Trade Impacts of the Terrorist Attacks of 11 September 2001: A Quantitative Assessment

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Abstract

This paper used estimates of changes in frictional trading costs and the Global Trade Analysis Project (GTAP) computable general equilibrium model to assess the effects of the terrorist attacks of 11 September on international trade. Following the 11 September events, regulatory measures were implemented to tighten security at air and seaports as well as land border crossings. As a result, trading and transport companies have been confronted with additional frictional trading costs, in particular costs relating to transport, handling, insurance, and customs. These additional costs make international trade more expensive and will tend to reduce trade flows. The results from scenario analysis show that regions with high trade to GDP ratios, such as South Asia or North Africa and the Middle East, suffer the largest trade and welfare losses in relative terms. Across sectors, trade in agri-food products, textiles, non-metallic minerals, and machinery is most severely affected by the higher frictional costs of trade.

Keywords

Terrorism, security concerns, non-tariff measures, frictional trading costs, CGE modeling.

JEL classification

National security and war (H560); Country and industry studies of trade (F140).

1. Background

The nature and scale of the terrorist attacks of 11 September 2001 on New York City and Washington, D.C., meant that the political and economic impacts would not be locally or nationally confined, but would affect governments, businesses, and people world-wide. Consumer and investor confidence plummeted after the tragic events, and economic researchers downgraded their forecasts of short and medium-term economic growth for virtually all countries around the globe. Moreover, emergency measures were taken to tighten security at air and seaports as well as land border crossings. Some disruption of trade flows during the immediate aftermath of the attacks seemed almost inevitable, yet additional frictional trading costs due to tighter security, notably costs relating to transport, handling, insurance, and customs, have the potential to continue to affect trade in the medium to long term.

Some have likened the higher frictional trading costs to additional taxes on business activity or increases in border tariffs. Yet, a comparison with business spending on mandatory pollution abatement equipment seems more appropriate, as the higher expenses for the private sector provide benefits to the general public (higher environmental quality and lower risk of terrorist attacks, respectively), but are generally not accompanied by additional tax or tariff revenues for governments. Some industry experts have estimated that the additional security-related costs amount to up to three per cent of the value of traded goods (Leonard, 2001), while other analysis suggests that the magnitude of the effects is more

modest (OECD, 2002a, 2002b). Nevertheless, in an era of large-scale economic interdependance and vertical specialisation, even small changes in trading costs can have considerable economic effects.

Empirically, the impacts of the higher transport and trading costs on trade flows are to a large extent masked through other economic developments. For example, following the 11 September events world oil prices fell, thereby reducing the fuel costs of transport operators and at least partly offsetting the security-related cost increases. Also, existing capacities of transport operators did not make it possible for them in the short run to fully pass on the increases in frictional costs to consumers, so that transport fees after the attacks did not necessarily reflect the changes in security-related costs.

This paper uses estimates of changes in frictional trading costs and the Global Trade Analysis Project (GTAP) computable general equilibrium model to separate out and assess the effects of the terrorist attacks of 11 September on international trade. Combining data on frictional cost changes with GTAP's information on transaction costs and bilateral trade flows across a large number of sectors and countries makes it possible to analyse and quantify the trade effects of the 11 September events. Moreover, the general equilibrium framework enables an evaluation of the incidence of changes in the trading environment and an assessment of economic welfare effects.

The remainder of the paper is organised in four parts. Section 2 reports on available empirical evidence of the terrorist attacks of 11 September on the business environment for transport and trading companies. Section 3 presents the quantitative approach to model the impact of frictional cost changes on international trade flows and economic welfare. The results of the modelling analysis are then discussed in section 4, and the final section 5 contains conclusions.

2. Impact of the terrorist attacks on frictional costs of trade

Because of the fear of future terrorist attacks, the 11 September events have triggered a variety of regulatory measures and demands on transport companies that entail new costs and longer delays at border crossings. The prevalence and thoroughness of inspections at airports, seaports, and land borders has been increased, shipping companies have had to face expenditures for additional security equipment and personnel, and transport insurance rates have been augmented. These developments have been most pronounced in North America, but are similarly felt in other parts of the world.

2.1 Air transport

Tightening security on airports and aircraft has been one of the foremost priorities of public authorities. Immediately after the attacks, all US airports were closed for three days to review and strengthen security procedures. Around the world, access to airports and aircraft was tightened, training programmes for ground and flight staff were initiated, and more sophisticated alert and airspace management systems were launched. Concerning passenger traffic, more thorough controls of passengers and their luggage have been implemented, the classification of objects in hand luggage that could potentially be used as weapons has been modified, and in-flight protection has been stepped up by blocking cockpit access and putting armed air marshals on flights.

Air freight transport has been similarly affected. Since the 11 September events, x-ray machines to examine cargo boxes and check whether the contents match shipping labels have been used more extensively. Other precautions taken include earlier drop-off deadlines at airports, bans on shipments from unknown customers, and waiting periods before shipments are put on planes.

Following the 11 September attacks, insurers and re-insurers modified their aviation plans considerably whenever a "war and allied perils clause" in existing contracts authorised such changes. Coverage was reduced while premiums went up. Premia for air and sea cargo shipments were raised by

between 0.027 per cent and 0.05 per cent of total insured fleet value.[1] Additional premia of $1.25 to $1.85 per passenger have been charged in passenger transport. Also, insurers decided to limit the cover for third party damages caused by terrorist action to $50 million (instead of $1.5 billion). In order to avoid major disruptions of air traffic due to lack of insurance coverage, regulators in several countries enforced short-term measures to support third party insurance for airline companies in case of a new terrorist attack with damages above $50 million.

In response to increased security provisions and insurance costs, many airlines began to apply "security surcharges". Generally, fee increases amounted to up to $8 per passenger or fell within the range of $0.10-$0.15 per kg of cargo (OECD, 2002a). In addition to increases in security fees, cargo shipments have been affected by frequent hold-ups and detours. During the three-day shutdown of the US air transport system, many transportation providers had to shift from air transport to road or rail transport to maintain shipment commitments. Later on, many airlines in North America, Europe, and Asia dropped flights from schedules, because of the weakening of passenger confidence and demand for air transport. On a year on year basis, world-wide passenger traffic dropped by 23 per cent in October and freight traffic by 9 per cent.[2] This decrease was far more pronounced than the reduction in air traffic during the Gulf War, for example. Yet, traffic volumes have been recovering towards normal levels by the end of 2001.

The marked decline in passenger traffic in autumn 2001 caused delays in the movement of goods that are carried in the belly space of passenger planes. Also, several airlines closed some of their freight handling facilities as a result of decreasing cargo volumes. For example, American Airlines temporarily closed its freight handling operations at the international airports of Buffalo-Niagara, Greater Rochester, and Salt Lake City. As a result, cargo had to be routed through other transport hubs.

2.2 Maritime transport

A large share of the world's cargo moves through seaports. Yet, in the past port facilities often lacked security equipment, such as x-ray devices, and had relatively lax controls of access to docks and ships. Only about 2 per cent of the 72 million containers that are moved internationally every year used to be inspected.[3] After 11 September, more extensive security checks and use of surveillance cameras and cargo scanners have been a priority. The Port Authority of New York and New Jersey closed its operations for two days, and more intensive screening of cargo loads in US and Canadian harbours has caused substantial delays before cargo could be picked up. These hold-ups disturbed shipping timetables world-wide during the first weeks following the terrorist attacks. As ships to and from North America have experienced delays, subsequent routes have been affected by delays as well.

Other precautionary measures in Canada and the USA have consisted of mandatory 96-hour advance arrival notices and more frequent onboard Coast Guard inspections of crews and cargo. Also, ships have had to travel at slow speeds inside US harbours, flanked on each side by a tugboat in order to protect, for example, bridge supports against abrupt changes in direction. Shipping companies have been charged $1 000 to $1 500 for the required tugboat escorts.[4]

Over time, emergency measures taken immediately after the 11 September events have been relaxed, transport operators have adjusted to the new procedures, and transport and trading activities seemed to be running relatively smoothly again by the end of 2001. In the longer run, technological and procedural progress might make it possible to further reduce the post-11 September delays and procedural costs while providing the desired high level of security.

Similar to developments in the air transport industry, war-risk insurance premia for maritime transport rose sharply after the terrorist attacks on New York City and Washington, D.C. In response, ship

owners and vessel operators have implemented war risk surcharges on ocean freight cargo transiting the Middle East, Red Sea and Eastern Mediterranean. Beginning in early October, ocean carriers operating in the Europe/Far East and certain Middle East trade lanes announced war risk surcharges for traffic to and from specific ports as well as cargo transiting the Suez Canal, regardless of the origin and destination ports. War risk surcharges range from $10 to $450 per Twenty Foot Equivalent Unit of full container loads, and from $5 to $12 per cubic metre of less than full container loads.[5] The application of the surcharges meant that total insurance rates for shipments from India to Persian Gulf ports, for example, went up by about 50 per cent.[6]

2.3 Road and rail transport

The reinforcement of US customs vigilance during the processing of commercial vehicles led to lengthy delays immediately after the terrorist attacks. The US-Mexican border was closed for a short period, but hold-ups at the US-Canadian border were at least equally substantial. In Detroit, Port Huron, and Buffalo waiting times amounted to 10 to 12 hours in mid-September. Later, delays were reduced as additional customs personnel took up duty and logistics were improved by posting wait times on the US customs internet-site. But by the end of September, truck operators still reported four-hour backups at the US-Canadian border while loads were searched by customs agents. Prior to 11 September, delays at the border had typically lasted only about 30 minutes (OECD, 2002a).

Road transportation companies themselves have been taking a variety of new measures against terrorist attacks. Some are fencing unsecured freight yards and terminals, conducting background checks on drivers, and issuing identity badges to employees, while others have installed satellite-tracking systems to monitor the exact location of trucks and trailers or equipped their vehicles with sensors that can detect whether a cargo container has been opened before reaching its destination. Similarly, train operators have taken precautionary measures such as more frequent inspections of tracks, bridges and tunnels, strengthening critical buildings and communication facilities, and installing fibre optic cables along tracks to detect tampering.

2.4 Customs procedures

Prior to the terrorist attacks, estimates of the cost of time delays, paperwork, and compliance related to border crossing ranged from 5 per cent to 13 per cent of the value of the goods involved, depending on the types of goods traded (OECD, 2002a). The increased security at borders after 11 September 2001 has further augmented these customs-related costs. However, in the longer term the attention and resources newly devoted to customs inspections might trigger efforts to develop more efficient security procedures and improve border management.

Measures to facilitate trade could include the reduction of the number of in-transit cargo inspections, the electronic collection of customs duties, and improved information sharing between authorities. As a result, customs services could become more able to reconcile policing of borders with smooth and open trade flows. The benefits of customs harmonisation have recently been illustrated through research by Japan's Ministry of Economy, Trade, and Industry and the Mitsubishi Research Institute that shows that the introduction of automated customs would lower the direct costs of customs clearance by the equivalent of 0.2 per cent of the value of traded goods. If furthermore the indirect benefits of a reduction in customs related delays are taken into account, additional cost reductions of up to 1 per cent of merchandise value could be realised (Hertel, Walmsley and Ikatura, 2001).

Some concrete results of trade facilitation efforts following the 11 September events have already materialised. For example, on 12 December 2001 Canada and the USA signed a "smart border

declaration" that outlines an 30-point action plan to collaborate in identifying and addressing security risks while expending the flow of people and goods back and forth across the Canada-USA border. The action plan aims to enhance security and strengthen cross-border commerce through improved technology, co-ordination, and information sharing.[7] A similar initiative for the US-Mexico border was unveiled in March 2002.

3. Implications for international trade

Most operators will try to pass along any new frictional trading costs to their clients, although excess capacities and resulting price competition might make it difficult to raise prices in the short term. For example, during the first weeks following the 11 September attacks, many airlines actually lowered their fares for passenger transport as demand collapsed. One major reason for the demand reduction was the substantial decline in travel for tourism purposes. People were concerned about potential further attacks by terrorists and postponed or cancelled their travel plans. Destinations world-wide were affected. Excess capacity has also been an issue in the air and maritime cargo industry, so that transport operators have not been able in the short run to pass on higher security-related costs.

At the same time, developments for fuel prices have been favourable during autumn 2001, lowering overall operating costs for transport companies. Transport activities are fuel-intensive, and expenditure on propulsion fuels accounts for a large share of operating costs. Thus, increases in fuel costs have a substantial impact on transport operators. In past incidents of war and terror in the Middle East, oil prices tended to increase markedly, due to concern over a possible disruption of supplies. For example, after Iraq's invasion of Kuwait in 1990, oil prices shot up from less than $20 to more than $35, triggering a slowdown in global economic growth as well as a substantial increase in transport costs.

Oil price developments after the 11 September events have in comparison been rather atypical. During the first month after the events, oil prices were on average about $4 per barrel lower than during the preceding month (Figure 1). Throughout the subsequent military action in Afghanistan, oil prices stayed below $20 per barrel. The corresponding decline in fuel costs facilitated the adjustments to new security arrangements for transport operators. Indeed, several North American and European airlines, including Northwest Airlines, British Airways, and Lufthansa, eliminated previously existing fuel surcharges that had been introduced earlier in response to then rising expenditures on fuel.

(Figure 1)

Industry experts have estimated that the total costs of extra security measures implemented after the 11 September events could amount to 1 to 3 per cent of the value of traded goods (Leonard, 2001). However, these estimates were made soon after the 11 September events and seem to reflect the major disruptions in the weeks following the terrorist attacks. Over time the costs of the new border security measures have been declining and might continue to do so as technical and procedural progress is realised. On the other hand, new terrorist attacks could give rise to renewed security concerns with implications for the level of frictional costs to international trade.

Some researchers have empirically estimated the impact of changes in transport costs on trade. For example, a recent study of bilateral trade between 103 countries reported an elasticity of trade flows with respect to transport costs of about -3, implying that a transport cost increase of 1 per cent would lead to a reduction in trade volume of 3 per cent (Limao and Venables, 2001). Also, concerning delays at borders, researchers estimated that the daily cost of hold-ups equals on average a 0.5 per cent ad-valorem tariff, with lower values for raw commodities and higher values for intermediate and consumer goods (Hummels, 2001).

In the USA, transport and insurance costs amounted on average to 3.4 per cent of customs value in 2000 (OECD, 2002a). Yet, the cost shares ranged from about 1 per cent for pharmaceuticals to more than 23 per cent for crude fertilisers. Increases in transport and insurance costs will naturally have a stronger impact on those commodities for which frictional costs are more important. Hence, trade in commodities with a high ratio of weight and volume relative to value, like fertilisers, coal, and certain fruits and vegetables, will tend to be more impeded by higher frictional costs than imports and exports of, for example, transport equipment, pharmaceuticals, and natural gas.

A second cross-commodity consideration concerns the prevailing transport mode. Air transport has been relatively most affected by the tightening of security after the 11 September events, so that commodities that are to a large extent shipped by aircraft will likely be subject to higher relative increases in transport costs than commodities that go normally by ship, train, or truck. Goods that are typically transported by air tend to be light, high-value products that need to be delivered quickly, as they are typically subject to frequent lifecycle or fashion changes. Examples include electronics equipment and apparel. However, as indicated in the preceding paragraph, frictional costs generally represent only a small percentage of the value of these products.

Besides higher transport and insurance costs, longer delays at air and seaports, as well as land border crossings have represented another type of international trade impact. Such security-related delays may make producers of perishable products, such as vegetables or fish, reluctant to ship overseas. The risk of spoilage at airports may induce producers to limit their distribution to distances that can be served by truck or train, for example. Moreover, about half of all trade between the USA, Canada, and Mexico is in machinery and transportation equipment, in particular automotive products. Over the past years many automotive companies have adopted just-in-time inventory practices that depend on frequent and predictable shipments from suppliers, including those located in other countries. In this context, unforeseen delays at border crossings can have immediate, disruptive effects on production runs, leading in several cases to factory shutdowns after the 11 September events.[8]

The tightening of security measures and the impact on trade flows has been most pronounced in the countries and regions directly affected by the terrorist attacks and the subsequent "war on terror", i.e. North America, the Middle East, and Central Asia. Hence, trade with countries in these “sensitive” regions has been subject to relatively steep increases in frictional costs following 11 September. Naturally, all US trade was affected by the tightening of security at US borders, but as a large share of Canadian and Mexican exports go to the USA, these NAFTA-partners were almost as strongly exposed to the new measures as the USA itself.

Yet, changes in frictional trade costs were not limited to North America, but occurred world-wide. Indeed, North America is a region with a very low trade to GDP ratio, implying that changes in trade costs tend to affect NAFTA countries to a lesser extent than other regions (Figure 2). In particular, South Asia as well as North Africa and the Middle East, but also Western and Eastern Europe, show a trade to GDP ratio that is more than twice as high as the North American one.

(Figure 2)

In order to determine the overall impact of higher frictional costs on different countries and regions, the importance of trade for particular countries, the mix of traded commodity and their mode of transport, as well as the exposure to "sensitive" locations have to be taken into account. Given the complexity of international trade relations, applied economic models that make it possible to derive estimates of the quantitative impacts of changes in commodity-specific trade costs are necessary tools for this type of analysis. Quantification also enables comparisons of the relative magnitude of the economic

effects of terrorism risk occuring through trade *vis-à-vis* those coming about through other economic activities, such as tourism, finance, and insurance.

4. Modelling the effects of increased security concerns on trade

Earlier research on the economic effects of terrorism has covered a number of issues, including game-theoretic aspects of terrorist action (Lapan and Sandler, 1993), the impact of terrorism on investment and economic growth (Enders and Sandler, 1996; Poirson, 1998; Abadie and Gardeazabal, 2001), and the assessment of terrorism-related losses in the tourisms sector (Enders, Sandler, and Parise, 1992; Pizam and Smith, 2000). Concerning the trade impacts of tighter security measures, limited research has been carried out to date. Anderson and Marcouiller (1999) investigate the linkages between economic insecurity and trade and find that inadequate institutions to constrain corruption and contract negligence reduce trade flows to a larger extent than tariffs. Moreover, Bougheas, Demetriades, and Morgenroth (1999) report a positive relationship between the level of trade cost-reducing infrastructure and the volume of trade, and Hertel, Warmsley and Ikatura (2001) predict considerable gains from reducing frictional costs of trade through improved customs administration.

The following analysis aims to complement existing research by deriving estimates of the post-11 September impact of increased frictional costs on trade flows and economic welfare across geographical regions and economic sectors. Half a year after the terrorist attacks, it remained unclear to what extent the existing increases in frictional costs would persist, and how businesses and public authorities would adjust to the new security environment in the longer term. Evidence to assess these issues will only become available over time, so that a certain degree of uncertainty concerning the frictional cost effects of 11 September remains. Hence, any quantitative estimate should be seen as being primarily indicative.

4.1 Model and data

The analysis is carried out by using the well-established GTAP database and model. The latter is a static, multi-region, computable general equilibrium model that operates under assumptions of perfect competition and constant returns to scale. The model reflects bilateral trade flows, international transport margins, and country and sector-specific rates of import protection. GTAP thereby makes it possible to determine changes in production, consumption, trade, and economic welfare from particular trade-related external shocks, such as changes in trade margins. A full description of the model can be found in Hertel (1997).

The following investigation uses information from the GTAP-5 database to specify ten regions and ten sectors. Nine of the ten regions refer to semi-continental or continental groupings, and the tenth to an aggregate of small countries, for which no detailed information on economic structure is available in the GTAP database. Of the ten sectors, nine represent different types of goods, while services are aggregated into the tenth one. The correspondence of the regions and sectors modelled and their GTAP-5 components is given in Annex Tables 1 & 2.

The GTAP trade data set contains information on transport margins, which are derived from actual transport costs data at the detailed commodity level (SITC-4/5) in the United States. Based on this US data, bilateral margins for other countries are estimated (Gehlhar and McDougall, 2002). Similarly, US data on the commodity-specific modes of transport (ground, sea, air) is extrapolated to other countries.

As discussed earlier, the increase in frictional costs following the 11 September events results in higher trading costs, which are, unlike tariffs, not accompanied by additional revenue for the government. Instead, the benefits of the additional precautionary expenditures take the form of increased public security. Yet, the costs and benefits of providing this public security service are not as such covered in the

GTAP database. Therefore, the analysis of non-tariff shocks and their impact on trade flows requires some adjustments.

The approach taken in this study is analogous to the analysis of non-tariff liberalisation carried out by Hertel *et al.* (2001). It rests on the notion of defining an "effective price" PMS^*_{irs} of commodity *i*, imported from country *r* at domestic prices in destination market *s*. This price is related to the observed price PMS_{irs} as follows:

(1) $PMS^*_{irs} = PMS_{irs} / AMS_{irs}$;

where the technical coefficient *AMS* is unobserved and equal to one in the initial equilibrium. Changes in the value of *AMS* capture the impact of changes in unobserved trading costs on the price of imports from a particular exporter. Thus a decrease in AMS_{irs} triggers an increase in the effective domestic price of good *i* exported from *r* to *s*.

In order to maintain balanced trade flows in the data set, a compensating quantity adjustment is required, so that the "effective quantity" of exports associated with this price is defined such as to ensure that the product of observed price and quantity equals the product of effective price and quantity:

(2) $QXS^*_{irs} = QXS_{irs} \bullet AMS_{irs}$;

Taking the total derivative of expressions (1) and (2), re-arranging terms, and expressing them in percentage terms (denoted by lower case letters) gives the equations for import demand (equation (3)) and composite import price (equation (4)):

(3) $qxs_{irs} = - ams_{irs} + qim_{is} - \sigma^i_m \bullet [pms_{irs} - ams_{irs} - pim_{is}]$;

(4) $pim_{is} = \Sigma_k \theta_{iks} \bullet [pms_{iks} - ams_{iks}]$;

where:

qxs_{irs}: percentage change in bilateral imports of *i of s* from *r*;

qim_{is} : percentage change in total imports of *i* into *s*;

σ^i_m : elasticity of substitution among imports of *i*;

pms_{irs}: percentage change in price of imports of *i* from *r* in *s*;

ams_{irs}: percentage change in effective price of *i* from *r* in *s* due to change in unobserved trade costs;

pim_{is}: percentage change in average import price of *i* in *s*;

θ_{iks}: share of imports of *i* from *k* in total imports of *s*;

With the existing trade elasticities in GTAP, it can be expected that an increase in trade costs will result in a decrease of both observed expenditures on imports and the share of imports from the particular trading partner to which the increase in trade costs applies.

4.2 Simulation scenarios

Several experiments are carried out to analyse the impact of post-11 September increases in frictional costs on trade flows and economic welfare. There is ample anecdotal evidence that frictional costs have risen since the terrorist attacks on New York and Washington. Yet, systematic statistical data on the magnitude and structure of the changes is not available to date. Hence, the simulated changes in trade cost have to be based on assumptions that generalise from the available empirical evidence.

Four scenarios were evaluated that use differing data on the structure of frictional cost changes. The overall magnitude of the frictional cost change was taken to be one per cent of the value of transported goods. Given the average magnitude of transport and insurance costs of 3.4 per cent ad valorem and estimates of the average costs of time delays, paperwork, and compliance related to border crossing of 9 per cent, an increase in frictional trading costs by one per cent *ad valorem* appears to be an upper bound for the long-term impacts of the increased security concerns following the terrorist attacks on the World Trade Center and the Pentagon. Further terrorist action triggering additional tightening of border controls could lead to renewed increases of trade costs, and impact predictions made immediately after the 11 September events (Leonhard, 2001) put the increases of frictional costs as high as three per cent of the value of traded goods, but relatively flexible adjustments of businesses and customs authorities to the new security environment during the six months following the attacks suggest that the cost increases in the medium and long-term are much lower than during the days immediately after the tragic events.

The lower bound of trade impacts from the 11 September events might be seen as no change in frictional costs and trade flows, implying that in the long run the increased attention devoted to optimisation of customs services and technical progress will offset any burden from security measures put into place after the attacks. This no-change situation is taken as the baseline against which four other scenarios are evaluated. The latter are outlined in the following:

- Uniform increase in frictional costs: In this scenario, all frictional costs are increased by one per cent *ad valorem*.

- Region-specific increase in frictional costs: In this scenario, frictional costs are on average increased by one per cent *ad valorem*. However, the increases are not uniform across regions. High risk regions (North America, North Africa & Middle East) and medium risk regions (Western Europe & South Asia) are assumed to experience increases in frictional costs that are two and one-and-a-half times as high, respectively, as the cost increases in low risk regions (Eastern Europe, Latin America, Sub-saharan Africa, Oceania, North Asia, Rest of World). Using expenditure on frictional costs as weights, the frictional cost increases amount to 0.7 per cent in low-risk regions, 1.05 per cent in medium-risk regions, and 1.4 per cent in high-risk regions.

- Sector-specific increase in frictional costs: In this scenario, frictional costs are on average increased by one per cent *ad valorem*. However, the increases are not uniform across sectors. In particular, it is assumed that the change in frictional costs for commodities that are transported by air and sea are two and one-and-a-half times as high, respectively, as the cost increases in ground transport. In particular, when using expenditure on frictional costs as weights, the mode-specific frictional cost increases amount overall to 0.69 per cent for ground transport, 1.03 per cent for sea transport, and 1.38 per cent for air transport. With the information on the sector-specific composition of transport modes in the GTAP database, sector-specific estimates of frictional cost changes can be derived.

- Region and sector-specific increase in frictional costs: In this scenario, frictional costs are on average increased by one per cent *ad valorem*, and a regional and sectoral differentiation as in the

"region-specific" and "sector-specific" scenarios is applied. The derived changes in frictional costs range from 0.52 per cent (products in a low-risk region that are largely transported by road or rail) to 1.78 per cent (products in a high-risk region that are largely transported by air).

The changes in frictional costs for the selected sectors and regions were introduced into GTAP, and the model was solved using the Gregg 2-4-6 step solution procedure under standard closure.

4.3 Results

The results from the simulations suggest considerable trade and welfare impacts of a one per cent *ad valorem* increase in frictional costs to trade. World welfare, measured in terms of equivalent variation, would decline by about $75 billion per year. The biggest welfare losses in absolute terms would occur in Western Europe, North America, and North Asia (Table 1).

(Table 1)

Yet, if the welfare losses are related to the size of the economies in the different regions, the ranking of most affected regions changes considerably (Figure 3). In relative terms, South Asia as well as North Africa and the Middle East are far more affected by higher frictional costs than, for example, North America or North Asia. These results are largely driven by the economies' strong dependence on international trade (Figure 2).

(Figure 3)

Across sectors, the most marked impacts occur for agriculture and food products, textiles and leather, non-metallic minerals, and machinery. Trade in these products is projected to decrease by one per cent or more as a result of a one per cent *ad valorem* increase in frictional costs (Figure 4). In other words, import demand for these commodities is elastic, while for mining products, chemicals, and basic metals trade flows are expected to change only to a less than proportional extent.

(Figure 4)

Differences in the results across scenarios are apparent, but do not fundamentally change the assessments. Only in a few cases are the scenario outcomes significantly different, as, for example, for the region of North Africa and the Middle East that seems less affected than Western and Eastern Europe under the assumption of uniform increases of frictional costs, but suffers more marked welfare losses than the two European regions if it is taken to be a high-risk region that experiences higher than average increases in frictional costs. Hence, exposure to international trade and the elasticities of import demand appear to be more important parameters for determining the impact of higher frictional costs than regional or sectoral differences in the magnitude of the frictional cost increases.

In general, the findings highlight the close economic relationships in the international economy. Small changes in trade costs can have considerable impacts on trade flows and economic welfare. Increases in frictional costs for imports into particular countries affect not only the importing and exporting countries, but also other countries through the diversion of trade flows and substitution between products. Hence, even countries that are not directly involved in a conflict or subject to terrorist attacks might nevertheless suffer losses in trade and welfare as a result of increased security concerns and higher frictional costs of trade.

5. Conclusions

This paper used estimates of changes in frictional trading costs and the GTAP model to assess the effects of the terrorist attacks of 11 September on international trade. Following the 11 September events, regulatory measures were implemented to tighten security at air and seaports as well as land border crossings. As a result, trading and transport companies have been confronted with additional frictional trading costs, in particular costs relating to transport, handling, insurance, and customs. These additional costs make international trade more expensive and will tend to reduce imports and exports.

Four scenarios are evaluated that quantify the trade and welfare impacts of a one per cent *ad valorem* increase in frictional costs of trade applying either uniformly across sectors and countries, or being sectorally or regionally differentiated according to presumed exposure to terrorism risk following the 11 September events. Given that after the initial disturbances following the terrorist attacks on New York and Washington international trade relations have returned towards normal again, a one per cent *ad valorem* increase of trade costs likely presents an upper bound for the impacts of 11 September. The global welfare losses of such an increase in frictional costs are estimated to amount to about $75 billion.

The analysis shows that even though North America would face substantial losses from the increase in frictional costs, other regions that depend to a larger extent on international trade, such as South Asia or North Africa and the Middle East, are more severely affected in relative terms. Many of the countries in these regions are middle-income developing countries that have progressively opened their economies towards international markets. The above-average losses in trade and welfare from increased security measures following the 11 September events could raise popular concerns about further steps of trade liberalisation and thereby compromise the long-term development prospects of these countries.

Agriculture and food products, as well as textiles and leather are among the product categories for which above average impacts on trade flows are predicted. Trade in these products is often politically sensitive and many countries retain substantial protection against imports of these products. In the Uruguay Round of multilateral trade negotiations some progress was made in reducing trade barriers for agri-food products and textiles, which would be partly offset through increases in frictional costs.

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Notes

1. See "Survey of members: national measures in respect of war risk insurance," International Air Transport Association, 27 November 2001.

2 See "October traffic shows intensified decline." Press release no. 36, International Air Transport Association, 30 November 2001.

3 See "When trade and security clash." The Economist, 6 April 2002.

4. See "Freight-transportation system gets more expensive, slower." Wall Street Journal of 27 September 2001.

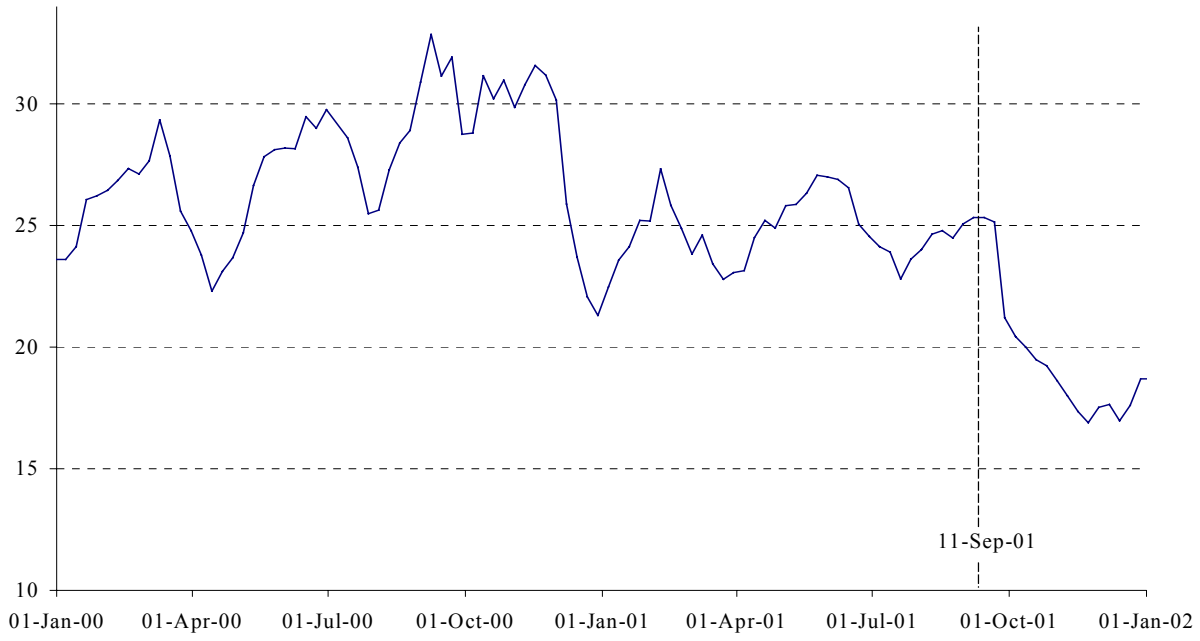
5 . See "War risk surcharge summary," Fritz Transportation International, December 2001.

6 . See "Ocean rates rising in Indian region." Journal of Commerce, 25 September 2001.

7. See "Canada and the United States sign smart border declaration." Government of Canada News Release No. 162, 12 December 2001.

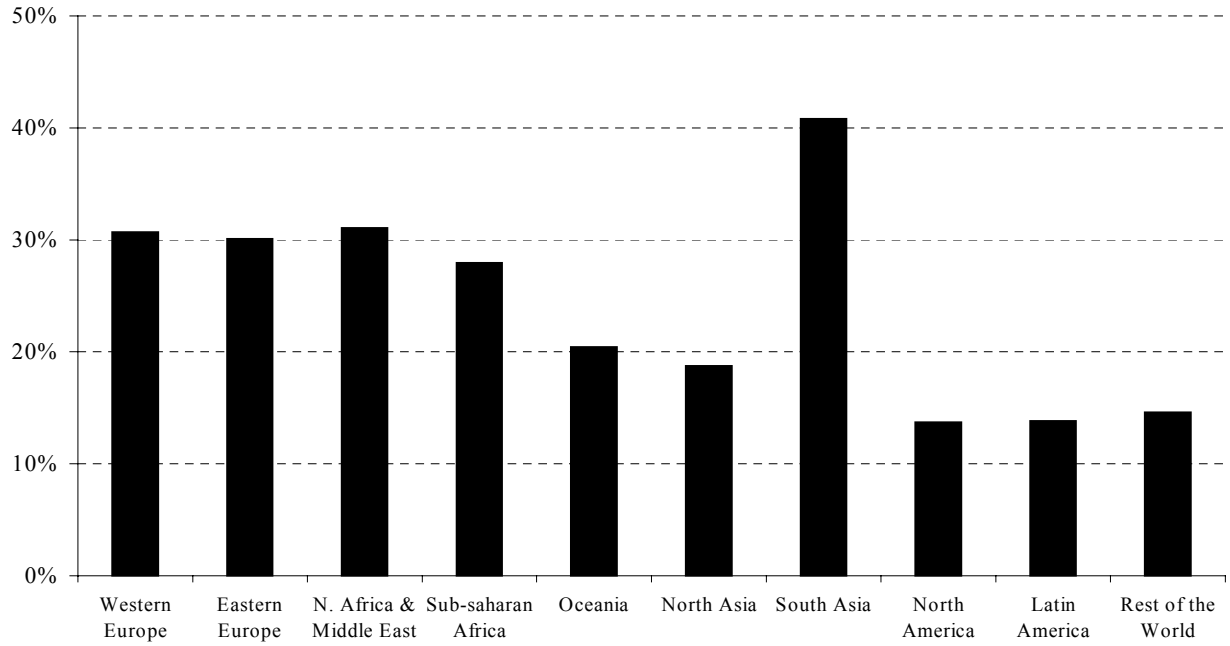
8 See "The Canada-US border: an automotive case study." Center for Automation Research, Ann Arbor, Michigan, January 2002.

Figure 1: World oil prices (weekly data), Jan. 2000 - Dec. 2001 (US Dollar per barrel)



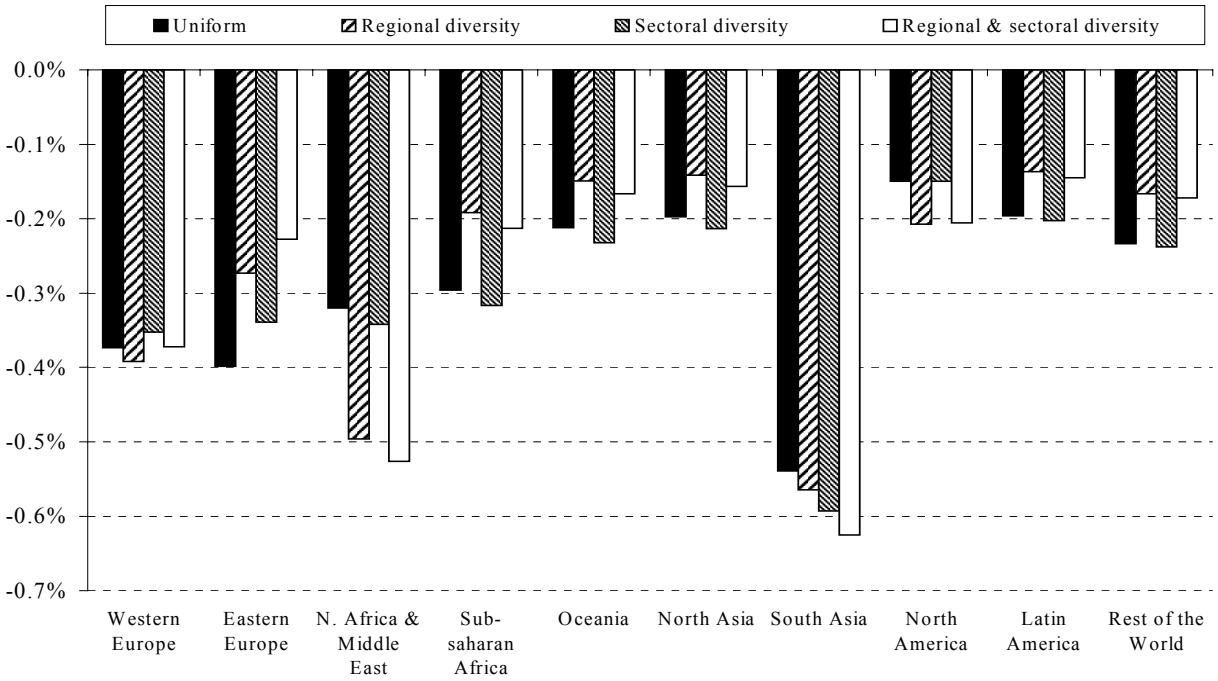
Source: OECD (2002a).

Figure 2: Ratio of imports to gross domestic product in selected regions



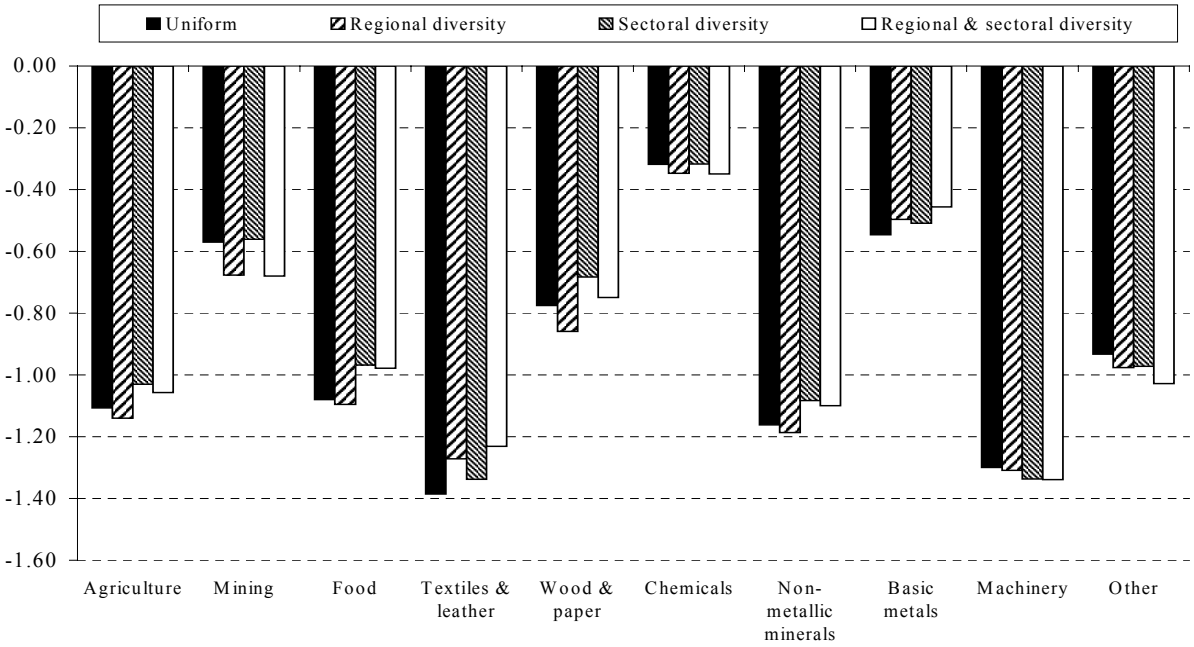
Source: GTAP-5 database.

Figure 3: Scenario results on welfare changes due to a 1% *ad valorem* increase in trade costs



Note: Welfare changes are calculated as equivalent variation divided by gross domestic product.
Source: Authors.

Figure 4: Scenario results on changes in imports due to a 1% *ad valorem* increase in trade costs



Source: Authors.

Table 1: Change in imports and welfare as a result of a 1% *ad valorem* increase in trade costs

	Imports (per cent)										Welfare (mill. USD)
	Agriculture	Mining	Food	Textiles & leather	Wood & paper	Chemicals	Non-metallic minerals	Basic metals	Machinery	Other	
Uniform increase											
Western Europe	-0.9	0.8	-1.1	-1.0	-0.7	-0.2	-1.2	-0.3	-1.2	-1.1	-31282
Eastern Europe	-1.0	-0.8	-0.9	-1.3	-0.7	-0.2	-1.0	-0.6	-1.3	-1.1	-3518
N. Africa & Middle East	-1.0	-1.3	-0.6	-1.0	-0.6	-0.2	-1.2	0.0	-0.8	-0.8	-2942
Sub-saharan Africa	-1.5	-0.6	-1.1	-1.2	-0.7	-0.2	-1.0	-0.4	-0.5	-0.7	-1027
Oceania	-1.4	-0.2	-1.2	-1.1	-0.7	-0.1	-1.0	-0.7	-0.8	-0.8	-972
North Asia	-0.6	0.4	-0.7	-1.6	-0.6	-0.5	-1.2	-0.9	-1.8	-0.7	-11845
South Asia	-1.9	0.2	-1.7	-2.0	-1.2	-0.3	-1.5	-0.9	-0.6	-1.5	-6380
North America	-1.0	-0.3	-1.0	-1.1	-0.9	-0.6	-1.1	-0.9	-1.3	-0.6	-13434
Latin America	-1.3	-0.7	-1.0	-1.8	-0.7	-0.3	-0.9	-0.9	-0.8	-0.5	-3105
Rest of the World	-1.4	0.1	-1.0	-1.3	-0.6	-0.3	-0.8	-0.5	-0.9	-0.7	-639
Total	-1.1	-0.6	-1.1	-1.4	-0.8	-0.3	-1.2	-0.5	-1.3	-0.9	-75143
Regional differentiation											
Western Europe	-0.9	0.8	-1.1	-1.1	-0.7	-0.2	-1.2	-0.3	-1.3	-1.2	-32798
Eastern Europe	-0.7	-0.6	-0.6	-1.0	-0.5	-0.2	-0.7	-0.4	-0.9	-0.7	-2413
N. Africa & Middle East	-1.5	-1.8	-1.0	-1.5	-0.9	-0.4	-1.8	0.0	-1.3	-1.3	-4564
Sub-saharan Africa	-1.1	-0.5	-0.7	-0.9	-0.5	-0.2	-0.6	-0.3	-0.3	-0.4	-664
Oceania	-1.1	-0.1	-0.8	-0.8	-0.5	-0.2	-0.6	-0.4	-0.5	-0.4	-684
North Asia	-0.4	0.2	-0.5	-1.1	-0.4	-0.4	-0.8	-0.7	-1.3	-0.4	-8470
South Asia	-2.0	0.2	-1.8	-2.0	-1.3	-0.3	-1.6	-0.9	-0.6	-1.5	-6672
North America	-1.4	-0.4	-1.5	-1.5	-1.3	-0.8	-1.6	-1.2	-1.8	-0.9	-18602
Latin America	-1.0	-0.5	-0.7	-1.3	-0.5	-0.3	-0.6	-0.6	-0.5	-0.2	-2166
Rest of the World	-1.0	0.1	-0.7	-1.0	-0.4	-0.3	-0.5	-0.3	-0.6	-0.4	-456
Total	-1.1	-0.7	-1.1	-1.3	-0.9	-0.3	-1.2	-0.5	-1.3	-1.0	-77489
Sectoral differentiation											
Western Europe	-0.7	0.7	-0.9	-0.9	-0.6	-0.2	-1.0	-0.2	-1.1	-1.1	-29494
Eastern Europe	-0.7	-0.7	-0.7	-1.0	-0.5	-0.1	-0.8	-0.4	-1.1	-0.9	-2993
N. Africa & Middle East	-1.0	-1.3	-0.6	-1.0	-0.6	-0.3	-1.3	0.0	-0.9	-0.9	-3144
Sub-saharan Africa	-1.6	-0.7	-1.2	-1.3	-0.8	-0.3	-1.1	-0.5	-0.6	-0.9	-1096
Oceania	-1.5	-0.2	-1.2	-1.2	-0.8	-0.2	-1.1	-0.7	-0.9	-0.9	-1063
North Asia	-0.7	0.4	-0.7	-1.6	-0.6	-0.5	-1.3	-1.0	-2.0	-0.9	-12772
South Asia	-2.0	0.3	-1.7	-2.0	-1.3	-0.4	-1.6	-1.1	-0.8	-1.8	-7008
North America	-0.9	-0.2	-0.9	-1.0	-0.7	-0.6	-1.0	-0.7	-1.3	-0.6	-13451
Latin America	-1.2	-0.7	-0.9	-1.7	-0.7	-0.3	-1.0	-0.8	-0.8	-0.6	-3214
Rest of the World	-1.3	0.0	-0.9	-1.3	-0.6	-0.3	-0.8	-0.4	-1.0	-0.7	-650
Total	-1.0	-0.6	-1.0	-1.3	-0.7	-0.3	-1.1	-0.5	-1.3	-1.0	-74886
Reg. & sect. differentiation											
Western Europe	-0.8	0.8	-0.9	-1.0	-0.7	-0.2	-1.1	-0.2	-1.2	-1.1	-31160
Eastern Europe	-0.5	-0.5	-0.5	-0.7	-0.4	-0.1	-0.5	-0.3	-0.7	-0.5	-2010
N. Africa & Middle East	-1.6	-1.8	-1.0	-1.4	-1.0	-0.4	-1.9	0.1	-1.5	-1.5	-4835
Sub-saharan Africa	-1.2	-0.6	-0.8	-0.9	-0.6	-0.3	-0.7	-0.3	-0.4	-0.6	-736
Oceania	-1.1	-0.1	-0.9	-0.8	-0.5	-0.2	-0.7	-0.5	-0.6	-0.6	-763
North Asia	-0.5	0.2	-0.5	-1.2	-0.4	-0.4	-0.9	-0.7	-1.5	-0.6	-9390
South Asia	-2.1	0.3	-1.8	-2.1	-1.4	-0.4	-1.7	-1.2	-0.8	-1.9	-7394
North America	-1.2	-0.3	-1.2	-1.4	-1.0	-0.7	-1.4	-1.0	-1.7	-1.0	-18401
Latin America	-0.9	-0.5	-0.7	-1.3	-0.5	-0.3	-0.7	-0.6	-0.6	-0.3	-2302
Rest of the World	-1.0	0.1	-0.7	-1.0	-0.4	-0.3	-0.5	-0.3	-0.7	-0.5	-470
Total	-1.1	-0.7	-1.0	-1.2	-0.7	-0.3	-1.1	-0.5	-1.3	-1.0	-77461

Source: Authors.

Annex Table 1: Sectors defined by reference to the GTAP-5 Sectoral Classification

Sectors	GTAP-number	GTAP-sector
Agriculture	1	Paddy rice
	2	Wheat
	3	Cereal grains not elsewhere covered
	4	Vegetables, fruit, nuts
	5	Oil seeds
	6	Sugar cane, sugar beet
	7	Plant-based fibers
	8	Crops not elsewhere covered
	9	Bovine cattle, sheep and goats, horses
	10	Animal products not elsewhere covered
	11	Raw milk
	12	Wool, silk-worm cocoons
	13	Forestry
	14	Fishing
Mining	15	Coal
	16	Oil
	17	Gas
	18	Minerals not elsewhere covered
Food	19	Bovine meat products
	20	Meat products not elsewhere covered
	21	Vegetable oils and fats
	22	Dairy products
	23	Processed rice
	24	Sugar
	25	Food products not elsewhere covered
	26	Beverages and tobacco products
Textiles and leather	27	Textiles
	28	Wearing apparel
	29	Leather products
Wood and paper	30	Wood products
	31	Paper products, publishing
Chemicals	32	Petroleum, coal products
	33	Chemical, rubber, plastic products
Non-metallic minerals	34	Mineral products not elsewhere covered
Basic metals	35	Ferrous metals
	36	Metals not elsewhere covered
Machinery	37	Metal products
	38	Motor vehicles and parts
	39	Transport equipment not elsewhere covered
	40	Electronic equipment
	41	Machinery and equipment not elsewhere covered
Other manufacturing and services	42	Manufactures not elsewhere covered
	43	Electricity
	44	Gas manufacture, distribution
	45	Water
	46	Construction
	47	Trade
	48	Transport not elsewhere covered
	49	Water transport
	50	Air transport
	51	Communication
	52	Financial services not elsewhere covered
	53	Insurance
	54	Business services not elsewhere covered
	55	Recreational and other services
	56	Public Administration, Defense, Education, Health
	57	Dwellings

Source: Authors.

Annex table 2: Regions defined by reference to the GTAP-5 regions

Model region	GTAP-Code	GTAP-region	Model region	GTAP-Code	GTAP-region
Western Europe	AUT	Austria	**Oceania**	AUS	Australia
	BEL	Belgium		NZL	New Zealand
	DNK	Denmark	**North Asia**	CHN	China
	FIN	Finland		HKG	Hong Kong
	FRA	France		JPN	Japan
	DEU	Germany		KOR	Korea
	GBR	United Kingdom		TWN	Taiwan
	GRC	Greece	**South Asia**	IDN	Indonesia
	IRL	Ireland		MYS	Malaysia
	ITA	Italy		PHL	Philippines
	LUX	Luxembourg		SGP	Singapore
	NLD	Netherlands		THA	Thailand
	PRT	Portugal		VNM	Vietnam
	ESP	Spain		BGD	Bangladesh
	SWE	Sweden		IND	India
	CHE	Switzerland		LKA	Sri Lanka
	XEF	Rest of EFTA		XSA	Rest of South Asia
Eastern Europe	HUN	Hungary	**North America**	CAN	Canada
	POL	Poland		USA	United States
	XCE	Rest of Central Europe		MEX	Mexico
	XSU	Former Soviet Union	**Latin America**	XCM	Central America
N. Africa & Middle East	TUR	Turkey		COL	Colombia
	XME	Rest of Middle East		PER	Peru
	MAR	Morocco		VEN	Venezuela
	XNF	Rest of North Africa		XAP	Rest of Andean Pact
Sub-Saharan Africa	BWA	Botswana		ARG	Argentina
	XSC	Rest of SA Customs Union		BRA	Brazil
	MWI	Malawi		CHL	Chile
	MOZ	Mozambique		URY	Uruguay
	TZA	Tanzania		XSM	Rest of South America
	ZMB	Zambia	**Rest of World**	XRW	Rest of World
	ZWE	Zimbabwe			
	XSF	Other Southern Africa			
	UGA	Uganda			
	XSS	Rest of Sub Saharan Africa			

Source: Authors.