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Trade and Sectoral Impacts of the Global Financial Crisis:

A Dynamic CGE Analysis

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Abstract

The current global financial crisis has resulted in a significant downturn in the global economy, with impacts felt throughout the world. We use a dynamic global general equilibrium model to explore the effects of two economic slowdown scenarios, with a particular focus on trade and sectoral impacts. We include the impact of fiscal stimulus packages and a general decline in global investment. We also explore the potential impacts of using trade policy to respond to the crisis, by investigating the impact on the global economy of moving toward greater protection of domestic industries. In the short and long run, most countries lose as a result of the crisis, as expected. The extent of the declines in the long run depend on the extent to which investment declines in the region and on the extent to which savings declines globally. Globally, our results suggest that under a 'moderate' crisis scenario, trade falls by approximately 14 percent from the 2020 baseline. Within this, the composition of trade changes quite markedly, with shifts reflecting changes in demand for construction of investment goods; the increasing longer-term demand from China and India; and at least in the short run, different capital intensities of production in different economies. A more extended crisis or increased protection are both expected to further accentuate global losses. While the more severe crisis adversely impacts all sectors, the increase in tariffs mainly impacts sectors and regions which increase protection significantly.

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1 Introduction

The current global financial crisis has resulted in a significant downturn in the global economy. Although there have recently been signs that the worst of the crisis may be over, the global economy remains fragile, with much uncertainty remaining (IMF, 2009b; WTO, 2009a). Meanwhile, the impacts of the crisis continue to be felt throughout the world. This paper uses a dynamic computable general equilibrium (CGE) model to explore some of the effects of two different crisis scenarios, with a particular focus on trade and sectoral impacts in ESCAP member countries. We also analyse potential impacts of the recent tendency to move toward greater protection of domestic industries.

Computable general equilibrium (CGE) models have some limitations in their ability to analyse financial crisis, however, they have been used to generate insights into the impacts of previous economic crises (e.g. Anderson & Strutt, 1999; McKibbin *et al.*, 2001; Siriwardana & Iddamalgoda, 2003). Some efforts to model the current crisis have also been made, including through use of comparative static versions of the well-known Global Trade Analysis Project (GTAP) model (Jongwanich *et al.*, 2009; Strutt, 2009). In the current study we use GDyn, a dynamic global CGE model, developed by Ianchovichina and McDougall (2000) and based on the GTAP model (Hertel, 1997).[2] The GDyn model incorporates most features of the GTAP model, including bilateral trade flows, a sophisticated consumer demand function and inter-sectoral factor mobility. In addition, GDyn tracks foreign ownership of capital and investment behavior. This allows us to include the impacts of endogenous capital accumulation and the movement of investment between countries in response to differing expected rates of return, unlike simulations using comparative static models. Use of a dynamic model also allows us to model consecutive periods of the crisis, along with policy responses over time and the consequent time-path of adjustment for each economy. While GDyn has an improved treatment of investment and captures errors in expectations, it does not contain debt obligations or money and therefore does not purport to explain the financial crisis. Thus we endeavour to mimic the key macroeconomic impacts

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[2] See www.gtap.agecon.purdue.edu for detailed and updated information.

of the financial crisis, in an effort to shed light on the impact of the crisis on production and trade.

The paper begins with a discussion of the current extent of the global financial crisis and policy responses. We then develop a baseline scenario for GDyn, which depicts how the global economy might change over time, excluding the impact of the global financial crisis. From this baseline, we model three scenarios: a moderate and more severe global financial crisis scenario, along with the possible policy response of increased protection. Results are presented for some important macroeconomic indicators, along with discussion of the trade and sectoral impacts of each scenario. Finally we offer some concluding comments, including on limitations of this study.

2   The Extent of the Global Financial Crisis

The full extent of the current global economic crisis, in terms of growth impacts and their duration, is not yet clear. The IMF's October 2009 projections indicated that the global economy was expected to decline by 1.1 percent in 2009, with advanced economies hardest hit and experiencing an average decline in output of approximately 3.4 percent (IMF, 2009b). While the financial crisis began in developed countries, the subsequent collapse of aggregate demand is still working its way through the global economy. Average growth rates for developing and emerging economies was well under two percent in 2009, representing a significant deviation from the previous high growth path many emerging countries were following. Recent indications suggest that the global economy may be over the worst of the crisis, with the global rebound being driven particularly by strong performance in Asian economies including, China and India (IMF, 2009b). However, advanced economies are expected to expand sluggishly through 2010, though unemployment will continue to rise and risks to the outlook "remain on the downside" (IMF, 2009b).

Table 1 presents World Bank estimates of growth rates by individual country/region. While forecasts will differ depending on the assumptions made and when they were updated, it is

hoped that data presented in this table give a reasonable indication of annual changes in GDP that include the impact of the crisis.[3] As previously noted, growth rates in developed countries tend to decline the most significantly, particularly in 2009. However, growth rates in many other regions also suffer from the crisis. As indicated in Table 1, some rebound is anticipated in 2010 and 2011.

Table 1 Annual change in real GDP (%)

Region	2007	2008	2009	2010	2011
Advanced economies					
US	2.0	1.1	-3.0	1.8	2.5
EU[a]	2.7	0.6	-4.5	0.5	1.9
Japan	2.3	-0.7	-6.8	1.0	2.0
Emerging & developing economies					
Russia	8.1	5.6	-7.5	2.5	3.0
China	13	9.0	6.5	7.5	8.5
India	9.0	6.1	5.1	8.0	8.5
Other Regions					
East Asia and Pacific	11.4	8.0	5.0	6.6	7.8
Europe and Central Asia	6.9	4.0	-4.7	1.6	3.3
Latin America and Caribbean	5.8	4.2	-2.2	2.0	3.3
Middle East and North Africa	5.4	6.0	3.1	3.8	4.6
South Asia	8.4	6.1	4.6	7.0	7.8
Sub Saharan Africa	6.2	4.8	1.0	3.7	5.2
WORLD	**3.8**	**1.9**	**-2.9**	**2.0**	**3.2**

[a] Euro zone
Source: (World Bank, 2009b)

The global financial crisis has led to substantial and rapid responses, with many governments implementing stimulus packages in an effort to dampen the impact on their domestic economies (Freedman *et al.*, 2009; Horton & Ianova, 2009; World Bank, 2009a). It is difficult to precisely quantify the fiscal stimulus packages being implemented, with the

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[3] Such estimates are of course continually updated as economic conditions change. For example, the most recent data available as we finalise this paper suggests that 2009 GDP declined by 2.2 percent globally (World Bank, 2010).

absence of a standard definition of implementation making cross-country comparisons very difficult (IMF, 2009a). In Table 2, we provide a summary of government spending growth, which includes known fiscal stimulus packages. We note that the growth in government spending increased significantly in 2009 for some countries, including the US, EU and particularly Japan, with some tapering-off forecasted for 2010 and 2011. Current stimulus packages have focused on fiscal stimulus, in contrast to the Great Depression of the 1930s, where the case for fiscal stimulus was not well understood (Eichengreen & Irwin, 2009). The implications of this are important since monetary stimulus benefited the initiating country but had a negative impact on its trading partners, while the use of different fiscal stimulus policy instruments today tends to benefit trading partners as well as the country implementing the stimulus (Eichengreen & Irwin, 2009).[4]

Table 2 Fiscal stimulus: government consumption growth rates (%)

	2007	2008	2009	2010	2011
Australia	2.4	3.6	4.0	3.5	3.0
China	11.2	10.7	10.0	10.2	9.0
Hong Kong	3.0	1.7	5.0	4.0	3.0
Taiwan	0.9	1.1	12.0	8.0	7.0
Japan	1.9	0.8	6.5	4.0	4.0
Korea	5.4	4.2	6.0	5.0	4.0
India	7.0	20.3	10.0	5.0	4.0
US	2.1	2.9	4.0	4.0	3.0
EU[a]	2.2	1.6	3.7	3.1	2.3
Russia	3.4	2.4	1.0	1.0	3.0

[a] Euro zone
Source: (World Bank, 2009b)

In addition to fiscal stimulus packages, global economic decline can also increase pressures on policymakers to assist distressed industries, including through raising barriers to trade. Indeed the 1930s were marked by protectionist policies and the breakdown of the multilateral trading system (Eichengreen & Irwin, 2009). The current global economy may be viewed as having 'firewalls' against protectionism that did not exist in the 1930s, including

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[4] Albeit many of the stimulus packages currently being implemented do include "buy local" clauses.

more institutionalized obstacles to protectionism, more policy instruments to address the economic slowdown, and a more interdependent and open world economy (Ahearn, 2009). However, despite the commitment in April 2009 by the G-20 nations not to "repeat the historic mistakes of the protectionism of previous eras", ad hoc trade policy measures have increasingly been put in place (Saez, 2009). Some governments thus appear to have reacted to the crisis by imposing new trade-restricting and distorting measures and even with signs that the worst of the crisis may be over, there appears no indication yet that governments are unwinding or removing trade restrictive measures imposed early in the crisis (WTO, 2009a, 2009b).

There remains substantial room for increases in trade measures and barriers that are consistent with countries' WTO obligations (Ahearn, 2009; Bown, 2009). There is some evidence of rising WTO-legal protection (Matoo & Subramanian, 2009) with the WTO noting that there has been "a marked increase in protectionist pressures globally since September 2008, driven by demands to protect domestic jobs and businesses" (WTO, 2009b). One possible WTO-compliant measure is to increase tariffs toward bound levels. In some cases these are substantially above the current applied tariffs, therefore countries may have flexibility to substantially increase their applied tariffs while still meeting their WTO obligations. These binding overhangs tend to be particularly high for developing countries, who may view trade policy as one of the few policy instruments available to help shield domestic markets and relieve some of the pain of the global crisis (Hufbauer & Stephenson, 2009). If this flexibility were fully exploited by all countries, Bouet and Laborde (2009) estimate that average levels of protection would increase by more than 90 percent from baseline levels. They estimate the average increase in protection for high income countries would be 48 percent, for middle-income countries it would be 132 percent and for LDCs, 270 percent. Furthermore, if countries do not maintain their WTO obligations, the consequences could include major trade conflicts and damage to the world trading system (Ahearn, 2009).

3   The Model

The GDyn model we use incorporates a new treatment of investment that relies on a) the gradual elimination of errors in expectations; b) the gradual equalization of rates of return to investment and c) the gradual movement of economies towards steady state growth (Ianchovichina & McDougall, 2000).

The GDyn model has also been adapted for our purposes to include endogenously determined employment of skilled and unskilled labour, along with capital. This is achieved through a complementarity (Elbehri & Pearson, 2005) which sets employment equal to the natural rate of employment, unless real wages must fall by more than a threshold rate to achieve this.[5] If real wages are required to fall by more than this, we fix the change in real wages at this threshold rate and allow employment to adjust endogenously. In the next period the employment rate will attempt to move back to the natural rate again, but this will only be achieved if to do so requires less than the threshold percentage change in the real wage. If a larger decline is required, the change in the real wage will be fixed and the employment rate will again be determined endogenously. Provided the economy does not continue to be hit by negative shocks, employment is expected to gradually move back to full employment.

In combination with the GDyn model, we use version 7 of the GTAP Data Base, which has a base year of 2004 (Narayanan & Walmsley, 2008). This Data Base is augmented with supplementary data required for the GDyn model (McDougall *et al.*, Forthcoming). The 113 countries/regions and 57 sectors in the full GTAP Data Base are aggregated to 29 regions and 27 sectors, focusing particularly on ESCAP countries. This is a fairly challenging level of disaggregation to work with in this kind of dynamic global study, however, necessary to appropriately model the regions and sectors of key interest. For clarity of exposition and to

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[5] The threshold rate is greater than zero because there is some evidence that real wages have declined in response to the crisis. The threshold rate depends on the extent to which unemployment is higher than the natural rate of unemployment, where the relation is non-linear. It is assumed that as unemployment rises, the extent to which workers will accept declines in their wages increases. Note that this threshold rate can be altered, depending on the extent to which we believe real wages are flexible.

highlight key insights, results are generally presented in more aggregated form (see Appendix Table A1 and Table A2).

4   The Model Baseline

Before examining the impacts of the global financial crisis, we first need to develop a baseline for the model which represents how the global economy might have looked in the absence of the crisis. The development of a baseline is an important component of the experimental design when using a dynamic model and the choice of baseline can affect the results of the scenario under consideration (Adams & Parmenter, 2000). However, building a baseline that adequately reflects expected changes in the world economy is a difficult task.

Given the difficulties in creating a baseline for the GDyn model, previous baselines have focused on obtaining projections for a few key macroeconomic variables, such as real GDP, population, skilled and unskilled labour, along with the implementation of key policies which have already been agreed upon and are expected to affect the regions/sectors being considered (Walmsley, 2006). An alternative approach, developed by Dixon and Rimmer (2002) for single country model baselines, uses a series of simulations (historical, decomposition and forecasting) to develop a baseline scenario. We use a combination of these approaches, focusing on the path of the macro variables. Previous work indicated that the way we model errors in expectation and productivity changes tends to have significant impacts on the baseline (Walmsley & Strutt, 2009), therefore we focus particularly on improving the specification of these. Key aspects of our baseline are summarised below.[6]

4.1.1   *Data sources*

Historical data were collected primarily from the World Development Indicators for available countries (World Bank, 2009c). Some additional data for Asian economies were also collected.[7] Historical data were generally found to be particularly good prior to 2006. If

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[6] Further details will be available in a forthcoming paper.
[7] We are grateful to Ginalyn Komoto and Susan Stone of ADBI for their assistance in collating this additional data.

data were not available for a country, it is assumed to grow at the same rate as other regions with which it is aggregated.[8] We use the available historical data to find average annual growth rates and construct an historical baseline. We then include the following variables in the baseline: real GDP, investment, consumption, government spending, population, and skilled and unskilled labour.[9]

The assumptions we make on sectoral productivity growth broadly follow the approach of Hertel et al. (2006) and Golub et al. (2007), which base non-agricultural productivity growth on economy-wide labour productivity growth rates, adjusted for productivity differences across sectors. In addition, we update the labour productivity differentials,[10] employ greater sectoral differentiation and also apply this approach to agricultural sectors.

4.1.2   Calibration of the baseline

As outlined in Walmsley (2006), historical investment can be accommodated in one of two ways: a) by introducing an additional risk premium to explain the difference between actual and model determined investment; or b) by introducing errors in expectations. The two alternatives can result in considerable differences in the long run behaviour of the model, once investment is endogenised. In the first case, any large risk premiums created as a result of tracking investment are assumed to be permanent and therefore remain; hence large changes in investment do not occur. In the second case, large differences in historical and model determined investment can lead to large errors in expectations which, once investment is endogenised, can lead to large changes in investment. Note that while the choice between these two alternatives outlined above can be important, in this study there is little difference between the two methods, since the errors in expectations are never completely eliminated, and therefore could also be thought of as risk premiums.

We simulate a business-as-usual scenario from 2004-2007 to calibrate the changes in errors in expectations required to achieve actual investment over this period and use real GDP

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[8] The exception to this was the People's Republic of Korea. It is assumed to have zero growth; otherwise aggregation with the very high growing economy of Macau (and Mongolia) resulted in unrealistic growth rates which had significant and implausible effects on the baseline in later years.

[9] Employment of land and labour does not have a consistent trend, but averages zero over time. While foreign income payments have tended to increase over time, continuation of this trend cannot continue indefinitely.

[10] Using estimates from 1995-2003, contrasting with previous estimates based on 1970-90 data.

data to calibrate technological change in the baseline.[11] We find that the errors in expectations are generally consistent and positive over the period. Relatively high errors in expectations tend to be found in the developed (and some developing) economies, suggesting that investment tends to be higher than theory would predict given the current rates of return. The resulting errors in expectation for the US, Japan and the EU are also consistent with the hypothesis that actual investment has been higher than current rates of return would predict, due to large errors in expectations (or low risk premiums). We include these calibrated errors in expectations, along with some average growth rates in the 2004-2020 baseline.

5   Scenarios Modeled

As previously discussed, the full extent of the current global economic crisis is difficult to accurately predict. While the GDyn model has improved our ability to track foreign capital flows, as discussed earlier, the model does not profess to be useful in predicting the extent of the financial crisis. Our aim here is therefore to mimic the behavior of the crisis to assess the likely impact on production and trade.

Three scenarios are modelled to capture different assumptions on the level of severity of the global financial crisis:

1. *Moderate Financial Crisis*: A moderate financial crisis with investment recovering to pre-crisis levels in 2012.

2. *Severe Financial Crisis*: A more severe crisis where investment recovers gradually after 2010, returning to pre-crisis levels in 2015.

3. *Financial Crisis with increased protection*: A moderate financial crisis, with protection increases included in 2010.

The first scenario, *Moderate Financial Crisis*, models the impact of the financial crisis through four mechanisms. First, we argue that the financial crisis was caused by investors

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[11] This calibration baseline is based on and utilizes some of findings from the work undertaken by Walmsley and Strutt (2009) using the GTAP 6 Data Base.

re-adjusting their expectations of US and EU returns on investment relative to other countries, in light of news about fundamental problems with the US banking system that also affected the viability of the EU banking system. This is implemented by calibrating the changes in errors in expectations required to track changes in (forecasted) investment in each region between 2007 and 2011,[12] as estimated by the World Bank (2009b). We find that expectations of rates of return have adjusted downwards across the world as investors re-evaluate their expectations about the profitability of all their investments as a result of the financial crisis. The global decline in expectations, however, hides the fact that the re-adjustment has not affected all economies equally. China for instance moved from being in the bottom position in 2007 to the highest in 2009, in terms of expectations, while the relative positions of the USA and Europe have moved in the opposite direction. This pattern reflects the fact that investment in China has been less affected by the crisis than the USA and Europe. In 2010 and 2011, World Bank investment forecasts imply that expectations will rise again, and the US and Europe return to their relative pre-crisis positions with higher expectations than India and China. Therefore in this scenario, we assume that after 2011 the crisis is essentially over and the relative attractiveness of investment returns to pre-crisis levels.[13]

Second, in addition to the changes in expectations about future returns to capital/investment, we argue that the crisis causes an immediate but temporary decrease in efficiency and return to capital in all countries. Between 2007 and 2011 this decrease in efficiency is obtained through calibration; it is the decrease required for real GDP to decline by the amount forecasted by the World Bank (Table 1) in that year. With the exception of the USA, the baseline changes in technology in 2007 were similar to previous years and

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[12] In previous work, errors in expectations were reduced only for the US and European Union and we allowed investment to relocate to other regions (Strutt & Walmsley, 2009). In the current simulation we attempt to capture the actual and forecasted changes in investment across the world, which has a significant impact on results.

[13] Note that while this assumption is in line with the World Bank forecasts, it could also be argued that changes in relative errors in expectations may continue. That is US errors (and investment growth) might be permanently lower than the baseline. This reflects the fact that economists have for some time argued that the rate of growth of the US trade deficit is unsustainable and that adjustments would eventually be required to bring it back into a long run sustainable equilibrium. Under this assumption, there is a re-adjustment of investment across regions and as a result some countries (e.g., China) experience increased investment which leads to increased capital accumulation and growth in the long run, at the expense of the US economy. Strutt and Walmsley (2009) explored this possibility and future work will further investigate this.

these, along with the changes in investment and employment explained most of the change in real GDP in that year. Hence no decline in capital efficiency was experienced outside of the USA in 2007. After 2007 the contagion affects of the crisis could be felt on capital efficiency across the world. After 2011 the decrease in efficiency of capital is assumed to end, returning to baseline levels by 2012.

Third, unemployment of skilled and unskilled labour and capital are modeled according to the mechanisms outlined in section 3.

Fourth, we include implementation of known fiscal stimulus (see Table 2).[14] We assume that the fiscal stimulus diverts savings from investment towards funding of fiscal deficits.[15] The fiscal stimulus and decline in savings are incorporated over the period 2007 to 2011. After 2011 no further changes are made, so that the share of government spending and savings are assumed to remain fixed.[16]

The second scenario, *Severe Financial Crisis*, models the impact of a severe financial crisis that continues to negatively impact the world until 2015. This scenario is similar to the first scenario, with the key difference being the assumption that the world economy takes longer to recover. As in the first scenario, the changes in errors in expectations in the US, Europe and the rest of the world are found in the calibration simulation between 2007 and 2010.[17] After 2010 errors slowly adjust so that investment growth rates return to baseline levels by 2015 (not 2012, as in the first scenario). Moreover the temporary decrease in efficiency continues to 2015, albeit the decline is gradually eliminated so that by 2015 the technological change has returned to baseline levels.

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[14] For further detailed country information on stimulus packages for WTO member countries, see the WTO reports (2009a; 2009b).

[15] Ordinarily the GDyn model would divert income from both savings and private consumption towards government spending. We have allowed the diversion to be greater on savings for two reasons: first, government must pay for these deficits through increasing debt and so reduce savings available for private investment and secondly, it allows us to capture the global decline in savings available for investment.

[16] Note that the alternative assumption, that governments would be able to rein in their fiscal stimulus packages and reduce spending, is also worth exploring - although we have not done this here. It is expected that a decrease in government spending would increase savings which would have positive effects on private investment.

[17] Note that we do not use the 2011 World Bank forecasts as these are consistent with the first scenario of complete recovery in investment by 2012.

Finally the third scenario, *Financial Crisis with Increased Protection*, reflects concern about the potential for increased use of protection in response to the financial crisis. This scenario follows the first scenario, with the addition of increased rates of protection as a policy response to the crisis. As discussed in section 2, while it is difficult to assess the full extent, there is evidence of some increase in protection levels. While there may be significant differences by industry and region, import restrictions also tend to lead to a domino effect (Saez, 2009). Therefore, some researchers have explored the impact of increases in tariffs to their full bound rate by all countries (e.g. Bouet & Laborde, 2009; Jongwanich et al., 2009; Willenbockel, 2009); however, we view this as unlikely given the current evidence of much more moderate increases in tariffs (WTO, 2009a). Therefore, in this final scenario we make a relatively simple assumption that tariffs are raised from the applied towards the bound rates by 10 percent of the difference between the two.[18] Tariff increases are calculated at the disaggregated HS6 level, then aggregated to match the regions and commodities we model in this study, using the TASTE program (Horridge & Laborde, 2008).

6   Results

Results for a wide range of effects, including potential trade, investment and sectoral impacts of the global financial crisis (and potential responses) are available for all countries and regions in our aggregation. However, given the large number of sectors and regions modeled, we present most results in summary form here. We focus particularly on the first scenario, before exploring some implications of a more extended crisis or tariff increases.

6.1.1   *Moderate Financial Crisis*

Table 3 presents the macro-economic results under the first *Moderate Financial Crisis* scenario. All results shown in the table are cumulative percentage differences from the baseline in 2020.[19] Due to space constraints we are unable to show every result over time,

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[18] We note that our results may overestimate some of the impacts since regional agreements may limit the scope for increasing tariffs in some cases.

[19] To interpret the results, take the example of Chinese real GDP of 11 percent: this means that in 2020 China's real GDP would be 11 percent higher than what it would have been, had the crisis not occurred.

although there are sometimes considerable differences between the short run (2010) and long run (2020) results. For example, real GDP results are shown for both 2010 and 2020.

Table 3 Cumulative difference in selected macroeconomic variables due to a moderate financial crisis relative to 2020 baseline, selected countries and regions (%)

	Real GDP in 2010	Real GDP in 2020	Investment	Real exports	Real imports
Australia	-5.99	-2.22	-0.93	3.97	-8.56
New Zealand	-7.52	-6.48	-13.49	-7.94	-9.59
China	-8.46	-6.69	27.61	-20.14	-10.08
Hong Kong	-21.14	-11.28	17.61	-18.71	-5.66
Taiwan	-17.32	-14.18	-13.06	-25.80	-15.69
Japan	-10.43	-10.50	-32.48	-20.63	-13.67
Korea	-13.62	-9.69	7.09	-24.86	-10.96
Indonesia	-3.73	-4.35	-10.87	2.47	-11.27
Malaysia	-15.05	-7.97	6.27	-11.19	-8.14
Philippines	-12.33	-12.96	-13.40	-22.29	-15.15
Singapore	-20.46	-4.40	117.10	-15.23	-4.22
Thailand	-16.95	-19.70	-18.39	-25.81	-14.48
Vietnam	-8.78	-3.68	13.70	1.19	-3.36
Rest South East Asia	-8.19	-9.75	-12.74	-9.30	-19.71
Bangladesh	-4.39	-5.07	-10.08	-13.21	-9.36
India	-9.60	-7.44	16.29	-26.34	-1.43
Pakistan	-10.03	-6.46	25.41	-17.41	-3.23
Rest South Asia	-9.65	-5.90	17.42	-18.49	-3.16
US	-9.10	-9.95	-38.41	-8.47	-18.31
EU27	-9.97	-12.11	-29.70	-16.21	-15.84
Russia	-14.58	-7.83	46.79	-6.73	-8.79
Former Soviet Union	-16.07	-10.54	37.26	-7.75	-1.98

A key impact expected from the crisis is lower real GDP, with the most significant losses in real GDP occurring between 2007 and 2011. During this period, all economies experience a downturn relative to the baseline as capital efficiency, trade and employment fall. The subsequent rate of recovery is related to the gains in investment, with investment moving towards those countries with the highest relative rates of return. Many countries recover some of their real output losses over time, for example China and India are able to partially recover the reductions experienced in 2010 GDP, with the cumulative impact on real GDP approximately 2 percent less in 2020 than in 2010. However, for other countries including the US, Japan and particularly EU27, the reduction in GDP due to the financial crisis is even

greater in 2020 than in 2010, reflecting ongoing reallocation of investment away from these regions.

The changes in investment summarized in Table 3 indicate significant differences by country, reflecting the fact that the financial crisis has resulted in a readjustment of investment globally. This relocation of investment is also reflected in the adjustments of the trade balances. For example, China experiences a 28 percent increase in investment and a decrease in its trade surplus, relative to the 2020 baseline. This suggests that, longer-term, the financial crisis leads to an increase in the relative attractiveness of producing investment goods in China. This, in turn, has implications for sectoral output changes in China and other countries. In terms of production, Table 4 indicates that those economies experiencing large increases (decreases) in investment also experience large increases (decreases) in construction. For example the increase in investment in China drives a 25 percent increase in construction relative to the 2020 baseline. On the other hand, countries such as Japan and the US experience a reduction in investment and the construction industry consequently experiences a substantial decline in output relative to the baseline.

Given the decline in global investment due to the crisis, it is no surprise to find the world construction industry is particularly hard-hit in terms of reduced output. We also find relatively significant reductions in global output of manufactured products, particularly light industry. Drilling further into the broad manufactured goods aggregates shown in Table 4, we find the motor vehicle, metal products, electronics and other machinery sectors all tend to be hardest hit, declining by 15 percent or more relative to the 2020 baseline. Crops (particularly rice), along with extraction, petroleum and coal products, and health and education are the least adversely affected sectors globally. For agricultural products, this is primarily because they tend not to be as capital intensive as other sectors. Instead the fall in incomes and demand for agricultural goods causes a decline in the return to land,[20] lowering prices and limiting the losses in global output due to the financial crisis. The story is similar for forestry and extraction sectors, where falling returns to land and natural resources,

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[20] Note that land and natural resources are the only factors which assumed to be fully employed. Hence with reduced demand returns fall which push down the prices of commodities that depend on them (agriculture, forestry and extraction). Labour and capital however will become unemployed if the wage and/or rental price of capital fall too far.

lower prices and increase demand. For petroleum and coal products, extraction is an important input and with the fall in the price of extractions and natural resources, the price of petroleum products can also fall.[21] Health and Education clearly benefit from the global fiscal response to the crisis.

The US and Europe experience a considerable fall in the production of almost all goods. There is a tendency for production of light manufactures to strengthen in relative terms over time in the US and Europe (particularly products like textiles and apparel). Countries like China, on the other hand, are increasingly pushed out of light manufactures towards products including agriculture and food processing (where declines are relatively smaller). The reason for this general shift is that light manufactures tend to be relatively less capital intensive in the USA and Europe than in the rest of the world,[22] particularly Asia; while agriculture in the US is much more capital intensive than in many other countries.[23] Countries tend to move out of sectors that are relatively intensive in the use of capital, towards less capital intensive goods, as a result of the crisis.

Most countries reduce exports and imports relative to the 2020 baseline, with Table 3 indicating the overall changes in real exports and imports by country/region. Declines in exports from the Asian region are often particularly strong, for example, more than 20 percent declines from 2020 baseline levels for countries including China, Japan and India. Declines in imports also tend to be relatively large for many Asian countries, along with countries such as the US and EU27. The overall impact of the crisis on exports and imports is driven by investment and the realignment of trade balances resulting from the crisis. In general Asia experiences an increase in investment, declining trade balances and decreased

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[21] The story is a little more complicated here since there are two sources of demand for petroleum products: first, private household demand for petroleum; and second, transportation. With a decline in global trade, global demand for transportation services to move exports from one country to the next experiences a considerable decline. The price of transportation services falls further, but since demand for global transportation is a 'derived' demand (i.e., it depends on demand for our exports in general and we don't buy more of it just because it's cheap) global transportation demand remains low. This allows private consumers to take advantage of the low prices of petroleum and their demand increases.

[22] 3.6 percent of the costs of producing wearing apparel is capital in the US according to the GTAP Data Base, while in Asia capital is anywhere between 4 percent and 20 percent of costs. The story is similar in textiles, leather products and electronics.

[23] According to the GTAP Data Base 18 percent of the costs of producing wheat are capital costs in the US, while the capital the cost of producing wheat in the rest of the world range between less than 2 percent to a maximum of 10 percent.

exports; while the USA and Europe experience declining investment, increasing trade balances and decreased imports.

Turning to the declines in exports at a more detailed sectoral level, we find in Table 5 that relatively strong export declines tend to be associated with fairly strong output declines (Table 4), emphasizing the importance of trade to the sectoral output story. For example, we find that world exports of crops, along with forestry and extraction remain relatively robust, with output relatively unharmed. However, strong adverse impacts on exports from sectors such as construction and manufacturing are reflected in significantly reduced global output for these sectors.

While global trade falls across all sectors, there are some cases of increased trade to be found within this overall picture. These are primarily driven by China's increased demand for imports of other food, forestry, apparel, motor vehicles, business services and health and education; and India's demand for food, forestry, motor vehicles, machinery, electronics, metal products, other manufactures, construction, business services and health and education. The increases in demand for imports stem from either: a) a decline in the import price due to the general decline in prices of land and natural resources elsewhere (other food and forestry); b) the increase in construction and assembly of investment goods (apparel,[24] electronics, motor vehicles, metal products, other manufactures, machinery, and business services);[25] or c) the fiscal stimulus packages (health and education and business services).

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[24] Note that increase demand for imported apparel also comes from increased private household demand in China, as income in China rises.

[25] Note that the results for India reflect the high sales of these commodities – motor vehicles, electronics, metal products, machinery and other manufactures – to the capital goods sector, according to the underlying I-O table.

Table 4 Cumulative difference in 2020 of output due to *Moderate Financial Crisis, aggregated sectors and regions* (%)

	Australasia	China	Japan	High Income Asia	ASEAN	India	Rest of South Asia	US	EU27	Russia and Central Asia	Rest of World	**World Total**
Crops	-3.7	-4.2	-6.3	-4.9	-5.9	-6.3	-4.0	-5.3	-8.5	-7.0	-6.9	**-6.8**
Animals	-4.4	-4.7	-14.9	-7.5	-8.3	-6.7	-2.7	-8.4	-12.4	-10.1	-8.5	**-8.9**
Food Processing	-1.3	-8.1	-12.0	-7.4	-10.6	-11.6	-6.4	-9.4	-11.9	-13.5	-9.5	**-10.5**
Forestry and Extraction	-4.0	-3.3	-12.2	-7.0	-8.8	-6.1	-4.6	-6.5	-7.9	-4.7	-6.6	**-6.6**
Light Manufactures	2.0	-13.6	-19.9	-23.7	-11.1	-9.1	-12.0	-15.5	-15.9	-3.8	-2.1	**-14.1**
Heavy Manufactures	6.9	-4.8	-19.8	-13.0	-10.4	-4.3	-0.2	-16.1	-17.4	4.4	-4.5	**-11.4**
Construction	-2.7	25.0	-28.9	4.0	1.7	12.8	4.0	-30.0	-26.0	20.6	-9.9	**-16.0**
Services	-3.9	-8.6	-8.0	-10.5	-9.3	-10.5	-8.2	-7.1	-9.5	-13.4	-8.6	**-8.5**

Table 5 Cumulative difference in 2020 of exports due to *Moderate Financial Crisis, aggregated sectors and regions* (%)

	Australasia	China	Japan	High Income Asia	ASEAN	India	Rest of South Asia	US	EU27	Russia and Central Asia	Rest of World	**World Total**
Crops	-7.7	-10.2	-27.2	-20.4	-5.8	-5.0	7.7	-5.2	-13.1	-8.7	-7.1	**-8.2**
Animals	-19.0	-9.3	-27.9	-24.1	-3.5	-0.8	-1.1	-13.1	-16.4	-16.4	-7.1	**-13.4**
Food Processing	8.0	-21.4	-13.9	-16.5	-15.2	-50.1	-21.5	-11.0	-13.0	-20.8	0.6	**-11.9**
Forestry and Extraction	-13.5	-32.6	-3.4	-28.2	-14.5	-16.5	-23.4	-2.6	-1.3	-3.8	-10.6	**-9.8**
Light Manufactures	6.7	-19.8	-20.1	-27.7	-13.3	-27.2	-16.0	-6.8	-16.3	-5.2	4.6	**-15.8**
Heavy Manufactures	15.4	-14.2	-23.0	-16.9	-15.1	-15.7	-5.7	-13.8	-18.2	8.5	-0.8	**-13.6**
Construction	-5.0	-22.1	-12.6	-22.7	-19.1	-36.7	-33.9	-5.3	-17.8	-42.4	5.5	**-16.5**
Services	2.6	-36.2	-15.1	-22.1	-15.7	-50.2	-24.8	-2.8	-14.3	-25.1	8.3	**-12.8**

6.2 Severe Financial Crisis and Moderate Crisis with increased Protection

In the second scenario, we model a more *Severe Financial Crisis* with longer-lasting impacts than the first scenario, while in the third scenario, we model a *Moderate Crisis with Increased Protection* in 2010. Both of these scenarios may be expected to accentuate aspects of the damage caused by the global financial crisis and it is to these scenarios that we now turn.

6.2.1 Severe Financial Crisis

Comparing the results of selected indicators for the *Severe Financial Crisis* with the more moderate scenario (Table 6), not surprisingly, we find impacts are now more severe. While 2010 real GDP variations from the baseline will be identical to the moderate crisis scenario, by 2020 real GDP has declined further for all economies as indicated in the first column of Table 6. This is primarily due to the improvement in investment, as economies return to their pre-crisis levels, being delayed which in turn delays capital accumulation. The further decline in global GDP and incomes also causes global savings and investment to fall (-3.2 percent relative to the *Moderate Financial Crisis* scenario). The impact on investment differs across countries, implying that there is a further re-reallocation of investment, resulting from the more gradual adjustment in expectations.

An examination of the aggregate trade results indicates that exports across every sector decline significantly more the *Severe Crisis* scenario, with the total world export volume declining by 3 percent more than the moderate crisis. However, at the country level, there is substantial variation, for example, with Japanese and Russian exports rising. The differences in exports by country result from differences in relative investment flows and capital account changes that lead to real exchange rate re-adjustments.

Table 6 Cumulative difference in selected macroeconomic variable under *Severe Financial Crisis* relative to *Moderate Crisis*, selected countries and regions, 2020 (% deviation)

	Real GDP, 2020	Investment	Real exports	Real imports
Australia	-2.08	-0.52	-2.72	-1.38
New Zealand	-1.51	0.31	-2.12	-1.15
China	-1.58	3.88	-3.68	-1.91
Hong Kong	-9.29	-16.38	-8.35	-7.65
Taiwan	-2.62	-1.10	-1.33	-1.97
Japan	-1.42	-2.25	7.13	-3.86
Korea	-4.09	-5.62	-4.17	-3.77
Indonesia	-1.29	2.21	-3.15	-1.28
Malaysia	-5.11	-3.35	-5.40	-4.95
Philippines	-7.02	-9.81	-10.11	-7.44
Singapore	-7.13	-16.96	-6.16	-6.97
Thailand	-4.65	-4.30	-5.18	-3.62
Vietnam	-3.54	-0.03	-4.19	-2.92
Rest of South East Asia	-2.01	1.20	-1.90	-2.68
Bangladesh	-1.23	2.38	-2.93	-1.67
India	-0.79	4.26	-4.88	0.34
Pakistan	-5.40	-2.81	-7.79	-5.07
Rest of South Asia	-3.31	-0.92	-5.73	-2.94
US	-1.76	0.00	-1.71	-1.81
EU27	-2.75	-2.47	-3.70	-2.73
Russia	-1.40	5.02	2.17	-5.06
Former Soviet Union	-4.40	-1.25	-3.63	-2.89

These changes in aggregate exports are also reflected in output changes by sector and region. Table 8 indicates that while a similar relative sector pattern exists between the first and second scenarios, almost all sectors experience a decline in output by significantly more under the more severe crisis scenario. The exceptions are Japan and Russia, which experience a slight increase in exports in manufactured sectors along with the construction sector in China and Russia, which is responding to the relative increase in investment.

6.2.2 Moderate Crisis with increased Protection

Turning to selected macroeconomic indicators for the third scenario of *Moderate Crisis with Increased Protection* (Table 7), we find that when tariffs are increased 10 percent towards their bound levels, this tends to have a substantial and further negative impact relative to the first scenario. Almost all economies experience lower real GDP when tariffs are increased in 2010 (first column of Table 7). Longer term, however, it appears that some

economies including Australia, China, Taiwan, Japan, the US and EU experience some small benefits in terms of real GDP relative to the moderate crisis. It is important to note, however, that this does not suggest that countries raise their own protection as a means of reducing the impact of the crisis. Firstly, the gains are relatively insignificant; and secondly, the countries that experience minor gains are those that increased their tariffs by relatively less than the other economies, hence their gains are the result of declines in their protection relative to other countries. These gains would be even larger if these countries do not raise protection in response to increased protectionism by their trading partners. Global exports now fall by a further 1.63 percent. Furthermore, global exports and output fall across most commodities, relative to the first scenario. Therefore increasing protection can be seen to further harm the global economy and accentuate the negative impact of the crisis.

Under the third scenario, sectoral output falls for most countries and sectors, relative to the first scenario (Table 9). The exceptions are Japan and China, where output across most sectors tends to be slightly less harmed when tariffs are increased. For Australasia, the US and EU, we also find that output of manufactured goods and construction tends to decline relatively less when tariffs are increased. In all these cases, tariffs were raised relatively less than other countries, hence reinforcing the earlier claim that a country can limit the losses from the crisis by keeping tariffs low and not responding to the protectionist tendencies of others.

Table 7 Cumulative difference in selected macroeconomic variable under Scenario 3, *Moderate Financial Crisis with Increased Tariffs*, **relative to** *Moderate Crisis,* **selected countries and regions, 2020 (% deviation)**

	Real GDP, 2010	Real GDP, 2020	Investment	Real exports	Real imports
Australia	-1.44	0.08	0.27	-0.84	-0.53
New Zealand	-2.59	-0.09	-0.29	-1.06	-1.05
China	-0.01	0.19	0.62	0.11	-0.10
Hong Kong	-6.51	-0.81	-2.90	-2.30	-2.63
Taiwan	0.00	0.21	0.93	0.43	0.24
Japan	-3.37	0.11	0.69	0.28	-0.30
Korea	-4.34	-0.44	-1.18	-1.18	-1.39
Indonesia	-2.21	-1.12	-2.55	-5.97	-5.51
Malaysia	-4.43	-0.64	-2.35	-1.61	-2.09
Philippines	-6.44	-1.72	-4.44	-4.82	-4.13
Singapore	-6.61	-2.10	-7.76	-4.78	-4.54
Thailand	-8.02	-2.11	-4.53	-5.99	-4.49
Vietnam	-2.41	-0.58	-1.41	-1.07	-1.48
Rest of South East Asia	-1.08	-1.19	-3.04	-4.22	-4.64
Bangladesh	-2.61	-1.48	-4.97	-9.85	-11.18
India	-0.28	-0.61	-1.72	-3.28	-3.57
Pakistan	-2.44	-1.59	-4.94	-4.89	-4.92
Rest of South Asia	-4.43	-2.36	-6.47	-5.17	-5.87
US	-0.87	0.13	0.75	-0.15	-0.30
EU27	-3.23	0.20	0.90	-0.86	-0.64
Russia	-2.20	-1.14	-4.23	-3.92	-5.96
Former Soviet Union	-6.07	-2.14	-5.68	-7.90	-6.67

6.2.3 Comparison of Trade Results

Figure 1 compares the changes in world sectoral exports under all three scenarios, relative to the 2020 baseline. Exports decline across the board in every scenario, with a longer crisis and increasing protection (scenarios 2 and 3), further harming exports. However, while for the construction and services sectors, exports decline significantly more under the second scenario, this is not the case for the third scenario. This is because a longer crisis will lead to much more significant damage to these sectors, particularly construction that is heavily impacted by investment levels. However, there are no increases in tariffs for these sectors when tariffs increase toward their bound levels. Therefore the impacts on these sectors in the third scenario are very similar to the first, with only indirect impacts via tariff increases in other sectors. However, for crops and food processing, Figure 1 shows that increasing

tariffs a little toward their bound levels has an even more adverse impact on exports than an extended crisis does. These are sectors with relatively large scope to increase tariffs within current bindings, therefore exploiting this has a particularly adverse impact on these sectors. In addition, the financial crisis will have relatively less impact on these agricultural and food sectors than on sectors like construction and manufacturing, as discussed earlier.

Figure 1 Change in real global exports by sector, relative to 2020 baseline (% change)
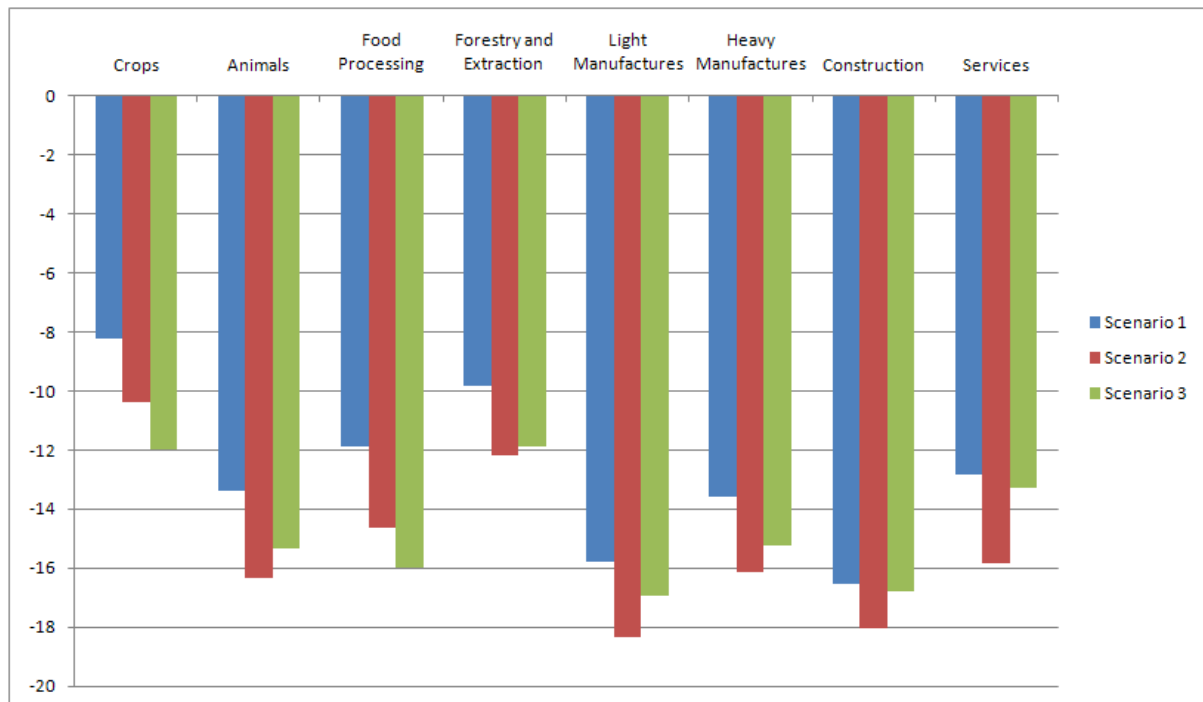
Table 8 Cumulative difference in 2020 of output due to *Severe Financial Crisis* relative to *Moderate Financial Crisis*, aggregated countries and regions (%)

	Australasia	China	Japan	High Income Asia	ASEAN	India	Rest of South Asia	US	EU27	Russia and Central Asia	Rest of World	**World Total**
Crops	-1.3	-0.6	-0.4	-0.8	-1.5	-1.0	-1.4	-1.1	-1.7	-1.2	-2.7	**-1.6**
Animals	-1.4	-1.0	-1.2	-2.5	-2.4	-0.8	-2.2	-1.7	-2.6	-3.2	-3.0	**-2.2**
Food Processing	-1.7	-1.6	-1.7	-3.1	-3.6	-1.3	-2.8	-1.9	-2.5	-2.9	-2.9	**-2.5**
Forestry and Extraction	-1.0	-0.5	-0.8	-4.0	-3.0	-0.9	-1.0	-1.1	-1.6	-0.7	-2.6	**-2.1**
Light Manufactures	-2.2	-2.5	4.4	-3.9	-5.6	-1.0	-5.9	-0.9	-3.0	1.0	-2.8	**-2.4**
Heavy Manufactures	-2.4	-1.6	2.4	-3.5	-5.2	-0.5	-4.7	-1.5	-3.4	0.8	-3.2	**-2.3**
Construction	-0.5	3.6	-2.0	-6.1	-2.8	3.4	-0.5	-0.7	-2.6	1.7	-3.9	**-2.0**
Services	-2.2	-2.2	-1.8	-5.0	-4.3	-1.3	-4.5	-1.9	-2.9	-4.0	-3.8	**-2.8**

Table 9 Cumulative difference in 2020 of output due to *Moderate Financial Crisis with tariff increase* relative to *Moderate Financial Crisis*, aggregated countries and regions (%)

	Australasia	China	Japan	High Income Asia	ASEAN	India	Rest of South Asia	US	EU27	Russia and Central Asia	Rest of World	**World Total**
Crops	-0.5	0.2	0.9	0.9	-0.6	-0.1	0.4	-0.2	0.0	-0.3	-0.2	**0.0**
Animals	-0.1	-0.1	0.1	-0.3	-0.3	0.0	-0.5	0.0	-0.4	-0.7	-0.1	**-0.2**
Food Processing	-0.3	0.2	0.1	-0.4	-0.5	0.5	0.3	0.0	-0.4	-0.6	0.0	**-0.1**
Forestry and Extraction	0.0	0.1	0.8	0.1	-0.2	0.1	-0.6	0.0	0.0	-0.3	-0.3	**-0.1**
Light Manufactures	0.4	0.3	0.7	0.3	-3.2	-0.9	-6.9	0.5	0.4	-0.7	-1.2	**-0.2**
Heavy Manufactures	0.3	0.5	0.4	-0.7	-2.9	-1.3	-2.7	0.4	0.3	-2.1	-1.2	**-0.2**
Construction	0.1	0.6	0.6	-1.0	-3.2	-1.5	-4.5	0.5	0.7	-3.9	-1.2	**-0.3**
Services	0.0	0.1	0.1	-0.3	-1.0	-0.4	-0.7	0.1	0.2	-1.3	-0.4	**-0.1**

7   Concluding comments

The global financial crisis is having a profound impact on many economies and while encouraging signs in the global economy have recently been noted, the world economy remains fragile with much uncertainty remaining. In this paper, we used historical data and forecasts to help model the impacts of the crisis within a general equilibrium framework. The current study of course has limitations. Of particular note, is that the dynamic CGE model used does not include debt or money obligations, therefore it does not offer insights into the causes or the total macroeconomic impact of the crisis. We are reliant on other sources for insights into these. The GDyn model we use does, however, offer a way of modeling how the expected changes in real GDP and investment are likely to work their way through each economy and sector over time.

Our findings suggest that the crisis is likely to have a significant effect on trade, due in part to the changes in capital flows resulting from the re-allocation of savings across regions. In the short run, all countries lose as a result of the crisis. In the long run, countries such as the USA and EU experience a persistent decline in real GDP, while some other regions recoup some of the losses. Globally, our results suggest that trade falls by 13.7 percent from the 2020 baseline and the composition of trade changes quite markedly as a result of the crisis, with shifts reflecting changes in demand for construction of investment goods; the increasing demands of China and India; and at least in the short run, different capital intensities of production in different economies. A longer-lasting crisis, as modeled in our second scenario, further harms most economies. While the depth and duration of the crisis may determine which policy responses prevail, the degree to which various policy measures are adopted may in turn affect the extent of the economic downturn (Ahearn, 2009). Potential policy responses to the crisis may include increased protection, which we model in our third scenario. Results for this scenario suggest that increased protection is likely to have a significant and detrimental impact on the global recovery. Furthermore, our findings suggest that those countries that refrain from raising protection so much are more likely to see the losses from the crisis reduced in the increased protection scenario.

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Appendix Table A1 Regional aggregation

Aggregated region	Country/region modelled	Description
Australasia	Australia	Australia
	NZ	New Zealand
	Oceania	Rest of Oceania
China	China	China
Japan	Japan	Japan
High income Asia	Hong Kong	Hong Kong, China
	Taiwan	Taiwan
	Korea	Republic of Korea
ASEAN	Indonesia	Indonesia
	Malaysia	Malaysia
	Philippines	Philippines
	Singapore	Singapore
	Thailand	Thailand
	Vietnam	Vietnam
	Rest of South-east Asia	Cambodia, Lao PDR, Myanmar, Brunei Darussalam, Timor-Leste
India	India	India
Rest of South Asia	Bangladesh	Bangladesh
	Pakistan	Pakistan
	Rest of South Asia	Sri Lanka, Afghanistan, Bhutan, Maldives, Nepal
United States	US	United States of America
EU27	EU27	European Union 27 members
Russia and FSU	Russia	Russian Federation
	FSU	Former Soviet Union
Rest of the world	Rest of North America	Rest of North America
	Latin America	Latin America
	Rest of Europe	Rest of Europe
	Rest of East Asia	Macau, Mongolia, Democratic PR Korea
	MENA	Middle East and North Africa
	SSA	Sub-Saharan Africa

Appendix Table A2 Sectoral aggregation

Aggregated sector	Sector
Crops	Rice
	Wheat
	Grains and crops
Animals	Cattle and wool
	Other animals
Processed foods	Meat products
	Processed rice
	Other Foods
Forestry and extraction	Forestry
	Mining and extraction
Light manufacturing	Textiles
	Wearing apparel
	Leather products
	Wood and paper products
	Electronic equipment
	Other machinery
Heavy manufacturing	Petroleum, coal products
	Motor vehicles and parts
	Chemical, rubber, plastic products
	Metals
	Metal products
	Other manufacturing
Construction	Construction
Services	Utilities
	Transport and communication
	Business services
	Housing, education and health