trade barriers in the United States and its low ratio of trade to GDP mute the predicted gains for that country. Nevertheless, the annual GDP increases of 0.4 percent (for unilateral opening) and 1.0 percent (for multilateral opening) are substantially higher than the 0.07 percent figure obtained by Hufbauer, Wada, and Warren (2002) for the benefits of price convergence for the United States, and than the estimate by Hufbauer and Elliott (1994) of about a 0.1 percent increase in GDP from removing US border barriers. Canada has about the same measured level of fragmentation as the United States but would gain two to three times as much as a percentage of GDP from opening, because Canada's trade share is much higher. Similarly, the Netherlands' high trade share amplifies its gains. On the other hand, Japan's barriers are so high that it reaps substantial gains from international integration despite the fact that Japan has the lowest trade share in the sample: trade accounts for only about 10 percent of Japan's economy. The 3.1 percent boost we estimate for Japan's GDP is considerably greater than the estimate of 1.8 percent of GDP obtained by Hufbauer, Wada, and Warren. Moreover, it is well in line with the total consumer gains (as opposed to just the deadweight gains) estimated by Sazanami, Urata, and Kawai (1995). Another factor at work is changes in the terms of trade. Such effects mute the gains for the United States, Japan, and Germany: these countries account for fairly large shares of total world trade, so that, when they open, they drive up their import prices and drive down their export prices.

The results also highlight some interesting international linkages and interactions. Canada gains more (1.7 percent of GDP) from opening by the United States than it does from its own opening (1.0 percent). Likewise, the Netherlands sees its GDP rise by a larger percentage (1.6 percent) when Germany opens unilaterally than does Germany itself (1.3 percent). The Netherlands also receives substantial boosts from openings in Italy (Dutch GDP rises 0.6 percent) and the United Kingdom (1.0 percent).

Our simulation results suggest that the focus on Japan's relatively closed market has not been misplaced. It is striking that both Australia

Table 4.1 Welfare impact of complete removal of barriers by country and region

Country or region affected	Country or countries removing barriers									
	Australia	Canada	Germany	Italy	Japan	Netherlands	United Kingdom	United States	All eight countries	Eight-country PTA
Percent of GDP										
Australia	1.61	0.02	0.11	0.03	1.66	0.01	0.25	0.27	3.95	4.35
Canada	0.04	1.00	0.03	0.10	0.52	0.01	0.07	1.71	3.49	3.66
Germany	0.03	−0.01	1.28	0.25	−0.04	0.29	0.30	0.12	2.26	1.96
Italy	0.05	0.02	0.66	1.97	0.03	0.10	0.37	0.16	3.46	4.61
Japan	0.04	−0.01	−0.01	0.11	3.06	0.01	0.00	0.12	3.27	2.18
Netherlands	0.05	0.01	1.56	0.58	0.14	3.84	1.03	0.33	7.71	9.38
United Kingdom	0.01	0.03	0.27	0.10	0.23	0.21	3.21	0.21	4.29	2.79
United States	−0.01	0.20	0.01	0.00	0.40	0.01	0.06	0.40	1.02	1.35
China	0.04	0.05	0.12	0.04	0.77	0.02	0.32	0.55	1.49	−0.57
Korea	0.04	0.00	0.03	0.01	0.62	0.06	0.03	0.25	0.96	−0.51
Rest of Asia	0.06	0.02	0.03	0.06	1.03	0.03	0.18	0.49	2.03	−0.81
Brazil	−0.03	0.06	0.18	0.06	0.41	0.03	0.10	0.32	1.05	0.00
Rest of Latin America	0.00	0.01	0.06	0.07	0.55	0.02	0.09	0.86	1.94	−0.53
Rest of Europe	0.02	0.03	0.59	0.20	0.13	0.18	0.47	0.15	1.69	−0.88
Middle East	0.01	0.03	0.35	0.13	0.55	0.10	0.37	0.41	1.96	−0.05
Rest of world	−0.01	−0.01	0.36	0.16	0.43	0.06	0.21	0.11	1.34	0.03

Developing countries	0.01	0.01	0.21	0.09	0.63	0.04	0.15	0.43	1.60	−0.36
Industrial countries	0.04	0.10	0.29	0.17	0.90	0.14	0.35	0.29	2.26	1.76
World	0.04	0.09	0.27	0.16	0.84	0.12	0.31	0.33	2.11	1.25
Billions of dollars										
Australia	5.68	0.07	0.39	0.11	5.85	0.04	0.88	0.95	13.93	15.34
Canada	0.21	5.19	0.16	0.52	2.70	0.05	0.36	8.87	18.11	18.99
Germany	0.54	−0.18	23.18	4.53	−0.72	5.25	5.43	2.17	40.93	35.50
Italy	0.51	0.20	6.73	20.08	0.31	1.02	3.77	1.63	35.26	46.98
Japan	1.76	−0.44	−0.44	4.84	134.73	0.44	0.00	5.28	143.98	95.99
Netherlands	0.15	0.03	4.76	1.77	0.43	11.73	3.15	1.01	23.54	28.64
United Kingdom	0.12	0.36	3.26	1.21	2.78	2.54	38.78	2.54	51.83	33.71
United States	−0.75	15.04	0.75	0.00	30.08	0.75	4.51	30.08	76.69	101.51
China	0.35	0.44	1.06	0.35	6.82	0.18	2.83	4.87	13.19	−5.05
Korea	0.16	0.00	0.12	0.04	2.43	0.23	0.12	0.98	3.76	−2.00
Rest of Asia	0.78	0.26	0.39	0.78	13.44	0.39	2.35	6.39	26.48	−10.57
Brazil	−0.20	0.40	1.20	0.40	2.72	0.20	0.66	2.13	6.97	0.00
Rest of Latin America	0.00	0.11	0.66	0.77	6.03	0.22	0.99	9.44	21.28	−5.81
Rest of Europe	0.56	0.84	16.50	5.59	3.63	5.03	13.14	4.19	47.25	−24.60
Middle East	0.06	0.17	1.98	0.74	3.11	0.57	2.09	2.32	11.09	−0.28
Rest of world	−0.15	−0.15	5.57	2.48	6.66	0.93	3.25	1.70	20.74	0.46
Developing countries	0.65	0.65	13.56	5.81	40.67	2.58	9.68	27.76	103.30	−23.24
Industrial countries	7.97	19.93	57.81	33.89	179.40	27.91	69.77	57.81	450.49	350.82
World	10.56	23.75	71.25	42.22	221.67	31.67	81.81	87.08	556.82	329.87

PTA = preferential trade agreement

and the United States would gain about as much from Japan's opening (1.7 and 0.4 percent of GDP, respectively) as they would from their own (1.6 and 0.4 percent, respectively). The benefits to Japan's neighbors would also be considerable, with GDP rising in China, Korea, and the rest of Asia by 0.8 percent, 0.6 percent, and 1.0 percent of GDP, respectively. Developing countries as a group would see their incomes rise by 0.6 percent, and the world by 0.8 percent. Measured in 1997 dollars, Japanese incomes would rise by $135 billion, and Japan's trading partners would see their incomes rise by $87 billion, of which $41 billion would accrue to developing countries. The world as a whole derives more than twice the benefits from Japanese as from US opening. Indeed, unilateral Japanese opening would yield benefits of $222 billion, or roughly 40 percent of the global benefits resulting from all eight countries opening together.

Yet despite the considerable gains that a more open Japan would confer on the rest of the world, of all the countries in the sample, Japan itself captures the largest share of the gains from its unilateral opening. The benefits to the rest of the world from unilateral Japanese opening amount to about 60 percent of the benefits enjoyed by Japan itself. Similarly, Japan gains only an additional 7.5 percent (the smallest additional percentage increase) when all eight countries open together than when it opens unilaterally. The unilateral opening of Japan would therefore be a win-win policy. Japan would reap most of the benefits, but the gains to the world would also be sizable.

Developing countries would also reap significant gains from unilateral US opening, equal to 0.4 percent of GDP, or about $28 billion in 1997 dollars. The United States is the only country in the sample whose barriers have a larger percentage impact on developing-country incomes than on those in other industrialized countries. Unlike the rest of Latin America, however, Brazil would benefit more from Japanese opening (GDP would rise by 0.4 percent) than from US opening (0.3 percent). The trade barriers of both Japan and the United States impose costs on lower-income countries that more than cancel out the annual development aid they give.

Although all countries gain more from multilateral opening than from unilateral opening, Australia, Canada, and the United States receive especially large extra payoffs: their gains from multilateral removal of barriers are about 2.5 times or more the unilateral gains. Not surprisingly, these three countries have the lowest barriers. They thus have an especially large incentive to engage in multilateral trade reform as opposed to unilateral opening. Nonetheless, when these countries do open, they confer far larger benefits on the rest of the world than they derive themselves. Indeed, the global benefits that would result from Canada's opening are 4.6 times as large as the benefits realized by Canada itself. For the United States and Australia, the ratios are 2.9 and 1.9, respectively. German unilateral liberalization would confer global benefits that are three times as large as Germany itself captures.

Five of the eight countries in the sample actually do better with a preferential trade agreement (PTA) among the group than with multilateral removal of all barriers against the rest of the world. The exceptions are Germany, Japan, and the United Kingdom. Apparently these three countries gain proportionately more from trade with countries outside the sample than do the other five. Developing countries, however, lose from such an exclusionary arrangement. Instead of the 1.6 percent of GDP gain they would experience from multilateral opening by all eight sample countries, developing countries would lose 0.4 percent from such a PTA.

Anderson et al. (2001) present a simulation in which all countries remove all (traditional) global trade barriers that remain after the Uruguay Round. They conclude that the benefits of such removal would have amounted to $254 billion in 1995. They also estimate that the global benefits from removing barriers in the high-income countries alone would be $140 billion, of which $97 billion would accrue to the high-income countries themselves. This is analogous to our multilateral opening simulation, since we remove all barriers only in the industrial countries in our sample. In addition, the countries in our sample account for only about 86 percent of the combined GDP of all industrial economies. Nonetheless, we project that multilateral opening in all eight would raise global incomes by about $550 billion (in 1997 dollars), with developing countries gaining $100 billion. Thus (allowing for inflation between 1995 and 1997) our estimated gains are about four times as large as those of Anderson et al. for the world as a whole, and about six times as large for the industrial (or high-income) countries. This indicates that the potential gains from deeper integration among the industrial countries are far larger than estimates that consider only conventional barriers (as do Anderson et al. 2001) would suggest. Of course, such extensive liberalization in these countries may not be an option because of the short-run political stresses that would be caused by contraction in these countries' protected sectors. Our analysis does not provide a recipe for reform, but it does show that the potential gains from future attempts to integrate markets remain quite large.

Winners and Losers

Although our analysis shows that all the countries examined would gain from further opening to trade, some groups within those countries would lose, while others would win. An examination of real factor price changes sheds light on this issue. The model we use contains five factors: capital, skilled labor, unskilled labor, land, and natural resources. We can therefore obtain broad results on income distribution among these large groups.

Table 4.2 reports the effects of trade opening on after-tax real factor prices for the different scenarios.

Both types of labor gain in all countries in each scenario, indicating that, for these industrial countries at least, market fragmentation imposes burdens on workers as a whole. The more efficient allocation of resources that opening brings would raise workers' real income overall. Of course, some workers may have to pay the costs of adjusting between sectors in the short run—costs that the model does not capture. Overall, these gains are remarkable but not entirely unexpected, given that the model is not based solely on perfect competition. Whereas traditional models based on the Hecksher-Ohlin framework would lead us to expect that the production factors used relatively intensively in import-competing industries, such as unskilled labor, would lose from liberalization (the Stolper-Samuelson theorem), models that allow for imperfect competition, scale economies, and additional investment can yield more optimistic implications.[3]

Capital benefits from opening as well, except in Australia in the cases of multilateral opening and the eight-country PTA, and in the United States under the PTA. Japanese capital owners would gain quite a bit more than their counterparts in other countries, reflecting the fact that Japan generally has comparative advantage in capital-intensive goods.

These simulations imply huge impacts on landowners in certain countries. In all scenarios involving Japan, the modeling predicts that Japanese landowners' real incomes would decline by nearly half. Indeed, these results may help explain why Japan has been slow to liberalize despite the benefits that it would enjoy in the aggregate. Italian, British, and, to a more moderate degree, German landowners would also be hurt by unilateral opening. On the other hand, Australian, Canadian, and Dutch landowners would reap huge benefits from both multilateral opening and the PTA.[4] These gains would be much higher than with unilateral opening because agricultural protection in these countries is relatively low, meaning that enhanced export opportunities, not cheaper imports, provide the main payoffs. The opening of foreign markets, especially in Japan, combined with free markets in manufactures at home, would increase real returns to land by one third or more in these countries. In the United States, landowners' welfare depends crucially on whether opening is unilateral or multilateral. Whereas unilateral liberalization hurts US landowners, multilateral opening increases the real returns to US land by 6 percent, and a PTA provides a 12 percent boost. The results also indicate

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[3] . For a review see Krugman and Obstfeld (2003, chapters 4 and 6).

[4] . It should be kept in mind that these countries' large shares of trade in GDP amplify the percentage changes.

Table 4.2 Welfare impact on economic factors in sample countries of complete removal of barriers

(percent of income of indicated factor)

Type of opening and factor affected	Australia	Canada	Germany	Italy	Japan	Netherlands	United Kingdom	United States
Worldwide opening by countries individually								
Skilled labor	2.3	3.8	5.2	3.4	7.8	9.1	6.4	1.1
Unskilled labor	2.5	3.8	5.3	3.2	7.0	10.7	6.6	1.1
Capital	0.2	1.3	3.4	1.6	6.8	2.5	1.5	0.4
Land	5.5	3.0	−0.4	−14.0	−47.4	8.5	−6.4	−0.6
Natural resources	9.6	7.7	6.6	0.0	−21.6	14.3	18.9	6.6
Worldwide opening by all eight countries								
Skilled labor	3.2	5.0	5.8	4.0	8.0	11.0	6.9	1.2
Unskilled labor	4.5	5.7	6.1	4.3	7.3	14.2	7.3	1.4
Capital	−0.4	1.1	3.4	1.4	6.9	2.0	1.3	0.0
Land	36.5	38.3	7.4	−7.9	−47.2	33.3	−1.0	6.4
Natural resources	14.5	14.6	10.4	1.8	−21.1	19.7	25.7	11.0
FTA by the eight countries								
Skilled labor	3.0	4.4	3.6	3.2	6.0	8.8	4.1	1.0
Unskilled labor	4.8	5.7	4.1	4.4	5.4	13.6	4.8	1.3
Capital	−0.7	0.5	1.8	0.6	5.0	0.8	0.2	−0.2
Land	49.9	45.0	15.5	2.8	−42.2	74.0	4.5	11.6
Natural resources	−2.5	4.1	4.8	1.5	−13.3	1.8	9.0	1.7

that natural resource owners are heavily protected in Japan. However, natural resource factors are the most difficult to measure, making these results the most uncertain.

Overall, these simulations provide a compelling picture of the potential gains from deeper international integration in industrial countries. They suggest not only that each country will gain in the aggregate, but also that most productive factors within each country will gain. The noteworthy exceptions are owners of land in Italy, Japan, and the United Kingdom and owners of natural resources in Japan. They help explain, too, why the trends toward deeper integration among industrial countries have been so strong over the past half century and why agriculture, particularly in Europe and Japan, has been a noteworthy exception.

Additional Description of the Model and Methodology

Production Structure

Production involves the use of intermediate goods and, as noted above, five factors: capital, skilled labor, unskilled labor, land, and natural resources. In our model only capital can move freely across national boundaries; all factors can move freely across sectors. Value added in each sector has a constant elasticity of substitution (CES) production function. This formulation means that, within each sector, the elasticity of substitution between any two factors is the same. We use the same values as Harrison, Rutherford, and Tarr (1997) for these elasticities, which they estimated using US time-series data from 1947 to 1982 and using the same functional form as we used in our applied general equilibrium model. They, however, used only three factors—capital, labor, and land—instead of five. See table 4.3 for these estimates and their standard errors. The production function for intermediate goods and the value-added composite is that of Leontief. Relaxing this assumption does not significantly change the results.

Some sectors are assumed to have constant returns to scale. Other sectors, however, are modeled with increasing returns to scale and imperfect competition.[5] In these sectors there is firm-level product differentiation, with output being a composite of varieties. Firms have fixed costs and constant marginal costs, meaning that reducing the number of firms leads to gains from rationalization. These firms compete using quantity conjectures, with entry and exit that drive profits to zero.

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[5] See table 4.3 for the sectors and the markups used. The table also presents alternative markups from the GTAP model. The results are robust to the set of markups used.

Table 4.3 Estimated factor substitution elasticities and Lerner indices by sector

Product category	Factor substitution elasticity	Standard error	Lerner indices[a]	
			HRT	GTAP
Fruits, nuts, vegetables	0.945	0.041	0	0
Other agriculture	0.945	0.041	0	0
Other crops	0.945	0.041	0	0
Live animals	0.945	0.041	0	0
Other animal products	0.945	0.041	0	0
Fish	0.945	0.041	0.05	0
Coal, gas, oil	0.293	0.102	0.03	0.05
Other minerals	0.426	0.105	0.08	0.05
Bovine cattle, sheep, goat, and horse products	0.945	0.041	0.10	0
Other meat products	0.945	0.041	0.10	0
Vegetable oils and fats	0.945	0.041	0.03	0
Dairy products	0.945	0.041	0	0
Processed rice	0.945	0.041	0.13	0
Sugar	0.945	0.041	0.03	0
Other food products	0.945	0.041	0.03	0
Beverages and tobacco products	0.945	0.041	0.03	0
Textiles	0.927	0.077	0.06	0.14
Wearing apparel	0.927	0.077	0.13	0.13
Leather goods	0.927	0.077	0.13	0.13
Lumber and wood products	0.945	0.041	0.05	0
Pulp, paper products, publishing	1.202	0.090	0.05	0.15
Coal and petroleum products	0.293	0.102	0.03	0.05
Chemicals, plastics, and rubber	1.009	0.027	0.04	0.15
Nonmetallic mineral products	0.426	0.105	0.08	0.05
Primary ferrous metals	0.911	0.241	0.05	0.13
Nonferrous metals	0.958	0.132	0.05	0.13
Fabricated metal products	1.189	0.055	0.05	0.12
Motor vehicles and parts	1.202	0.090	0.11	0.12
Electronic equipment	1.202	0.090	0.06	0.15
Machinery and equipment	1.202	0.090	0.06	0.15
Other manufacturing products	1.202	0.090	0.06	0.15
Trade and transport services	1.283	0.525	0	0
Other services	3.125	0.817	0	0
Investment goods	1.988	0.477	0	0

GTAP = Global Trade Analysis Report, www.gtap.org.
HRT, as estimated by Harrison, Rutherford, and Tarr (1997).

a. Defined as $(P - MC)/P$, where P is price and MC is marginal cost.

Dynamics are incorporated by allowing the capital stock to vary in response to changes in the rate of return caused by liberalization. If the rate of return increases, investment increases the capital stock until its return is driven back down to the long-run equilibrium. The results, therefore, reflect the model's predictions for what happens after the capital stock has changed by enough to return the price of capital to its original level. The capital adjustment process is not modeled, and the time horizon implied by these results depends on how long one thinks it takes capital to respond to differences in interest rates. The model ignores the consumption forgone by the increased investment, which may overstate the estimated benefits. On the other hand, the model ignores any impact of growth on productivity and innovation, which leads to an underestimate of the gains.

Demand Structure

On the demand side, each region has a representative consumer and a single government agent, each of whom has a nested CES utility function and practices multistage budgeting. At the top level, demand across the 33 sectors is Cobb-Douglas. Consumers first decide how much to spend on each of the 33 aggregate goods, given total income and aggregate prices. Each of these goods is a CES composite of domestic output and an import composite, which are imperfect substitutes. At this second level, consumers divide spending between the domestic good and the import by maximizing a CES utility function subject to the total spending they have allocated to that sector and given the aggregate prices in that sector. At the third level, the model invokes the Armington assumption in that imports of the same good from different countries are assumed to be imperfect substitutes. Preferences across these different goods from different countries are given by a CES utility function. At this third level, consumers choose quantities of each import subject to the amount they have budgeted for aggregate imports at the second level and subject to the various prices. We follow Harrison, Rutherford, and Tarr (1997) and set the elasticity of substitution across import varieties, σ_{MM}, equal to 8 and the elasticity of substitution between the import composite and the domestic good, σ_{DM}, equal to 4. The choice of these elasticities does affect the results. Higher elasticities lead to greater substitution in response to price reductions and, in general, larger welfare gains from liberalization. Roughly speaking, cutting these elasticities in half reduces the gains by 10 to 50 percent, depending on the region and the simulation. Similarly, doubling them increases the estimated gains by about 20 to 100 percent. Even such wide changes in the calibration, however, do not change any of our main conclusions.[6]

In the sectors with increasing returns, yet another level of constrained choice is introduced. In this setup the domestic good and each import good produced in each region, instead of being homogeneous goods, are themselves composites of different varieties produced by the different firms. Consumers have CES preferences over these varieties and allocate spending across them subject to the amount they budgeted

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[6] . Recent studies indicate that elasticities of 8 and 4 are perhaps on the low side, indicating that our predicted gains are conservative.

for each good at the third level. The elasticity of substitution across these varieties is set at 15. All results are robust to wide changes in this parameter.

Incorporating Our New Data

In the original model, all policy distortions enter as ad valorem price wedges,[7] which, conveniently, is the form that our protection data take. So replacing the GTAP tariff equivalents with our own is fairly straightforward. We did not, however, simply use our fragmentation measures, since they apply only to final goods, whereas almost all of the sectors of the model contain a combination of final and intermediate goods. Instead we used a weighted average of our data (BL) and the original GTAP data. The weight on our measure was the fraction of output in that sector sold to final demand; the weight on the GTAP measure was 1 minus our weight. Thus, letting BL and GTAP be the two protection measures, and α the final demand fraction, the protection estimate used was $\alpha\text{BL} + (1 - \alpha)\text{GTAP}$. Using this method ensures that model sectors with a high proportion of final goods use an estimate of protection close to ours, whereas sectors with a low fraction of final goods use an estimate close to the GTAP measure. Put another way, the lower the final demand fraction, the less we deviated from the standard GTAP data. See table 4.4 for a comparison of these weighted data and the original GTAP data.

The data on distribution margins used to derive the protection measures allow us to model distribution more accurately within the applied general equilibrium (AGE) framework. Most AGE trade models using this framework do not account for margins explicitly. All distribution services are lumped into the trade and transport sector and consumed as a separate good, instead of being linked to the goods that use those distribution services. Since margins vary across sectors, this obscures the role of distribution in the economy and can skew the results of applied general equilibrium analyses. For instance, simulations of price reductions in other sectors may imply a large substitution out of trade and transport services, even though actual consumption of these services would probably increase in order to facilitate commodity flows. Also, not accounting for margins implies that consumers base their choices on producer prices instead of the higher consumer prices, which include margins.

We attempt to address these problems by incorporating distribution explicitly into each final demand sector for which we have data on margins. We do this by treating margins like taxes, since margins create a wedge between consumer and producer prices. For the eight countries

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[7] Government revenue is held constant throughout all simulations by assuming that lump-sum taxes are enacted to replace any lost tax revenue.

Table 4.4 Comparison of weighted data and original GTAP data

Product category	Australia	Canada	Germany	Italy	Japan	Netherlands	United Kingdom	United States
New data[a]								
Fruits, nuts, and vegetables	4.6	6.0	35.1	15.3	94.1	13.9	34.0	17.4
Other agriculture								
Other crops	2.1	66.8	83.0	6.9	52.5	9.7	89.1	32.2
Live animals	1.0	0.3	36.6	31.4	149.1	34.9	38.2	1.1
Other animal products	7.2	19.3	6.7	6.4	7.8	7.2	25.6	2.3
Fish	8.6	1.2	11.4	11.4	16.2	8.7	7.7	5.1
Coal, gas, oil								
Other minerals								
Bovine cattle, sheep, goat, and horse products	0.0	18.1	109.7	39.0	265.4	80.6	99.6	8.3
Other meat products	3.0	29.3	41.8	23.3	119.8	29.6	37.6	5.5
Vegetable oils and fats	20.2	13.1	27.3	15.4	46.0	13.8	12.2	6.0
Dairy products	19.1	77.8	30.8	33.8	173.7	53.0	43.4	32.0
Processed rice	0.4	0.6	47.9	28.9	224.3	25.4	23.7	13.1
Sugar	11.7	8.3	66.3	37.2	111.0	72.4	69.2	46.9
Other food products	10.9	11.4	21.5	24.8	98.3	23.8	27.1	11.3
Beverages and tobacco products	54.1	35.6	33.9	37.8	59.6	35.2	45.2	15.4
Textiles	24.9	26.3	30.1	9.4	16.6	29.8	29.9	16.8
Wearing apparel	12.7	24.2	23.1	46.1	33.4	33.5	26.0	14.0
Leather goods	27.9	22.8	27.5	12.2	71.4	84.1	20.9	14.1
Lumber and wood products	5.7	8.4	4.2	4.4	4.6	6.2	8.8	2.6
Pulp, paper products, publishing	3.9	5.6	3.2	4.2	4.7	12.7	5.7	2.3
Coal and petroleum products								
Chemicals, plastics, and rubber	4.0	5.4	8.7	5.7	7.6	5.7	7.4	10.4
Nonmetallic mineral products	6.0	13.4	8.6	5.3	10.8	7.3	8.2	6.8
Primary ferrous metals								
Nonferrous metals								
Fabricated metal products	6.6	6.5	3.7	4.2	3.5	5.6	5.9	4.6
Motor vehicles and parts	11.4	6.7	11.1	9.7	0.1	20.1	27.9	7.8
Electronic equipment	3.4	10.6	5.7	5.6	5.9	4.9	8.5	2.4
Machinery and equipment	7.2	4.1	4.7	3.7	2.6	4.4	9.7	4.2
Other manufacturing products	10.3	9.3	10.7	5.1	18.7	21.8	11.9	5.7
Trade and transport services								
Other services								
Investment goods								

GTAP data								
Fruits, nuts, vegetables	2.0	1.9	14.5	14.5	44.9	14.5	14.5	4.7
Other agriculture	1.0	2.0	3.0	18.0	30.0	4.5	23.0	3.0
Other crops	2.7	2.4	3.1	3.1	22.1	3.1	3.1	21.5
Live animals	0.8	0.2	36.6	36.6	149.1	36.6	36.6	1.1
Other animal products	0.5	19.8	6.7	6.7	5.0	6.7	6.7	0.6
Fish	0.3	0.4	6.8	9.6	4.9	7.5	6.9	0.6
Coal, gas, oil	0.0	0.0	0.0	0.0	-0.8	0.0	0.0	0.2
Other minerals	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Bovine cattle, sheep, goat, and horse products	0.1	16.3	88.9	88.9	36.4	88.9	88.9	5.3
Other meat products	4.1	72.4	30.9	30.9	58.2	30.9	30.9	3.6
Vegetable oils and fats	2.8	8.6	11.4	11.4	6.6	11.4	11.4	4.3
Dairy products	7.3	214.8	87.7	87.7	287.0	87.7	87.7	42.5
Processed rice	1.0	0.7	87.4	87.4	409.0	87.4	87.4	5.3
Sugar	13.9	4.9	76.4	76.4	116.1	76.4	76.4	53.4
Other food products	5.6	14.1	28.8	28.8	38.3	28.8	28.8	11.4
Beverages and tobacco products	9.2	62.5	8.3	8.3	16.2	8.3	8.3	3.0
Textiles	17.0	15.7	9.7	9.2	8.5	9.8	9.5	11.2
Wearing apparel	29.3	21.2	12.1	12.2	12.5	12.0	11.9	13.3
Leather goods	13.0	15.3	8.4	6.5	15.3	8.7	8.7	13.5
Lumber and wood products	4.5	6.8	2.8	2.7	2.7	3.0	2.8	2.2
Pulp, paper products, publishing	3.1	1.9	2.9	2.4	0.5	2.7	2.6	1.0
Coal and petroleum products	0.0	6.2	2.7	3.0	3.3	3.1	2.9	2.2
Chemicals, plastics, and rubber	3.5	4.8	5.1	5.3	2.0	4.8	4.7	3.5
Nonmetallic mineral products	4.7	5.7	5.4	5.2	1.2	5.2	5.1	6.1
Primary ferrous metals	4.7	4.7	3.2	3.2	2.5	3.2	3.4	3.4
Nonferrous metals	1.4	0.5	2.1	1.2	0.4	2.9	1.5	1.7
Fabricated metal products	6.4	6.3	3.7	3.9	1.2	4.0	3.8	3.8
Motor vehicles and parts	9.2	6.1	7.7	8.6	0.0	8.4	8.3	2.4
Electronic equipment	1.6	1.2	4.3	4.5	0.0	4.2	4.2	1.2
Machinery and equipment	4.3	3.3	3.1	3.1	0.3	3.1	3.1	2.7
Other manufacturing products	3.7	3.8	3.7	3.8	1.9	3.9	2.5	1.7
Trade and transport services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Investment goods	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

GTAP = Global Trade Analysis Project data, www.gtap.org.

a. Weighted averages of authors' final goods protection data and GTAP data, with the final demand fraction in each sector used as the weight. Sectors for which the authors' protection data did not apply are left blank.

involved, therefore, we inserted margin wedges into each of the relevant sectors.[8] We also reduced the value of the trade and transport sector by the total value of these margins. Finally, we reduced inputs into the trade and transport sector and redistributed them across the final goods sectors in accordance with the amount of distribution services used in those sectors.[9]

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[8] See Gohin (1998) and Komen and Peerlings (1996) for other examples of modeling margins in this way within applied general equilibrium models. Bradford and Gohin (2002) explicitly model the distribution sector for the United States within such a model.

[9] These modifications apply only to final goods. Because of lack of data, we do not modify the model to account for distribution of intermediate goods. It turns out that these intermediate margins are quite a bit smaller than the margins for final goods.

Appendix 4.1
Confidence Intervals

Most researchers using applied general equilibrium models report only point estimates for their simulations and then check the robustness of their results by varying influential parameters in systematic but somewhat ad hoc ways. Abdelkhalek and Dufour (1998), however, present a straightforward procedure for developing well-grounded confidence intervals for these simulations. They point out that when simulation parameters are estimated and therefore have standard errors, one can derive confidence intervals for endogenous variables by using a projection technique. This involves using the standard errors for the estimated parameters to set appropriate lower and upper bounds.

Let $\hat{\beta}_i$ be one of k estimated model parameters. Invoking the Boole-Benferroni inequality, Abdelkhalek and Dufour show that the lower bound of a $1 - \alpha$ confidence interval for an endogenous variable can be found by setting all the estimated parameters equal to the lower bound of a $1 - \alpha/k$ confidence interval. Thus, if s_i is the standard error for $\hat{\beta}_i$ and is normally distributed, then the value of this parameter inserted into the model in order to get a lower bound is $\hat{\beta}_i - z_{\alpha/k}s_i$ (where z refers to a critical value from the standard normal distribution). This is done for all k parameters. Similarly, using $\hat{\beta}_i + z_{\alpha/k}s_i$ for each of the k parameters produces the upper bound. These confidence intervals will be conservative (that is, probably wider than needed), because this approach assumes that each of the parameter estimates is independent of each of the others. If some or all of the covariance structure across the parameter estimates is known, one could exploit that knowledge to derive tighter intervals (Abdelkhalek and Dufour 1998).

As discussed in the text, the only parameters that influence our results, besides σ_{MM} and σ_{DM}, are the factor substitution elasticities. Since these parameters are estimated, we can use their point estimates and standard errors to derive confidence intervals for our welfare results. Table 4.3 presents the substitution elasticity estimates, along with their standard errors. There are 12 different estimates, and so the lower bound of a 95 percent confidence interval on the simulation results will result from replacing each of these estimates with $\hat{\beta}_i - z_{0.05/12}s_i = \hat{\beta}_i - 2.64s_i$. The upper bound will be found by using $\hat{\beta}_i + 2.64s_i$ instead. Table A4.1 reports the upper and lower bounds for these 95 percent confidence intervals for overall welfare changes.[10] For all of the main results (those on the diagonal), the gains are positive with 95 percent confidence and are almost certainly large.

To be sure, these confidence intervals are conditional on the model and the other parameters (the ones that are not varied) being correct. Any

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[10] It turns out that the confidence intervals for factor prices are extremely small, so they are not reported.

Table A4.1 Upper and lower bounds on confidence intervals for welfare estimates

Country or region affected	Country or countries removing barriers																			
	Australia		Canada		Germany		Italy		Japan		Netherlands		United Kingdom		United States		All eight countries		Eight-country FTA	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Australia	0.67	2.51	0.01	0.03	0.05	0.17	0.01	0.04	0.99	2.31	0.00	0.02	0.14	0.35	0.15	0.39	2.02	5.89	2.37	6.29
Canada	0.02	0.06	0.16	1.80	0.02	0.06	0.08	0.12	0.32	0.72	0.01	0.02	0.04	0.11	1.26	2.16	1.86	5.15	1.93	5.39
Germany	0.01	0.04	−0.01	−0.01	0.47	2.04	0.17	0.32	−0.12	0.03	0.20	0.40	0.16	0.45	0.06	0.19	0.99	3.59	0.94	2.98
Italy	0.02	0.07	0.01	0.04	0.36	0.98	0.85	2.98	−0.09	0.14	0.06	0.17	0.17	0.60	0.07	0.26	1.51	5.42	2.36	6.78
Japan	0.03	0.06	−0.01	0.00	−0.02	0.00	0.00	0.01	2.92	3.19	0.01	0.02	−0.01	0.02	0.09	0.16	3.05	3.50	1.98	2.37
Netherlands	0.03	0.07	0.00	0.01	1.12	1.97	0.46	0.70	−0.03	0.29	1.37	6.03	0.66	1.41	0.22	0.42	3.77	11.59	5.58	13.00
United Kingdom	0.01	0.00	0.01	0.02	0.16	0.38	0.07	0.13	0.17	0.30	0.14	0.29	1.54	4.88	0.13	0.28	2.23	6.47	1.34	4.29
United States	0.00	−0.02	0.13	0.28	0.02	0.06	0.01	0.01	0.29	0.52	0.01	0.02	0.04	0.09	0.16	0.65	0.53	1.55	0.88	1.85
China	0.03	0.06	0.04	0.06	0.10	0.14	0.03	0.05	0.72	0.83	0.01	0.04	0.04	0.08	0.51	0.58	1.35	1.62	−0.62	−0.53
Korea	0.03	0.04	0.00	0.00	0.02	0.04	0.01	0.01	0.53	0.69	0.00	0.00	0.01	0.05	0.20	0.29	0.78	1.14	−0.49	−0.51
Rest of Asia	0.04	0.09	0.01	0.04	0.12	0.27	0.04	0.09	0.66	1.36	0.01	0.07	0.11	0.27	0.31	0.66	1.31	2.74	−0.77	−0.81
Brazil	−0.02	−0.04	0.01	0.02	0.12	0.24	0.03	0.09	0.34	0.50	0.01	0.04	0.06	0.13	0.21	0.43	0.77	1.36	0.10	−0.07
Rest of Latin America	0.00	−0.01	−0.01	−0.01	0.09	0.22	0.04	0.10	0.34	0.75	0.02	0.03	0.06	0.13	0.53	1.18	1.19	2.70	−0.35	−0.62
Rest of Europe	0.01	0.03	0.00	0.01	0.35	0.83	0.12	0.28	0.03	0.22	0.10	0.27	0.27	0.68	0.08	0.22	0.95	2.50	−0.71	−0.96
Middle East	0.01	0.00	0.02	0.03	0.20	0.49	0.10	0.22	0.40	0.72	0.06	0.13	0.23	0.51	0.29	0.53	1.32	2.67	−0.03	0.03
Rest of world	−0.01	−0.01	0.00	0.02	0.24	0.49	0.11	0.21	0.36	0.53	0.05	0.09	0.14	0.29	0.07	0.15	0.99	1.76	0.10	0.02
Developing countries	0.02	0.02	0.01	0.03	0.15	0.30	0.06	0.13	0.48	0.80	0.03	0.07	0.10	0.22	0.30	0.56	1.14	2.11	−0.29	−0.37
Industrial countries	0.02	0.07	0.05	0.16	0.14	0.44	0.09	0.26	0.78	1.03	0.07	0.21	0.18	0.54	0.15	0.43	1.45	3.13	1.13	2.42
World	0.02	0.06	0.04	0.13	0.14	0.40	0.08	0.22	0.70	0.97	0.06	0.17	0.16	0.46	0.18	0.46	1.37	2.88	0.78	1.74

confidence interval is conditional on the underlying model being correct, and so this aspect of our confidence intervals does not distinguish them from conventional ones. In addition, however, our confidence intervals depend on the value of any influential fixed parameters, such as the elasticity of substitution between domestic goods and the corresponding import composites, σ_{DM}, and the elasticity of substitution across import varieties, σ_{MM}. As mentioned in the text, varying these parameters widely by halving or doubling them does affect the magnitude of the welfare gains but does not affect whether any confidence interval lies entirely above zero. Thus the main story told by the interval estimates is robust to wide changes in other parameters.