



**Asia-Pacific
Economic Cooperation**

Advancing Free Trade
for Asia-Pacific **Prosperity**

Enhanced Resiliency of Cross-Border Value Chains: Impact Evaluation for the Asia-Pacific



APEC Policy Support Unit
October 27, 2014

Prepared by:
Ben Shepherd (Principal)
Developing Trade Consultants.
Ben@Developing-Trade.com.

Marinos Tsigas (Lead International Economist)
U.S. International Trade Commission
Marinos.Tsigas@USITC.Gov

The authors are writing in a strictly personal capacity. Any views expressed are those of the authors only and do not represent the views of any organizations with which they are affiliated or the views of any Officials of those organizations. They are grateful to Anasuya Raj for excellent research assistance.

Produced for:
Asia-Pacific Economic Cooperation Policy Support Unit
Asia-Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Tel: (65) 6891-9500 Fax: (65) 6891-9690
Email: psugroup@apec.org Website: www.apec.org

APEC#214-SE-01.29



This work is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Singapore License. To view a copy of this license, visit <http://creativecommons.org/licenses/by-nc-sa/3.0/sg/>.

The views expressed in this paper are those of the authors and do not necessarily represent those of APEC Member Economies.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	IV
1. INTRODUCTION AND PROJECT OVERVIEW	1
2. LITERATURE REVIEW	3
3. METHODOLOGY	5
GENERAL APPROACH AND COUNTERFACTUAL SCENARIOS.....	5
TWO-STEP METHOD	7
4. RESULTS OF QUANTITATIVE ANALYSIS.....	9
ECONOMETRIC ANALYSIS	9
CGE MODEL RESULTS.....	10
5. CONCLUSION AND POLICY IMPLICATIONS	24
APPENDIX 1: DETAILED SIMULATION RESULTS.....	26
AUSTRALIA AND NEW ZEALAND	26
BRUNEI DARUSSALAM.....	26
CANADA	26
CHILE.....	27
CHINA	27
HONG KONG, CHINA.....	28
INDONESIA.....	28
JAPAN	29
REPUBLIC OF KOREA.....	30
MALAYSIA.....	30
MEXICO.....	31
PAPUA NEW GUINEA	32
PERU.....	32
THE PHILIPPINES.....	32
RUSSIA.....	33
SINGAPORE.....	33
CHINESE TAIPEI.....	34
THAILAND	35
UNITED STATES.....	36
VIET NAM	36
APPENDIX 2: TECHNICAL DETAILS.....	38
ECONOMETRIC MODEL	38
GLOBAL CGE MODEL.....	40
REFERENCES.....	43

EXECUTIVE SUMMARY

This report presents results from the fourth and final phase of PSU's project on Value Chain Resilience (VCR). The first three phases examined particular components of VCR, namely Risk, Strength, and Connectedness. This report deals with the economic impacts of VCR using a global Computable General Equilibrium (CGE) model. Impacts are assessed using counterfactual simulation scenarios: three scenarios involve VCR improvements by APEC economies, and the fourth is based on a negative external shock. The purpose of presenting both positive and negative scenarios is to assess the benefits that can come from enhancing VCR, as well as the disruptions to APEC economies that can be caused by external events that affect value chain trade.

To better understand the implications of VCR for economic growth and development, this report uses a recently developed model of the global economy (Tsigas and Wang, 2010). It models firm input sourcing decisions differently from standard models, and in a way that accords more closely with the realities of value chain trade. In addition, the model includes processing zones in China and Mexico, two APEC economies where this kind of value chain related activity is particularly important. Together, these characteristics make the model a useful platform for examining the impacts of improvements in VCR, as well as the effects of a negative external shock.

The first three phases of this project represent standalone research products, but were also designed to be inputs into this, the final phase. In essence, the present report develops a methodology for linking VC Risk, Strength, and Connectedness to a complex model of the global economy. The model is then used to perform counterfactual simulations based on various scenarios of VCR improvement—i.e., improvement in each of the three component indices—or a negative external shock affecting VCR in another region. Outputs include indications of the impact of VCR changes on important economic indicators such as GDP, exports, imports, investment, and wages. The results presented here therefore make it possible to analyze some of the social development impacts of VCR changes in addition to the strictly economic ones.

Concretely, the model is used to perform four counterfactual simulations based on the following scenarios:

1. All APEC economies decrease VC Risk and increase VC Strength and Connectedness by 5%. Non-APEC economies do not change. Improvements take place on a most favored nation basis, i.e. they benefit all economies with which the improving economies trade.
2. All APEC economies decrease VC Risk and increase VC Strength and Connectedness by 5%, but the benefit only accrues to other APEC economies. Non-APEC economies do not change.
3. All developed APEC economies¹ decrease VC Risk and increase VC Strength and Connectedness by 5%, while developing APEC economies improve in each case by 10%. Non-APEC economies do not change. Improvements take place on a most favored nation basis, i.e. they benefit all economies with which the improving economies trade.

¹ In line with APEC practice, developed economies are considered to be Australia, Canada, Japan, New Zealand, and the United States. All other APEC economies are considered to be developing.

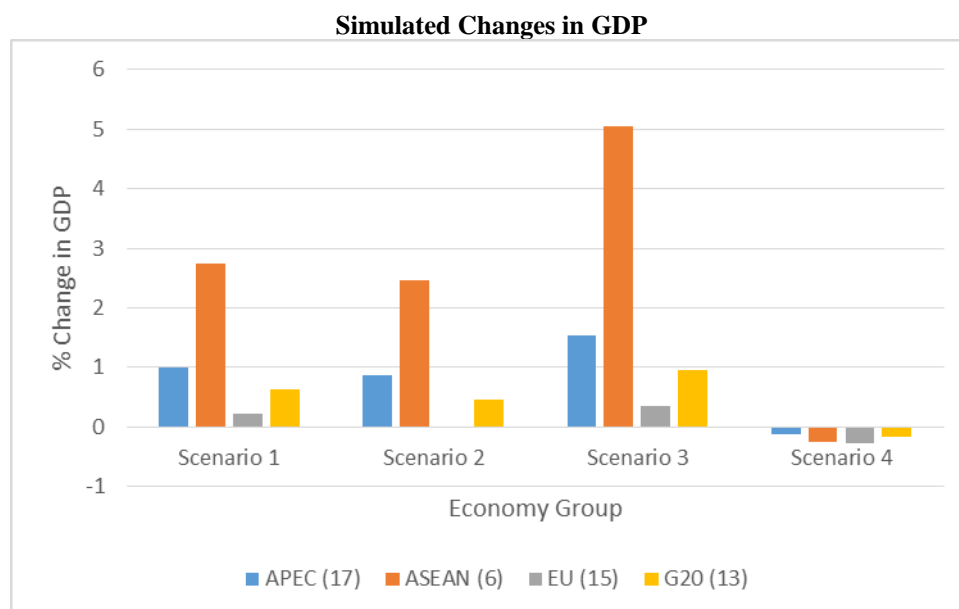
4. EU economies increase VC Risk and decrease VC Strength and Connectedness by 5%. Deteriorations take place on a most favored nation basis, i.e. they affect all economies with which those economies trade.

Summary results for the APEC region and selected comparator regions are presented in the figure below. It focuses on GDP. The main text of the report also covers a range of other indicators, and Appendix 1 provides an economy-by-economy breakdown of the simulation results.

APEC economies stand to experience substantial gains in GDP from improvements in VCR, as demonstrated by the results of Scenarios 1, 2, and 3. In percentage terms, the gains range between 0.9% (Scenario 2) and 1.5% (Scenario 3). Given that GDP accounts for all value added in an economy, the dollar figures associated with these changes are substantial: \$460bn for Scenario 3, \$300bn for Scenario 1, and \$260bn for Scenario 2. All figures are for a single year, after all necessary economic adjustments have taken place. Clearly, the economic gains from improvements in VCR are of interest to APEC economies in the context of broader efforts aimed at increasing international integration in the region, and promoting economic growth and development.

Comparing figures among the three scenarios is informative. Scenario 1 can be taken as a baseline: all economies improve at the same rate, and do so in a way that is non-discriminatory, i.e. the benefit accrues in part to all APEC economies as well as to all of their trading partners. By contrast, Scenario 2 considers a reform scenario that is more preferential in outlook, with the primary benefit of reform accruing to APEC economies. Nonetheless, the economic gains to APEC from non-discriminatory improvements in VCR are greater under Scenario 1 than under Scenario 2, as is the case, indeed, for all economy groups. The lesson to be drawn from this comparison is that APEC's traditional approach of open regionalism is an appropriate guideline to help maximize the economic benefits flowing from improvements in VCR. Some of those benefits accrue to economies outside the region, but the impact for APEC is more positive in the case of non-discriminatory, open improvements. Moreover, it is in the nature of VCR that improvements would tend to be non-discriminatory, which means that Scenario 1 is perhaps a more realistic benchmark for possible reforms than Scenario 2, which is presented for comparative purposes only.

Comparing Scenarios 1 and 2 with Scenario 3 shows that the gains from VCR improvements are considerably larger when even a subset of APEC economies move forward more quickly—in this case developing economies. The GDP gains from VCR improvements are about 50% higher for APEC economies as a whole when developing economies move forward by 10%, and developed economies move forward at the baseline rate of 5%. There is clearly a rationale in this case for willing APEC economies to play a pathfinder role in the area of VCR: benefits accrue to other APEC economies, as well as more broadly in the global economy.



Source: Authors.

Scenario 4 is fundamentally different from the others, because it considers the impact of a negative external shock centered on the EU. Economic impacts are quite modest, probably due to APEC's stronger engagement with other parts of the world. Results from this simulation suggest that although APEC is certainly susceptible to drops in economic activity caused by disruptions to value chains elsewhere in the world, it is also quite resilient as it maintains strong trading relations with a wide variety of other economies, as well as intra-regionally. It is important to keep in mind, however, that Scenario 4 is based on a value chain disruption with its epicenter in a relatively distant part of the world economy with respect to the Asia-Pacific. General crises, such as the Global Financial Crisis, as well as localized ones within APEC, would carry the possibility for more severe disruptions.

Phases 1 and 2 of this project concluded that although APEC economies face on average a moderate level of VC Risk, they have well developed capacities to respond to it through robust VC Strength mechanisms. Both characteristics of value chain trade in the region are reflected in APEC's VC Connectedness, which was analyzed in this project's third phase.

Phases 1-3 were primarily descriptive and diagnostic. This final phase has examined in more detail the economic stakes of VCR, focusing on the three indices developed earlier. It has combined an econometric model with a global CGE model to provide estimates of the economic impact of three reform scenarios, and one negative external shock scenario. All results are counterfactual simulations, not forecasts, and assume that all other exogenous factors remain constant. In other words, they examine the direction of change in key economic variables under a selection of hypothetical scenarios based on assumed changes in VCR variables from the current baseline. A comparison of results across scenarios reveals a number of features that are important from a policy point of view.

First, improving VCR in the region could have major economic gains. The simulations conducted here suggest that a 5% improvement in VCR—which is feasible and in line with previous approaches to reform in APEC, such as the Trade Facilitation Action Plans—could be associated with a comparative static increase in GDP of \$300 billion. Trade (summing exports and imports) would increase by \$827 billion. In addition, there is suggestive evidence

that investment, possibly including FDI, would also increase substantially. This kind of expansion in value chain trade would put upwards pressure on wages, and probably employment in labor surplus economies. From a development point of view, it is important to note that the effects on skilled and unskilled labor appear to be quite similar, which suggests that growth would be socially inclusive.

Second, the economic gains from VCR improvements are larger when the improvements are non-discriminatory, i.e. implemented on a most favored nation basis. The nature of most VCR improvements is indeed that they are non-discriminatory, but the role of measures such as regional trade arrangements in promoting Connectedness needs to be kept in perspective. APEC's open regionalism and emphasis on concerted unilateral action is the right one to move forward most effectively on VCR.

Third, the economic gains are larger with more ambitious reforms, even when a self-selected group of economies play a pathfinder role. As in most trade policy, the economic gains from improving VCR accrue primarily to those economies that reform, with spillover effects to their trading partners and other economies. Individual economies interested in joining or moving up value chains therefore have a real interest in moving forward jointly or unilaterally on VCR. The wide variety of policy measures included in the VC Risk and Strength indices is suggestive of a broad set of levers that could be used by policymakers to improve VCR.

Fourth, APEC economies are on the whole quite resilient to negative events elsewhere in the world economy. When such events are localized—as in the simulation example used here—the effects on the region overall are relatively small. This finding is a reflection both of the inherent resilience of APEC value chains, and the diversity of APEC's trading partners and the importance of intra-regional trade in the overall picture. Of course, APEC economies—like all other open economies—remain sensitive to major, worldwide shocks like the Global Financial Crisis. But as the case study on this shock in the phase 2 report showed, APEC value chains tended to remain intact even as their activity level temporarily fell, and then they rebounded quickly. The overall message is that value chains are relatively resilient in the APEC region, which provides a good basis for moving forward should policymakers decide that improving VCR is a priority.

1. INTRODUCTION AND PROJECT OVERVIEW

This report presents results from the fourth and final phase of PSU's project on Value Chain Resilience (VCR). The first three phases examined particular components of VCR, namely Risk, Strength, and Connectedness. This report examines the economic impacts of VCR using a global CGE model. Impacts are assessed using counterfactual simulation scenarios: three scenarios involve VCR improvements by APEC economies, and the fourth is based on a negative external shock. The purpose of presenting both positive and negative scenarios is to assess the benefits that can come from enhancing VCR, as well as the disruptions to APEC economies that can be caused by external events that affect value chain trade.

Global and regional value chains (VCs) are an important way of organizing trade and production across the globe, and particularly in the Asia-Pacific. They are best known in sectors such as electronic goods and transport equipment, but have now expanded to include numerous sectors of goods trade, as well as some types of services. Analyzing the economic impacts of VCR requires an approach based on the specific characteristics of VC trade. In particular, it needs to account for the importance of cross-border trade in intermediate inputs, and the ways in which firm sourcing decisions are affected by factors such as overall relative prices.

With these considerations in mind, this report uses a recently developed model of the global economy (Tsigas and Wang, 2010). It models firm input sourcing decisions differently from standard models, and in a way that accords more closely with the realities of VC trade. In addition, the model includes processing zones in China and Mexico, two APEC economies where this kind of VC related activity is particularly important. Together, these characteristics make the model a useful platform for examining the impacts of improvements in VCR, as well as the effects of a negative external shock.

The first three phases of this project focused on the production of indices to measure three key components of VCR, namely Risk, Strength, and Connectedness. The first two indices are effectively data aggregators: they include a variety of data from existing sources, brought together in such a way as to accurately summarize VC Risk and Strength. The third index uses advanced network analysis methods to map the global network of trade in value added using new data from the OECD and WTO. The result is an index measuring each economy's relative position in that network, which is interpreted in terms of VC Connectedness.

The first three phases of this project represent standalone research products, but were also designed to be inputs into this, the final phase. In essence, the present report develops a methodology for linking VC Risk, Strength, and Connectedness to a complex model of the global economy. The model is then used to perform counterfactual simulations based on various scenarios of VCR improvement—i.e., improvement in each of the three component indices—or a negative external shock affecting VCR in another region. Outputs include indications of the impact of VCR changes on important economic indicators such as GDP, exports, imports, investment, and wages. The results presented here therefore make it possible to analyze some of the social development impacts of VCR changes in addition to the strictly economic ones.

It is important to highlight that, as in any model-based assessment of policy changes, the outputs presented in this report are counterfactual simulations, not forecasts. They cannot be interpreted as guides to the actual way in which the world economy would evolve if changes were to be made to economies' VCR scores. Rather, they are indications of the forces that would be at play, assuming that all other exogenous factors remain constant. Although the simulations produce the familiar dollar and percentage outputs, they are best interpreted in relative terms, i.e. across scenarios, indicators, and economies. In addition to the region-wide results presented in the main body of the report, Appendix 1 provides more detailed information on an economy-by-economy basis.

The report proceeds as follows. The next section presents a brief literature review, focusing on recent work on similar types of simulations, as well as the general methodology used in this report. Section 3 presents the methodology in intuitive terms, with full technical details in Appendix 2. Section 4 provides an overview of the simulation results, focusing on a comparison of APEC with other regions, namely ASEAN, the G-20, and the EU. The final section concludes, and presents some possible policy implications for consideration by APEC member economies.

2. LITERATURE REVIEW

With the increasing segmentation of global production and the prevalence of trade in intermediate goods and services that represents more than half of global trade (Miroudot et al., 2009; Sturgeon and Memedovic, 2010), global and regional VCs have become a mainstream model for global business operations. The Global Value Chains Initiative (www.globalvaluechains.org) defines a VC as including the full range of activities undertaken to bring a product from the conception stage to the end user, and even beyond.

As noted in the reports for the previous phases of this project, there is relatively little literature directly on point for the analysis of VCR, and in particular its economic impacts. This review therefore focuses on one piece of recent work that can inform the study very closely: an analysis of the economic impacts of barriers to VC trade.

The most recent and well-known point of reference for the analysis of trade barriers and VC trade is WEF and World Bank (2013). Although it focuses on supply chains rather than value chains—the difference primarily residing in the former’s focus on point-to-point transactions compared with the latter’s evolution as a series of networks—it is highly informative for the present study.

The authors analyze the economic impacts of reducing barriers to what they call supply chain trade. They compare these impacts with other scenarios, including the reduction of traditional trade barriers, such as tariffs. They find that the economic impacts of reducing supply chain barriers are much larger than even the complete elimination of tariffs: the ratio of GDP gains, for example, is around 6:1. There are two main reasons for this result. First, tariffs in many economies are already low by historical standards, so further reductions can be expected to have only marginal effects. (Of course, reduction of higher tariffs in some developing economies could have much larger effects.) Second, tariff reductions primarily reallocate income from producers to consumers. Efficiency gains for the economy are second order (“triangle gains”). By contrast, supply chain barriers represent pure economic waste, and so their reduction results in first order efficiency gains (“rectangle gains”). The WEF and World Bank (2013) result is in line with work on related areas, such as trade facilitation, where the economic mechanisms are similar: it is generally recognized by economists that the potential gains from trade facilitation, for example, are considerably larger than those from the elimination of tariffs.

To analyze the economic impacts of reducing supply chain barriers, the authors use a complex model of the world economy. The model consists of two components. The first is a large set of equations relating various economic variables to each other. The second is a dataset on trade and production that informs the set of equations. Together, these components provide a platform on which counterfactual changes can be simulated and compared.

Even within the complex framework used by WEF and World Bank (2013), modeling supply chain barriers to trade is a complex undertaking. No model of the global economy directly includes such variables. It is therefore necessary to first measure supply chain barriers, and then link them to variables that are present in the model. The authors do that by using the WEF’s Global Enabling Trade Index (ETI) to measure supply chain barriers to trade, focusing on border administration, and transport and communications infrastructure. To link the ETI to the global economic model, they use a common econometric approach known as a gravity model. It is used to estimate the sensitivity (“elasticity”) of trade flows with respect to the relevant sub-indices of the ETI. Economic theory can then be applied to estimate the elasticity of trade costs with respect to the ETI sub-indices. Trade costs—the economic resources required to move goods from one

economy to another—feature prominently in global economic models, and provide the link from the ETI to the model. By considering counterfactual values of the ETI, it is possible to calculate counterfactual values of trade costs. These values can then be used to “shock” the global economic model, which is re-solved for equilibrium values of the other variables, with most adjusting to the new settings, and some remaining fixed as exogenous assumptions. Re-solving the model produces counterfactual values for indicators of interest, such as GDP and trade.

The WEF and World Bank (2013) report has been examined in some detail because it is the basis for the methodological approach used here. It is the closest piece of recent research to the present one, and provides an important baseline for comparison.

3. METHODOLOGY

Analyzing the economic impact of improvements in VCR is a very complex exercise. An economy-wide approach is necessary. It is not sufficient to examine individual companies or even sectors. It is important to look at the ways in which resources move from one part of the economy to another in response to changes in the different elements of VCR, so as to gauge the overall effects on macro-level variables, such as imports, exports, GDP as a proxy for economic welfare, and other indicators of policy interest.

GENERAL APPROACH AND COUNTERFACTUAL SCENARIOS

To conduct such an analysis, the “gold standard” approach is to use a global Computable General Equilibrium (CGE) Model, as in WEF and World Bank (2013). That is the methodology adopted in this report. CGE models are complex, mathematical representations of the global economy in which particular sectors and activities are identified, and their inter-relations mapped. CGE models are used to conduct counterfactual simulations: the baseline model is “shocked” by changing one or more variables and examining the impact on other variables of interest, after allowing for all model-based adjustments to take place. In this report, four counterfactual scenarios are considered, in order to better understand the possible economic impacts that improvements in VCR could have:

1. All APEC economies decrease their VC Risk index and increase their VC Strength and Connectedness indices by 5%. Non-APEC economies do not change. Improvements take place on a most favored nation basis, i.e. they benefit all economies with which the improving economies trade.
2. All APEC economies decrease their VC Risk index and increase their VC Strength and Connectedness indices by 5%, but the benefit only accrues to other APEC economies. Non-APEC economies do not change.
3. All developed APEC economies² decrease their VC Risk index and increase their VC Strength and Connectedness indices by 5%, while developing APEC economies improve in each case by 10%. Non-APEC economies do not change. Improvements take place on a most favored nation basis, i.e. they benefit all economies with which the improving economies trade.
4. EU economies increase their VC Risk index and decrease their VC Strength and Connectedness indices by 5%. Deteriorations take place on a most favored nation basis, i.e. they affect all economies with which those economies trade.

The first scenario reflects the possibility of a concerted unilateral reform by APEC economies, of the type that has been undertaken in other areas such as trade facilitation, and Ease of Doing Business. As in those cases, it is assumed that improvements by APEC economies affect their trade relations with all other economies in the world—even non-APEC economies—because of the nature of the processes in question. For example, decreasing VC Risk typically affects trade and investment decisions by all potential partners, not just other APEC economies. The figure of a 5% improvement was chosen as a reasonable but ambitious

² In line with APEC practice, developed economies are considered to be Australia, Canada, Japan, New Zealand, and the United States. All other APEC economies are considered to be developing.

benchmark that can be expected to provide significant economic impacts for comparative purposes.

The second scenario represents preferential regional reform. It is not typically the type of measure preferred by APEC economies, but may be of relevance in the context of possible discussions relating to the realization of the Bogor goals of open trade and investment in the region. Some policy measures that improve VCR, such as implementing broad-based and ambitious trade agreements, have benefits that accrue primarily to economies in the region, as opposed to those outside, which benefit less. The difference in results between Scenario 2 and Scenario 1 therefore reflects the economic effects of a preferential approach to improving VCR, as opposed to concerted unilateralism that is open and non-discriminatory.

Scenario 3 considers the important possibility of “catch up” by developing APEC economies. Those economies are actively engaged in joining and moving up global and regional VCs. A number of APEC economies are noted globally for their outward-oriented development strategies, which have brought considerable economic benefits. The rate of change in some developing APEC economies has been extremely rapid, although they have started from very different baselines from developed APEC economies. The purpose of Scenario 3 is to analyze the economic implications of more rapid movement forward by developing economies. As in Scenario 1, all APEC economies improve VCR to some degree, and do so in a non-discriminatory way, i.e. one that benefits all economies they trade with, APEC and non-APEC economies alike.

Scenario 4 is a negative external shock scenario. The Phase 2 report for this project highlighted recent cases in which negative events have adversely affected APEC VCs, and have had corresponding negative implications for the Asia-Pacific regional economy. This scenario considers the effect of a deterioration of VCR in the European Union (EU), an important external trading partner for some APEC economies. A deterioration in this case could reflect a natural disaster, such as the volcanic eruption of 2010, which seriously disrupted Europe’s ability to connect with the rest of the world by air. Another example of a negative shock could be the ongoing financial system uncertainty, which increases market risk for firms doing business in Europe, or which connect to VCs in which Europe is a key player. The purpose of this scenario is therefore to examine the economic impacts for APEC economies of a deterioration in external conditions.

By analyzing changes from the baseline model in each of the four counterfactual scenarios, it is possible to gain an idea of the ways in which economic activity in the APEC region is affected by the various aspects of VCR. Comparing results from the four scenarios provides an indication of the ways in which different approaches to reform could result in different patterns of benefits for APEC and non-APEC economies. Finally, results from Scenario 4 provide a concrete example of the impact of a negative external shock on APEC economies, of the type that could occur at any time. It therefore demonstrates the ways in which the APEC region is resilient to shocks in relation to VC trade.

It is important to emphasize that the dollar and percentage figures presented in the simulation results are counterfactuals, not forecasts. They are not predictions of the actual way in which economic activity would evolve following a particular change in policy course. Rather, they show the ways in which resources would be reallocated and variables like trade and GDP would change if VCR were to be altered and all other exogenous factors kept constant. In the real world, of course, reforms in one area interact with other policies and external events to

produce a concrete outcome. The simulation results abstract from such effects to provide an indication of the relative orders of magnitude involved in particular policy changes, under the assumption that all other exogenous factors remain constant. The scenario results are therefore primarily useful as comparisons amongst themselves, because they demonstrate in a concrete way the different economic effects that alternative approaches to reform can have. They should not be interpreted as indications of the likely effects of reform in the real world, in which the “all other factors remaining constant” assumption does not hold. Nonetheless, it is widely acknowledged that for this kind of work, CGE models are not only informative, but represent best analytical practice. It is for that reason that this report relies heavily on CGE simulation results.

TWO-STEP METHOD

There is no ready-made CGE model that incorporates VCR in its parameters. It is therefore not possible to take a commonly used model and directly perform counterfactual simulations on it using the four scenarios set out above. An intermediate step is necessary, namely estimating the relationship between the three aspects of VCR examined in the first three phases of this project, and one or more parameters that are present in standard CGE models, as in the WEF and World Bank (2013) report. The most obvious candidate is trade costs. All global CGE models incorporate trade costs: it is costly to move goods from one economy to another in the model, just as it is in real life. Trade costs are the result of many different factors, including tariffs, non-tariff measures, regulatory differences, and other at- and behind-the-border measures (Arvis et al., 2013). It is reasonable to posit that the three aspects of VCR all have an impact on bilateral trade costs: a lower level of Risk makes it less costly to engage in VC trade, thereby promoting exports, while higher levels of Strength and Connectedness also reduce trade costs with the same effect.

The analytical approach taken in this report therefore consists of two discrete steps. In the first step, an econometric model is used to estimate the relationships between trade costs and VC Risk, Strength, and Connectedness. Counterfactual values for those three variables are used to calculate counterfactual changes in trade costs, using the estimated relationships. In the second stage of the analysis, the counterfactual changes in trade costs are used to shock a global CGE model and produce simulation results for indicators of interest such as trade and GDP, focusing on the distinctions and similarities across the four scenarios.

The econometric model used in the first stage of the analysis is purpose-built for this project. It uses data on VC Risk, Strength, and Connectedness from the first three phases of this project. The data on bilateral trade costs are sourced from the UNESCAP-World Bank Trade Costs dataset (Arvis et al., 2013). Trade costs in that database are inferred from the observed pattern of trade and production across economies using recent theoretical advances. They cover all factors that drive a wedge between export and import prices, including those listed above. The model also includes control variables. Full details are set out in Appendix 2,

Time and resource constraints mean that it has been necessary to use a ready-made CGE model. Global CGE models are extremely complicated, based on large numbers of interrelated equations and extensive data on trade and economic activity across economies. The model chosen for the second stage of this report’s analysis is one specifically designed to deal with VC trade. It was constructed by researchers at the U.S. International Trade Commission (Tsigas and Wang, 2010), and is used here independently. The model is

designed to deal more realistically with VC trade than more standard models. (Koopman et al., 2013 discuss insights regarding VCs obtained from this model.)

The global CGE model includes data on 26 regions, and covers 17 APEC economies, both developed and developing. Economies for which data are unavailable are: Brunei Darussalam, Chile, Papua New Guinea, and Peru. In addition to providing information on economy aggregates, the model also identifies processing trade in two economies where that activity is particularly important: China, and Mexico. For those economies, processing and non-processing trade are dealt with separately. This level of detail, which is not found in other global CGE models, is particularly appropriate for a project on VC trade, in which processing is a vital activity. Again, other global CGE models typically do not distinguish between processing and non-processing trade, and the fact that this model does is a significant analytical advantage for the present project.

In terms of sectoral coverage, the global CGE model identifies 38 separate sectors. It covers both agricultural and manufactured goods, as well as services. Given that value chains are active in all sectors, having grown from their traditional focus on certain types of manufacturing, it will be important to obtain some level of sectoral detail in the analysis.

4. RESULTS OF QUANTITATIVE ANALYSIS

As noted above, the primary interest of results from simulations of global CGE models lies in their comparison across counterfactual scenarios. A comparative exercise gives an idea of the relative differences involved in particular approaches to reform, as well as providing order of magnitude estimates of the potential economic gains that could result. It is again important to highlight that CGE simulation results assume that all other exogenous factors are kept constant, and so should not be confused with forecasts of the actual path of particular economies following policy changes.

With those points in mind, the present section presents results from the quantitative exercise. The first section briefly discusses results from the first step econometric analysis, in non-technical terms. The second section turns to the CGE simulation results, which are the area of primary interest for this report.

ECONOMETRIC ANALYSIS

Appendix 2 provides full details of the econometric analysis. In broad terms, it is similar to the approach adopted by Arvis et al. (2013) in their World Bank Policy Research Working Paper. Bilateral trade costs are used as the dependent (left-hand side) variable. A set of control variables and the three VCR variables are used as the independent (right-hand side) variables. Control variables include: membership of the same regional trade arrangement; geographical distance; contiguity (common border); common language; a dummy indicating if one economy was ever a colony of its trading partner; a dummy for economies with a common colonizer; and a dummy for economies that were ever part of the same country. The control variables are standard based on the gravity model literature, which is the benchmark for applied international trade work.

The parameters of interest from the econometric analysis are the three estimated coefficients indicating the sensitivity of trade costs with respect to changes in VC Risk, Strength, and Connectedness. The model is set up so that each coefficient is reported as an elasticity, i.e. it relates percentage changes in each VCR variable to a percentage change in trade costs. All three estimated coefficients have magnitudes that accord with expectations, and are statistically significant at conventional levels. These factors mean that they can be used with confidence.

Concretely, the analysis shows that a 5% decrease in the VC Risk index is associated with a 1.5% decrease in trade costs. A 5% increase in the VC Strength index is associated with a 2.7% decrease in trade costs. Finally, a 5% increase in the VC Connectedness index is associated with a 1.4% decrease in trade costs. Treating all three variables as uncorrelated—which is an abstraction from reality—suggests that a 5% improvement in VCR, i.e. a decrease of that magnitude in VC Risk combined with increases of that magnitude in the other two variables, is associated with a 5.6% decrease in trade costs. The relationship between VCR and trade costs is therefore slightly greater than a 1:1 ratio.

As with any econometric estimate, these figures need to be interpreted with caution. First, the model establishes an association but does not account for the possibility of external or reverse causation. Second, the three VCR variables are correlated, which means that changes in one

variable are likely to be associated with changes in the others. Although the overall direction of that effect is open to question, it is possible that the estimated sensitivity of trade costs with respect to VCR is on the low end, as the cumulative effect of reforms could be greater than the sum of the parts of the overall reform package. Finally, although the model controls for standard intervening causes based on the gravity model literature, it is always possible to posit additional factors that might influence the relationship. Results therefore need to be interpreted as indicative estimates only, and not as a certain, precise relationship.

CGE MODEL RESULTS

Results from the first stage of the analysis can be used to drive simulations of the CGE model based on the four scenarios set out above. To do that, it is first necessary to calculate simulated values of bilateral trade costs for each of the four scenarios. Trade costs are bilateral, i.e. they vary according to economy pair, and in the index used in the econometric model, they are symmetrical, i.e. the trade costs index for exports from economy A to economy B is equal to the trade costs index for exports from economy B to economy A.

In calculating simulated values for trade costs, it is necessary to take account of the fact that on some bilateral routes, both economies reform in a particular scenario, on other routes only one economy reforms, and on still others neither economy reforms. To take account of the intermediate situation in which one economy only reforms, this report takes an approach that relies on the symmetrical nature of trade costs in the data used for the econometric model, and their definition as a geometric average of underlying trade costs in both directions.³ That makes it possible to arrive at simulated changes in trade costs for all three cases. Those cases are grouped together for ease of reference in the following tables, which provide the basis for the four simulations. Each cell in the table shows the change in trade costs for the economy combination in the row and column. For example, the yellow highlighted cell in Table 4.1 shows that under scenario 1, APEC economies would improve VCR so as to decrease trade costs by 5.6% with other APEC economies. Similarly, the orange highlighted cell in the same table shows that under scenario 1, APEC economies would improve VCR so as to decrease trade costs by 2.78% with non-APEC economies. The reason for the different numbers in the two cells is that in the first (yellow) case the exporting and importing economies both improve VCR simultaneously, but in the second (orange) case only one economy improves VCR—the other does not change its VCR level from the current baseline.

Table 4.1 Counterfactual Trade Cost Change Matrix for Scenario 1

	APEC Economies	Non-APEC Economies
APEC Economies	-5.60%	-2.78%
Non-APEC Economies	-2.78%	0.00%

Source: Authors.

Table 4.2 Counterfactual Trade Cost Change Matrix for Scenario 2

	APEC Economies	Non-APEC Economies
APEC Economies	-5.60%	0.00%
Non-APEC Economies	0.00%	0.00%

Source: Authors.

³ The fact that trade costs are a geometric average means that, for example, the figure in the orange cell is not exactly half of the figure in the yellow cell.

Table 4.3 Counterfactual Trade Cost Change Matrix for Scenario 3

		Developed Economies	APEC	Developing Economies	APEC	Non-APEC Economies
Developed Economies	APEC	-5.60%		-8.39%		-2.78%
Developing Economies	APEC	-8.39%		-11.20%		-5.54%
Non-APEC Economies		-2.78%		-5.54%		0.00%

Source: Authors.

Table 4.4 Counterfactual Trade Cost Change Matrix for Scenario 4

	EU Economies	Non-EU Economies
EU Economies	5.60%	2.82%
Non-EU Economies	2.82%	0%

Source: Authors.

Because of the link that has been made between VCR and trade costs, it is expected that simulation results will accord well with previous work on trade facilitation, in which improvements in trade facilitation are also modeled as non-discriminatory reductions in trade costs. The economic gains from reducing trade costs, be it through trade facilitation or improvements in VCR, can be substantial. Unlike tariff liberalization, which primarily reallocates resources from producers to consumers and produces second-order efficiency gains, lower trade costs translate into less wastage of economic resources due to inefficiency, and thus first-order efficiency gains. This effect is behind the well-known results referred to in the literature review to the effect that the economic gains from trade facilitation potentially dwarf the remaining gains to be had from liberalization of tariffs in the manufacturing sector, which are already low in general (e.g., WEF and World Bank, 2013). Although the changes in trade costs are relatively small in the four simulations—representing feasible reforms in APEC member economies—it is likely that they will be associated with economic gains that are of real significance in the context of overall efforts to boost integration and economic activity within the region.

Effects of VCR Improvements on GDP

Changes in GDP provide an overall indication of the ways in which improvements in VCR translate into increased economic activity around the region.⁴ Figure 4.1 presents results by economy group. The CGE model has more restricted economy coverage than the datasets used in the three previous phases of this project, which means that group figures tend to overlap to a greater extent. Nonetheless, the comparison is informative.

APEC economies stand to experience substantial gains in GDP from improvements in VCR, as demonstrated by the results of Scenarios 1, 2, and 3. In percentage terms, the gains range between 0.9% (Scenario 2) and 1.5% (Scenario 3). Given that GDP accounts for all value added in an economy, the dollar figures associated with these changes are substantial: \$460bn for Scenario 3, \$300bn for Scenario 1, and \$260bn for Scenario 2. All figures are for a single year, after all necessary economic adjustments have taken place. Clearly, the economic gains from improvements in VCR are of interest to APEC economies in the context of broader

⁴ GDP is not a true measure of economic welfare. However, the pattern of results using equivalent variation, a measure preferred by many economists, is comparable.

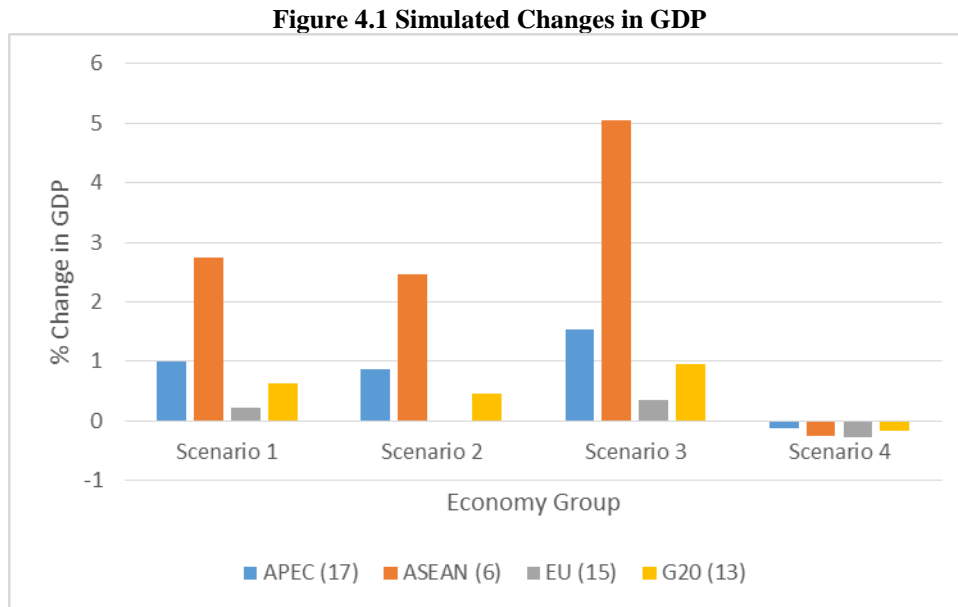
efforts aimed at increasing international integration in the region, and promoting economic growth and development.

Comparing figures among the three scenarios is informative. Scenario 1 can be taken as a baseline: all economies reform at the same rate, and do so in a way that is non-discriminatory, i.e. the benefit accrues in part to all APEC economies as well as to all of their trading partners. By contrast, Scenario 2 considers a reform scenario that is more preferential in outlook, with the primary benefit of reform accruing to APEC economies. Nonetheless, the economic gains to APEC from non-discriminatory improvements in VCR are greater under Scenario 1 than under Scenario 2, as is the case, indeed, for all economy groups. The lesson to be drawn from this comparison is that APEC's traditional approach of open regionalism is an appropriate guideline to help maximize the economic benefits flowing from improvements in VCR. Some of those benefits accrue to economies outside the region, but the impact for APEC is more positive in the case of non-discriminatory, open improvements. Moreover, it is in the nature of VCR that improvements would tend to be non-discriminatory, which means that Scenario 1 is perhaps a more realistic benchmark for possible reforms than Scenario 2, which is presented for comparative purposes only.

Comparing Scenarios 1 and 2 with Scenario 3 shows that the gains from VCR improvements are considerably larger when even a subset of APEC economies move forward more quickly—in this case developing economies. The GDP gains from VCR improvements are about 50% higher for APEC economies as a whole when developing economies move forward by 10%, and developed economies move forward at the baseline rate of 5%. There is clearly a rationale in this case for willing APEC economies to play a pathfinder role in the area of VCR: benefits accrue to other APEC economies, as well as more broadly in the global economy.

Leaving aside the comparison across scenarios to consider economy groups, Figure 4.1 is notable for the fact that the economic effects of reform in APEC are larger in percentage terms for ASEAN than they are for APEC as a whole. This result needs to be explained. The reason is that the model database is limited to just six ASEAN economies, all of which are also APEC developing member economies. As a result, all economies that are members of both APEC and ASEAN in fact reform in scenarios 1-3, so the figures for ASEAN cannot be interpreted as current situation benchmarks. If the model included Cambodia, Lao PDR, and Myanmar—which are not APEC member economies, and therefore would not reform—the impacts would likely be much weaker in relative terms, as these economies are much less integrated into global and regional VCs than their peers represented here, and in any case they are not APEC members, so their VCR scores would remain constant. It is also important to recall that the baselines for APEC and ASEAN are very different: based on the economies included in the CGE model, APEC's baseline GDP level is 23 times larger than that of ASEAN. In dollar terms, APEC's gains are therefore much larger: \$300bn for Scenario 1, for example, compared with \$35bn for the ASEAN economies included in the model.⁵

⁵ As a point of comparison, the total GDP gain for the G20 as represented in the model is \$297bn, and for the EU the figure is \$36bn.



Source: Authors.

Scenario 4 is fundamentally different from the others, because it considers the impact of a negative external shock centered on the EU. Economic impacts are quite modest, probably due to APEC's stronger engagement with other parts of the world. Results from this simulation suggest that although APEC is certainly susceptible to drops in economic activity caused by disruptions to VCs elsewhere in the world, it is also quite resilient as it maintains strong trading relations with a wide variety of other economies, as well as intra-regionally. It is important to keep in mind, however, that Scenario 4 is based on a VC disruption with its epicenter in a relatively distant part of the world economy with respect to the Asia-Pacific. General crises, such as the Global Financial Crisis, as well as localized ones within APEC, would carry the possibility for more severe disruptions, as evidenced by the noticeable effect on EU GDP of the 5% deterioration in VCR in this case (a fall of 0.3%).

Trade Effects of VCR Improvements

The GDP impacts of the simulation scenarios are driven in part by changes in trade flows associated with the counterfactual changes in trade costs. Trade is the variable most directly affected by changes in VCR, particularly in a model like this one, which incorporates VC trade. It is to be expected that the percentage trade impacts of VCR improvements will be larger than the GDP effects, because only part of an economy's output represents traded value added.

That pattern is reflected by a comparison of Figures 4.2 and 4.3 (exports and imports) with Figure 4.1 (GDP). Results for the two variables are strongly correlated across scenarios, as is to be expected in light of the economic forces such as real exchange rate adjustments and the balance between savings and investment that tend to promote relatively stable trade balances on a multilateral basis.⁶ To examine the model's output, it is therefore sufficient to focus on exports: the discussion applies equally well to imports.

⁶ The model does not, however, assume balanced trade either on a multilateral or bilateral basis.

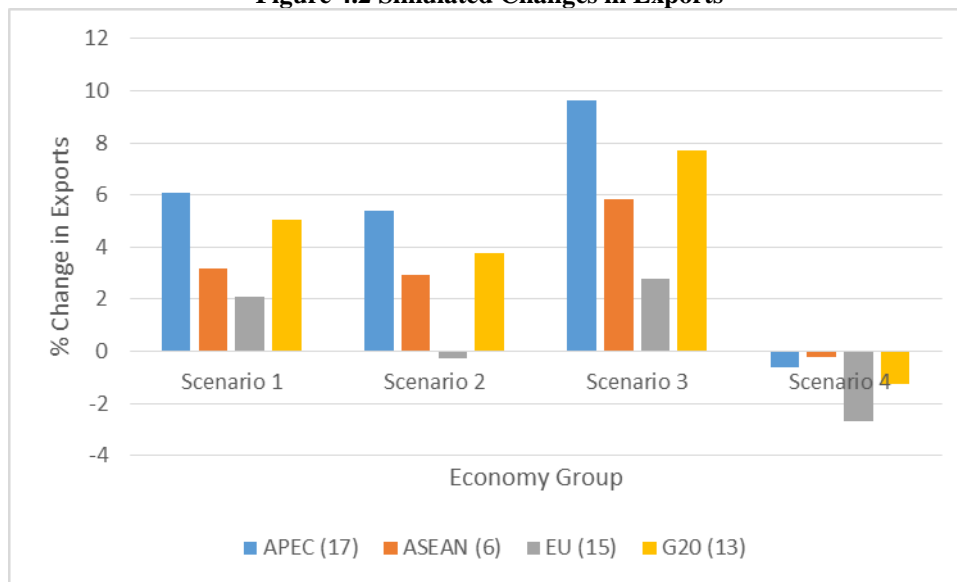
As can be seen from Figure 4.2, the simulated changes in exports for APEC are significant for Scenarios 1, 2, and 3. Indeed, APEC stands to realize the largest relative trade gains of any of the groupings under consideration.⁷ This is a natural result, given that the gains from trade reforms—including improvements in VCR—tend to be of most benefit to the reforming economies themselves. In Scenario 1, in which all APEC economies move forward at the same rate, the simulated change in exports is 6.1%, or \$374 billion annually.⁸ These numbers are highly significant from a policy point of view. Results are similar, but slightly lower for Scenario 2, at 5.4% or \$332 billion. Scenario 3 sees higher simulated changes due to the faster rate of reform in some APEC economies: in percentage terms, exports increase by 9.6%, which equates to \$593 billion in dollar terms. Finally, Scenario 4—the negative external shock scenario—sees exports fall in APEC, but only slightly, by 0.6% or \$38 billion.

The pattern of results across scenarios leads to similar policy implications as for the GDP results discussed above. Comparing Scenario 1 with Scenario 2 suggests that the more realistic case of non-discriminatory improvements in VCR is likely to bring greater trade benefits to APEC, as well as to other economy groups. The comparison with Scenario 3 indicates that selected APEC economies—developing economies in the simulation—can usefully play a pathfinder role by advancing at a more rapid pace. The result of more rapid VCR improvements in a subset of APEC economies is positive for all economy groups, but particularly for APEC. A faster pace of reform, even if limited to just some economies, is associated with the greatest trade gains. Finally, Scenario 4 shows that a negative external shock primarily affects the region that is the epicenter of the shock, in this case the EU. Impacts for other groups are lower, although still significant. Again, the trade impacts are larger than the GDP impacts, which was in fact the case in the Great Trade Collapse following the Global Financial Crisis. A defining characteristic of value chain trade is that goods move across borders multiple times during their production process, with the effect that the impact of shocks on trade can sometimes be relatively large. Nonetheless, the diversity of APEC’s trade relationships, and the strength of intra-regional trade, mean that the effects of a relatively small shock in a region like the EU are significantly damped: APEC VCs appear to be quite resilient to such events, as was demonstrated in the case studies on VC Strength in the second phase report for this project.

⁷ For scenario 1, the corresponding dollar figures that reflect different baselines are: \$374bn (APEC), \$25bn (ASEAN), \$47bn (EU), and \$390bn (G-20).

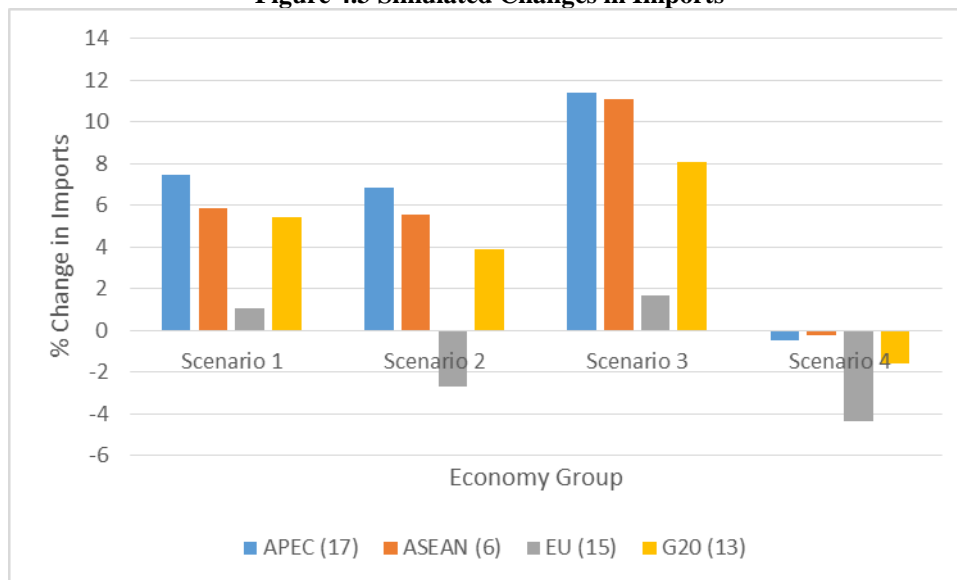
⁸ One of the reasons that the increase in exports is larger in dollar terms than the increase in GDP discussed in the previous section is that imports also increase. GDP includes the sum of net exports, i.e. exports less imports.

Figure 4.2 Simulated Changes in Exports



Source: Authors.

Figure 4.3 Simulated Changes in Imports



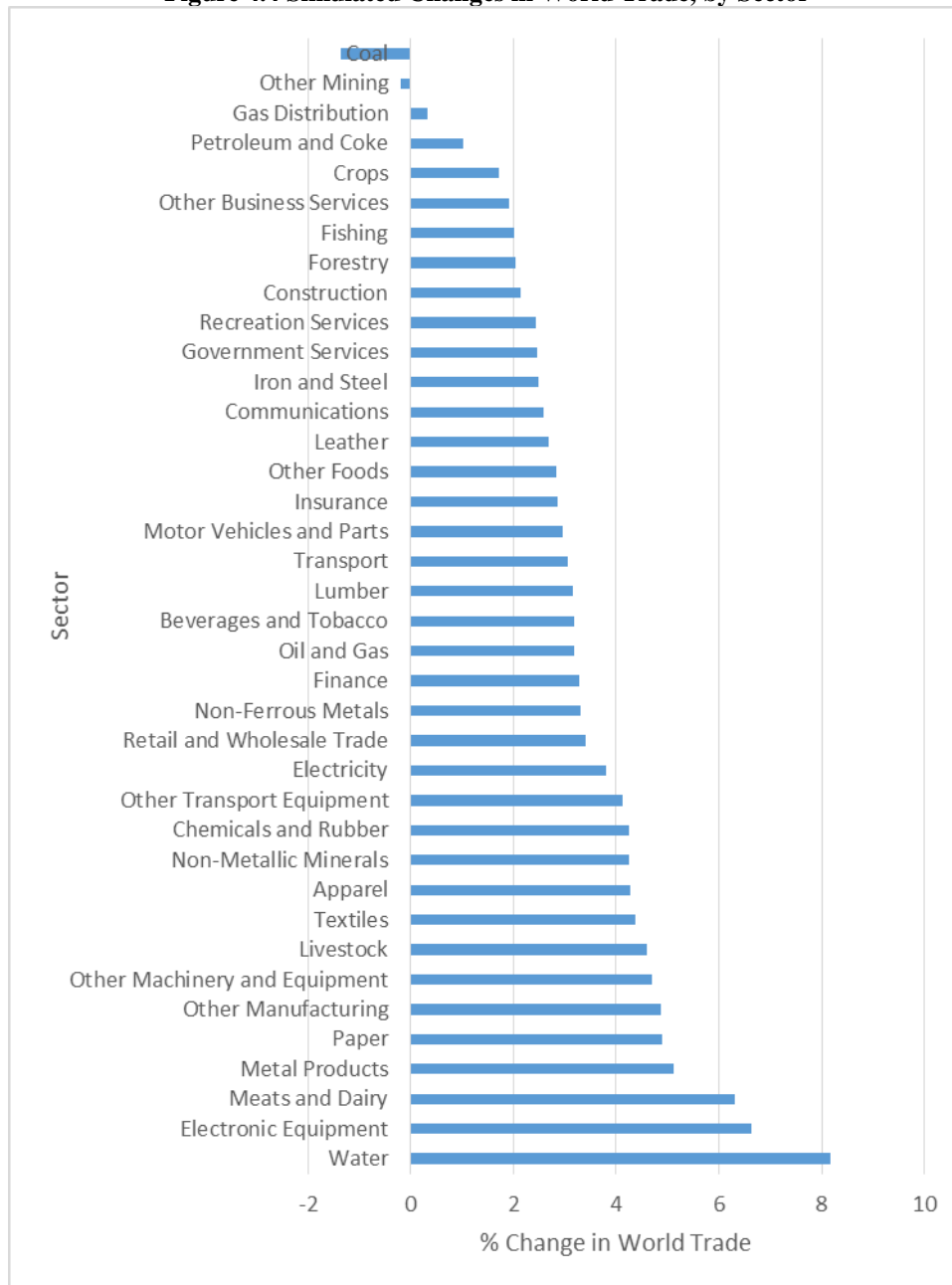
Source: Authors.

Figures 4.2 and 4.3 focus on aggregate impacts, i.e. summing across all product sectors. However, some sectors are more sensitive to trade costs—and thus to VCR improvements—than are others. This fact reflects in part the greater prevalence of VCs in some sectors. To provide some basic information on these dynamics, Figure 4.4 provides a breakdown of world trade by sector for Scenario 1. The other scenarios are omitted for brevity, because the general pattern reflects the sectoral breakdown in Figure 4.4 combined with the cross-scenario comparison of Figures 4.2 and 4.3.

Figure 4.4 shows that manufacturing is heavily represented among the ten sectors with the largest simulated trade effects following a uniform improvement in VCR in APEC member economies. Trade in electronic goods is particularly strongly affected. This finding is in line with the fact that VCs are highly prevalent in this sector, and changes in VCR can therefore have a large effect on trade. The phase 2 report for this project examined a case study of

disruption to Asia-Pacific VCs in electronic goods, and the phase 3 report focused on the sector as one of the examples of the results of mapping VC trade and measuring Connectedness in the region. The evidence in Figure 4.4 suggests that electronic goods, along with other manufacturing sectors such as machinery and equipment, as well as textiles and apparel, could benefit particularly from improvements in VCR.

The sectoral distribution of trade gains is also significant from a development perspective. Many developing APEC economies are already involved in electronic goods VCs. But for others yet to develop that capacity, other sectors, such as apparel, are attractive entry points into VC trade. The evidence in Figure 4.4 suggests that improving VCR could be one way of attracting VC activity in such sectors, and laying the groundwork for a later expansion into more sophisticated, higher value added sectors and activities. The same is true of certain agricultural products, particularly perishable goods. Such products need to be transported quickly and reliably to prevent spoilage. Improving VCR is one way of improving the business environment affecting producers of these products, and making it easier for them to do business across borders. Traditional agricultural exporters as well as new ones—covering both developing and developed APEC economies—potentially stand to benefit from VCR improvements in this sector too.

Figure 4.4 Simulated Changes in World Trade, by Sector

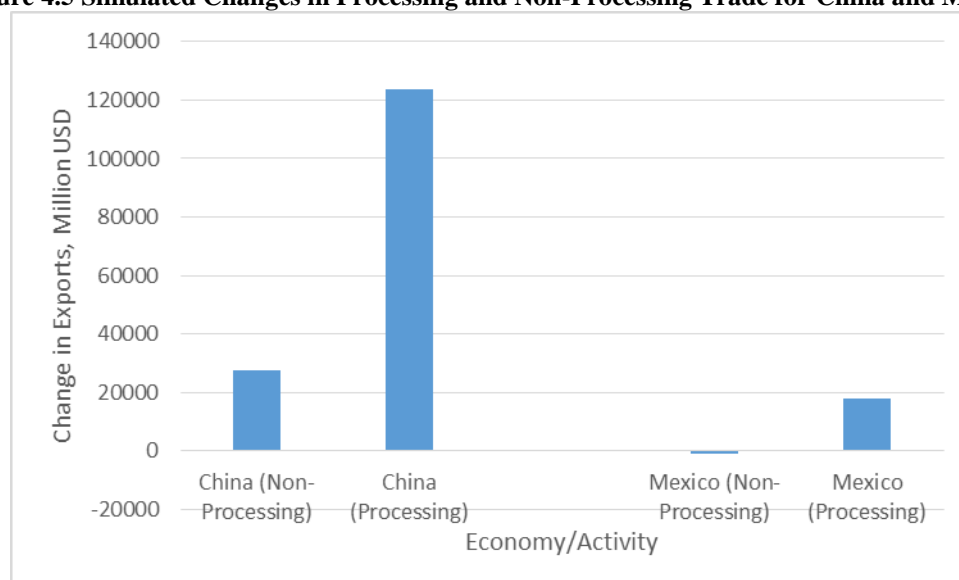
Source: Authors.

In interpreting Figure 4.4., it is important to pay attention to the fact that it records percentage changes, not dollar amounts. For example, the water services sector has the largest percentage change of any sector, but it is starting from a relatively small baseline. The change in dollar terms is \$185m. By comparison, electronic equipment, which has the second largest percentage change, experiences a dollar trade surge of \$76bn—a figure that is over 400 times larger, due to the fact that electronic goods are already very intensively traded, whereas water services are infrequently traded in a pure cross-border sense. Indeed, the largest dollar trade gain is experienced by the other machinery and equipment sector (\$77bn), followed by electronic equipment. Interestingly, the third largest trade gain in dollar terms is experienced by the crops sector (\$51bn), which reflects the size of global agricultural markets, but also in part the very aggregated nature of this sector—it covers a broader range of activities than does the definition of electronic goods, for example.

As noted in the previous Chapter, one of the unique features of this global CGE model is that it incorporates processing trade for China and Mexico. To examine the important differences that may be at work in terms of processing and non-processing trade, it is useful to break out Scenario 1 simulation results for those two economies based on the type of activity (Figure 4.5).

It is immediately apparent from the figure that the benefits of VCR improvements accrue primarily to processing trade in both China and Mexico.⁹ Both types of activities benefit from lower trade costs linked to VCR improvements in China, but in Mexico there is a slight decrease in non-processing trade, perhaps due to reallocation of resources towards processing trade. Nonetheless, the core message is clear: processing trade is a vital activity in the context of global and regional VCs, and improvements in VCR within APEC can result in significant boosts to that type of activity. From a development perspective, processing trade is important: although it can be focused on relatively low value added activities, it is an important source of employment and income, particularly for unskilled workers. It can be an important early step for an economy in joining VCs, and can provide a basis from which moving up to higher value added activities can take place.

Figure 4.5 Simulated Changes in Processing and Non-Processing Trade for China and Mexico



Source: Authors.

Investment Effects of VCR Improvements

The CGE model used here does not incorporate data on bilateral foreign direct investment (FDI) flows, because of the difficulty of assembling accurate data for a range of economies. Global savings and investment are required to be equal, with the total amount split among regions according to their propensity to save and the return on investment. It is therefore not possible to draw any strong conclusions on the FDI effects of VCR improvements, because the origin of investment is not explicitly modeled, i.e. it could be domestic or foreign. Nonetheless, it is useful to examine the impact of VCR improvements on investment

⁹ This result accords well with the fact that China was found to be a major global hub of value added trade in Phase 3 of this project, which dealt with VC Connectedness.

regardless of source (Figure 4.6), as well as the rate of return on investment (Figure 4.7), in order to draw out some suggestive ideas regarding FDI.

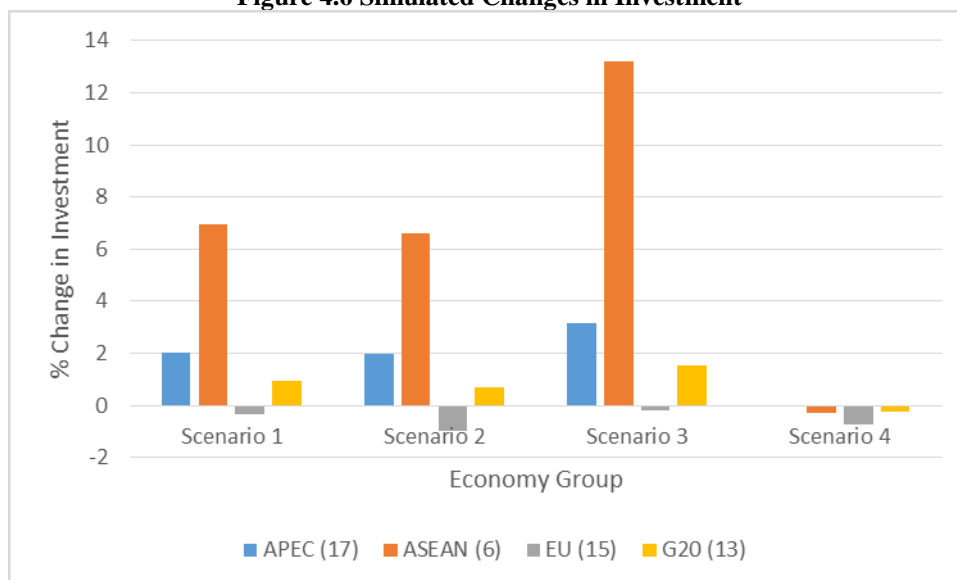
Investment increases significantly for APEC in Scenarios 1, 2, and 3. Changes in Scenarios 1 and 2 are approximately the same, at around 2.0% or \$140 billion annually. Interestingly, the percentage change is considerably higher in ASEAN, although different baselines mean that the dollar figure for APEC is nearly seven times higher than for ASEAN. As in the case of the GDP results, it is again important to stress that the ASEAN group is made up exclusively of APEC developing economies, due to the fact that reliable data are not available for the remaining ASEAN economies. If those economies that joined ASEAN relatively recently were to be included, results would likely be quite different: they are less involved in VC trade, and therefore the effects of improvements would be correspondingly less.

In the first three scenarios, the percentage investment effects seen in APEC are larger than for the G-20 and EU economies represented in the dataset.¹⁰ As in the discussion of other results, the reason is that the trade effects of VCR improvements are larger for APEC economies because they are the ones leading the reform effort. The main gains from reform again accrue to those economies that lead the way. A comparison of Scenarios 1 and 3 makes this point clear, but also highlights the fact that non-discriminatory improvements in VCR have spillover effects to economies that do not reform, or that reform more slowly.

Interestingly, the investment effect of a small external shock (Scenario 4) is very small for APEC, much smaller than for the comparator groups: it is a decrease of only 0.05%. A variety of reasons could be behind this result. One is the point touched upon earlier, namely that networks of trade and investment are well-developed within the region, and well-diversified in terms of other partners. These characteristics of APEC VCs mean that the slack from a deterioration in one region can be taken up by growth in other regions. In addition, many APEC economies—particularly some developing economies—have relatively high propensities to save, which means that the stock of potential resources available for investment is high, even before international linkages are taken into account.

¹⁰ Again, dollar baselines are important in interpreting these results. For scenario 1, the absolute change in investment for each economy group is: \$144bn (APEC), \$21bn (ASEAN), -\$11bn (EU), and \$104bn (G20).

Figure 4.6 Simulated Changes in Investment

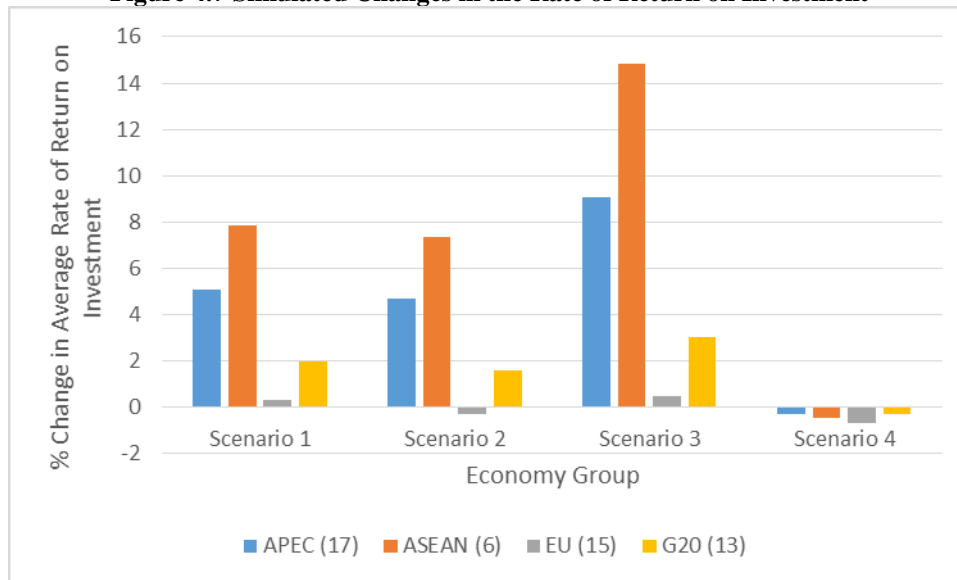


Source: Authors.

In addition to the quantity of investment, changes in the rate of return are also important (Figure 4.7). As noted above, bilateral FDI is not directly included in the model. However, differences in the rate of return across economies tend to lead to capital flows, including FDI. Significant increases in the rate of return could be one factor tending to promote inward FDI flows.

As the figure shows, Scenarios 1, 2, and 3 result in significant increases in the average rate of return in APEC. Although the percentage change in ASEAN is higher, it is again important to remember that the only ASEAN economies included in this analysis are also APEC developing economies. The figure can therefore be interpreted as suggesting that APEC as a region sees a higher rate of return, but that the effect is felt particularly strongly in developing member economies, such as those that are also members of ASEAN. Although the model does not include FDI, one possible implication of this finding that could be explored in future work is that improvements in VCR could lead to substantial increases in FDI as one type of capital flow. However, it is not possible to draw any strong conclusions on that point given the model used in this report.

As for the other variables considered in this section, the negative external shock in Scenario 4 only results in relatively weak effects in APEC. This finding is in line with similar ones for GDP and trade, and reflects the diversification of APEC economies, as well as, in this case, the availability of regional savings to fund investment.

Figure 4.7 Simulated Changes in the Rate of Return on Investment

Source: Authors.

Labor Market Effects of VCR Improvements

From a policy perspective, the labor market effects of VCs—and improvements in VCR—are crucial. Policymakers are rightly concerned about the social consequences of this business model, in addition to its strictly economic effects. Although the CGE model assumes that employment is fixed and labor markets clear, wages are allowed to vary. Two categories of employees are considered: skilled, and unskilled. In economies with tight labor markets, the model's outputs could indicate the direction in which wages would be likely to adjust to changes in VCR. In economies where there is considerable slack in the labor market, on the other hand, a more practical interpretation is in terms of changed demand for each type of labor. In practice, if not in the model, incipient wage rises would tend to translate into higher levels of employment in economies with excess labor. In any case, examining the impact of VCR improvements on wage rates potentially provides a useful window into the social consequences of such policies.

Figure 4.8 summarizes the model's results for unskilled labor, and Figure 4.9 does the same for skilled labor. The relative pattern of results by scenario is similar in both cases, so they can be discussed together. Scenarios 1-3 have strongly positive impacts on wages in APEC, as in all other groups except the EU. The difference between Scenario 1 and Scenario 2 is very small in this case, which indicates that the labor market effects of VCR improvement do not depend to a large extent on whether or not those improvements are discriminatory. Nonetheless, other results presented in the previous section clearly indicate that a non-discriminatory approach—which in any case accords better with the likely course of reform in practice—is preferable.

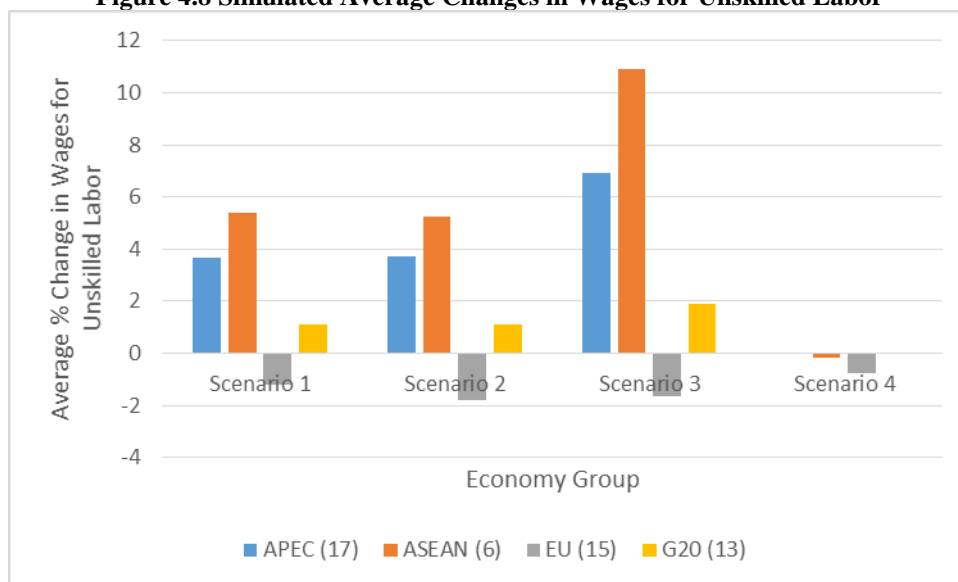
The contrast between the results for APEC as a whole and the subset of ASEAN economies for which data are available (i.e., selected APEC developing economies) reveals that developing economies stand to reap very significant labor market benefits from improved VCR. The benefits are particularly strong in Scenario 3, in which those economies lead the way in terms of an increased rate of reform relative to developed economies. However, this

pathfinder scenario is a win-win in terms of labor market outcomes: the biggest gains accrue to those economies that reform the most, but there are also considerable spillover effects to others.

From a social equity perspective, it is important to analyze changes in the rate of return for skilled versus unskilled labor. A greater increase for the former relative to the latter could be associated with some level of increased wage inequality. That is indeed what is observed when Figures 4.7 and 4.8 are compared, although the differences for APEC are quite small: for Scenario 1, the increase in skilled wages is 3.9%, compared with 3.7% for unskilled wages. The implication is that although VCR improvements could put some pressure on wage inequality, the effect is likely to be small overall. Indeed, it is slightly smaller for ASEAN than for APEC, which tends to indicate that inequality pressures may be felt less strongly in developing economies than in developed ones. Such a finding is consistent with the fact that developing economy participation in VCs tends to be relatively intensive in the use of unskilled labor, particularly at the early stages when activities are focused on low value added areas such as assembly.

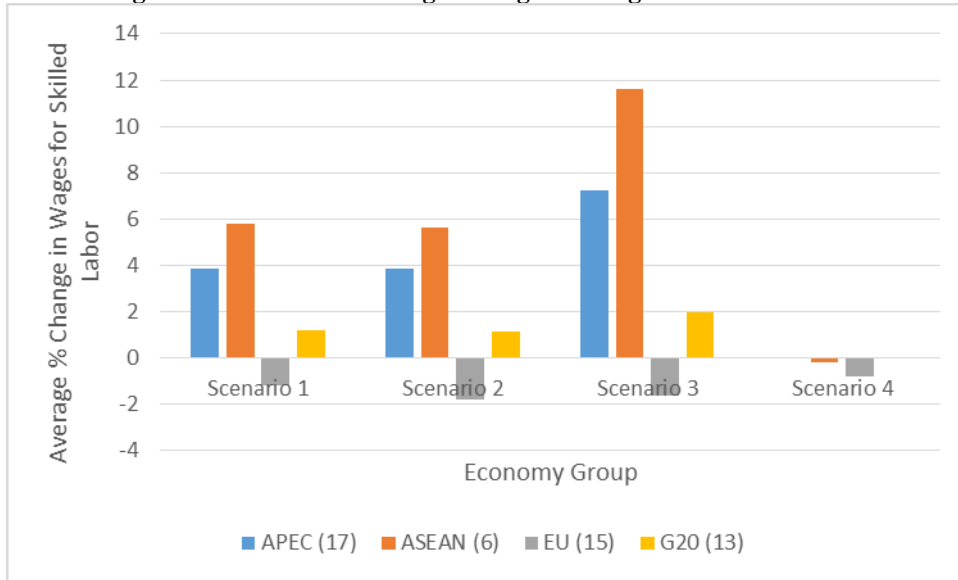
From a development perspective, it is important to highlight that the counterfactual wage increases reported here flow from the fact that labor is held constant, and the market clears, i.e. there is no unemployment. In reality, many developing economies are in a situation of excess labor. The wage rises observed in these results should therefore be treated as indicative of an incipient effect that would more likely be reflected in lower unemployment, and perhaps also greater labor force participation. Both effects are very important in terms of the twin goals of economic and social development, and suggest that VC activity—promoted by improvements in VCR—can be particularly beneficial for developing economies.

Figure 4.8 Simulated Average Changes in Wages for Unskilled Labor



Source: Authors.

Figure 4.9 Simulated Average Changes in Wages for Skilled Labor



Source: Authors.

5. CONCLUSION AND POLICY IMPLICATIONS

Phases 1 and 2 of this project concluded that although APEC economies face on average a moderate level of VC Risk, they have well developed capacities to respond to it through robust VC Strength mechanisms. Both characteristics of VC trade in the region are reflected in APEC's VC Connectedness, which was analyzed in this project's third phase.

Phases 1-3 were primarily descriptive and diagnostic. This final phase has examined in more detail the economic stakes of VCR, focusing on the three indices developed earlier. It has combined an econometric model with a global CGE model to provide estimates of the economic impact of three reform scenarios, and one negative external shock scenario. All results are counterfactual simulations, not forecasts, and assume that all other exogenous factors remain constant. In other words, they examine the direction of change in key economic variables under a selection of hypothetical scenarios based on assumed changes in VCR variables from the current baseline. A comparison of results across scenarios reveals a number of features that are important from a policy point of view.

First, improving VCR in the region could have major economic gains. The simulations conducted here suggest that a 5% improvement in VCR—which is feasible and in line with previous approaches to reform in APEC, such as the Trade Facilitation Action Plans—could be associated with a comparative static increase in GDP of \$300 billion. Trade (summing exports and imports) would increase by \$827 billion. In addition, there is suggestive evidence that investment, possibly including FDI, would also increase substantially. This kind of expansion in VC trade would put upwards pressure on wages, and probably employment in labor surplus economies. From a development point of view, it is important to note that the effects on skilled and unskilled labor appear to be quite similar, which suggests that growth would be socially inclusive.

Second, the economic gains from VCR improvements are larger when the improvements are non-discriminatory, i.e. implemented on a most favored nation basis. The nature of most VCR improvements is indeed that they are non-discriminatory, but the role of measures such as a regional trade arrangements in promoting Connectedness needs to be kept in perspective. APEC's open regionalism and emphasis on concerted unilateral action is the right one to move forward most effectively on VCR.

Third, the economic gains are larger with more ambitious reforms, even when a self-selected group of economies play a pathfinder role. As in most trade policy, the economic gains from improving VCR accrue primarily to those economies that reform, with spillover effects to their trading partners and other economies. Individual economies interested in joining or moving up VCs therefore have a real interest in moving forward jointly or unilaterally on VCR. The wide variety of policy measures included in the VC Risk and Strength indices is suggestive of a broad set of levers that could be used by policymakers to improve VCR.

Fourth, APEC economies are on the whole quite resilient to negative events elsewhere in the world economy. When such events are localized—as in the simulation example used here—the effects on the region overall are relatively small. This finding is a reflection both of the inherent resilience of APEC VCs, and the diversity of APEC's trading partners and the importance of intra-regional trade in the overall picture. Of course, APEC economies—like

all other open economies—remain sensitive to major, worldwide shocks like the Global Financial Crisis. But as the case study on this shock in the phase 2 report showed, APEC VCs tended to remain intact even as their activity level temporarily fell, and then they rebounded quickly. The overall message is that VCs are relatively resilient in the APEC region, which provides a good basis for moving forward should policymakers decide that improving VCR is a priority.

Together, the four phases of this project have provided encouraging information for APEC policymakers on the resilience of regional VCs. As complex networks, VCs can be highly efficient, but are also subject to significant systemic risks. Policies and private sector risk management practices are necessary to ensure that VCs work effectively for economic growth and development. Understanding and, if appropriate, improving VCR holds the potential to increase the economic activity associated with VCs, and bring significant gains to consumers, businesses, and workers. If APEC member economies decide to move forward in this area, they will need to develop effective policy targets and measurement methodologies, potentially extending the work done in this project using readily available proxies.

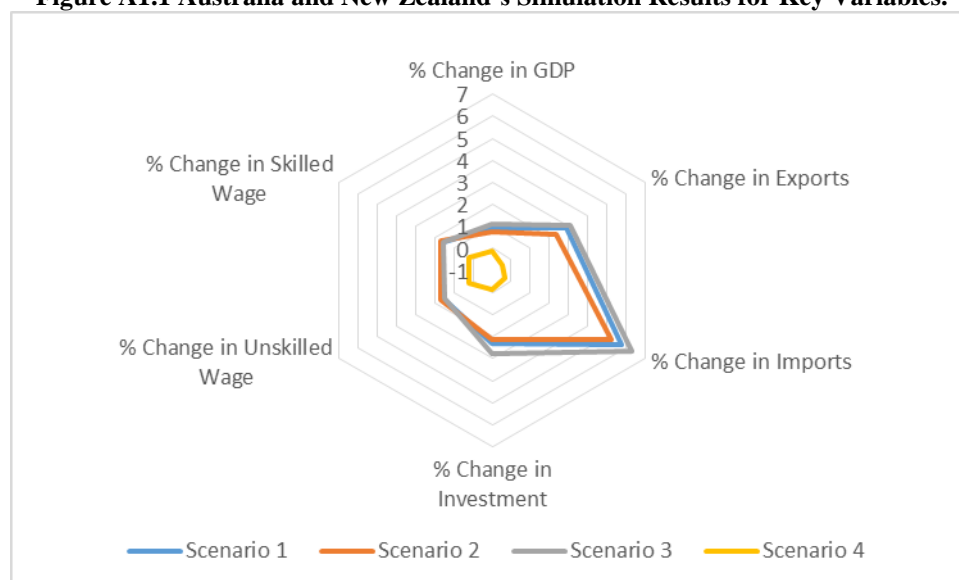
APPENDIX 1: DETAILED SIMULATION RESULTS

The analysis presented here is for general information purposes only. To make a detailed assessment of economy-level impacts, it is important to look at detailed scenario results in percentage and dollar terms. Results are available from the authors on request.

AUSTRALIA AND NEW ZEALAND

The CGE model used in this report groups Australia and New Zealand together as a single region because of the extremely close economic ties between them. Figure A1.1 shows simulation results for key variables. Changes in the two trade variables are considerably larger than the change in GDP, which is to be expected. Nonetheless, the increase in GDP is significant in the first three scenarios: 0.8%-1.1%. In the fourth scenario, the effect of the negative external shock is significantly damped due to the joint region's relative remoteness with respect to the EU, and the important role that other Asia-Pacific economies play in its trade relations.

Figure A1.1 Australia and New Zealand's Simulation Results for Key Variables.



Source: Authors.

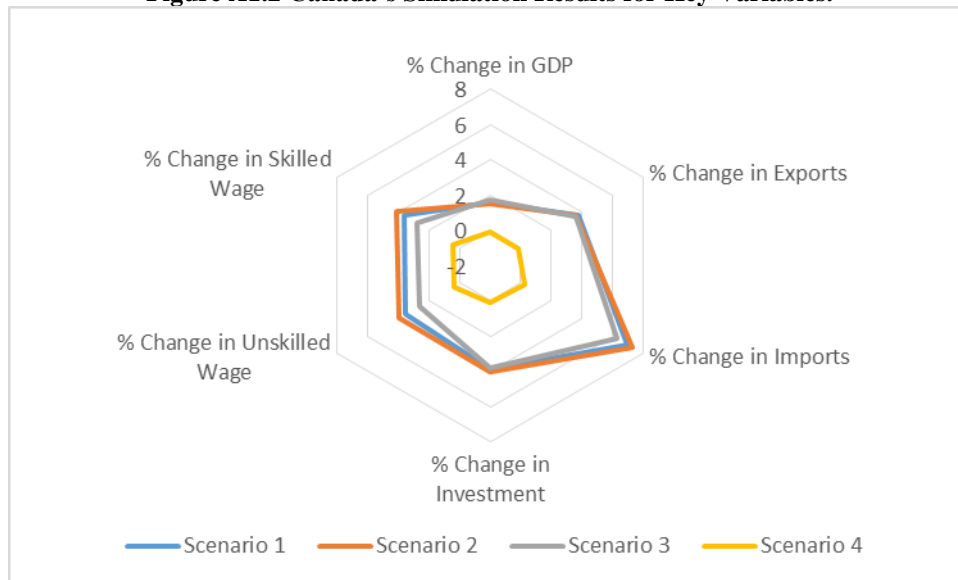
BRUNEI DARUSSALAM

Not included in the model due to data unavailability.

CANADA

Canada's GDP gains in the first three scenarios are strong, ranging from 1.5 to 1.7%. Interestingly, the negative external shock of scenario 4 is not associated with a significant GDP decline, less than 0.1%. This result suggests that Canada's close relationship with its Asia-Pacific trading partners, including the US, helps insulate it from negative shocks occurring elsewhere in the global economy. Again, trade effects are considerably larger than GDP effects. It is notable that upward pressure on both skilled and unskilled wages is stronger in the first two scenarios than in the third.

Figure A1.2 Canada’s Simulation Results for Key Variables.



Source: Authors.

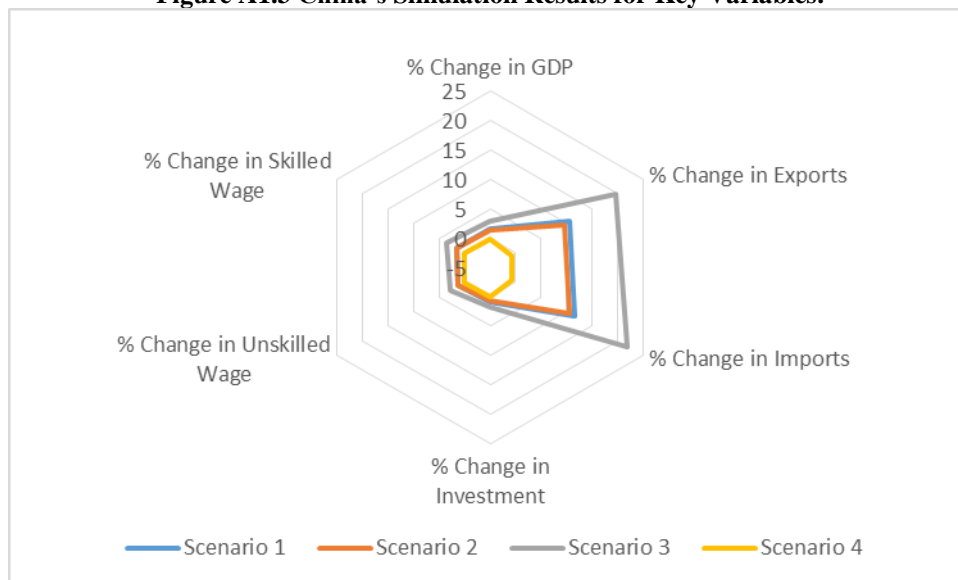
CHILE

Not included in the model due to data unavailability.

CHINA

Due to the importance of trade—particularly processing trade—in its economy, and value chains more specifically, China experiences relatively large economic gains in the first three scenarios: GDP effects range from 1.4% to 2.9%. Trade effects, as for other economies, are much larger, but are primarily linked to processing trade, as discussed in the main text. Skilled and unskilled wages experience relatively similar upward pressures, which suggests that growth in value chain trade due to VCR improvements can be consistent with social inclusion concerns in the developing economy context.

Figure A1.3 China’s Simulation Results for Key Variables.

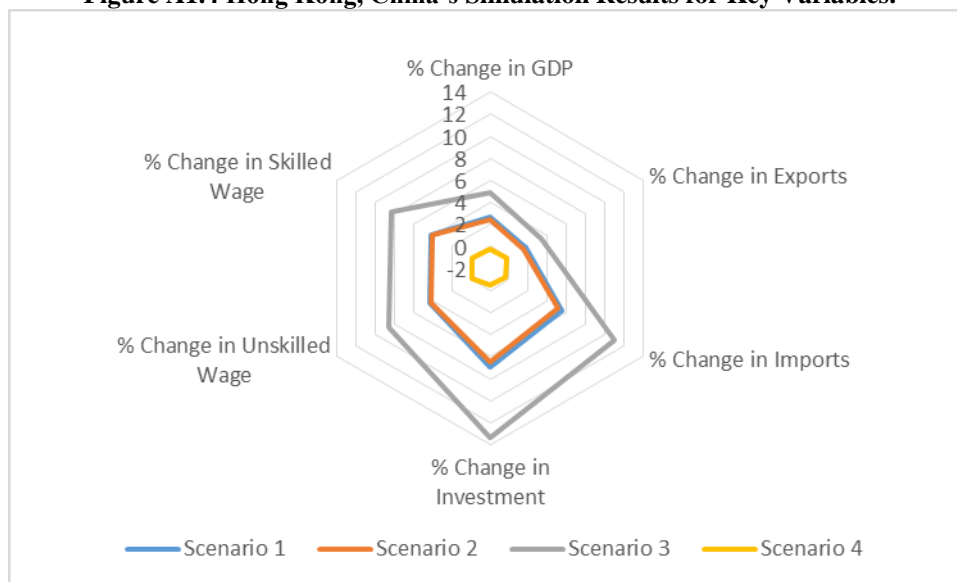


Source: Authors.

HONG KONG, CHINA

As an economy that is particularly reliant on trade, Hong Kong, China's simulation results are expectedly strong. Trade and GDP gains are both large in the first three scenarios. GDP, for example, increases by between 2.4% and 4.9%. Perhaps the most notable feature of this economy's results is the difference between scenario 3—in which developing economies reform at a faster rate—and the first two scenarios. These results clearly demonstrate the additional gains that can accrue to a small, open economy when it reforms trade-related measures at a rapid rate.

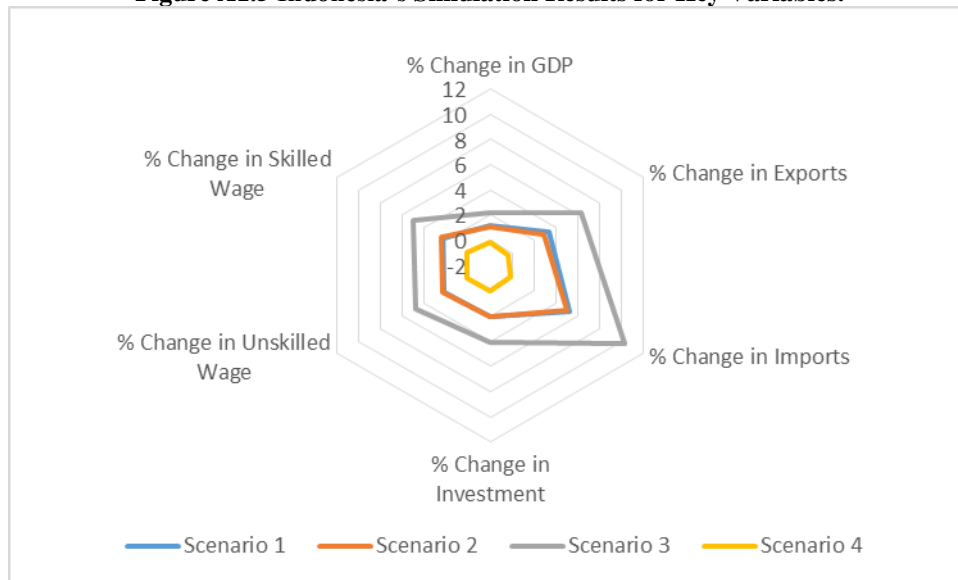
Figure A1.4 Hong Kong, China's Simulation Results for Key Variables.



Source: Authors.

INDONESIA

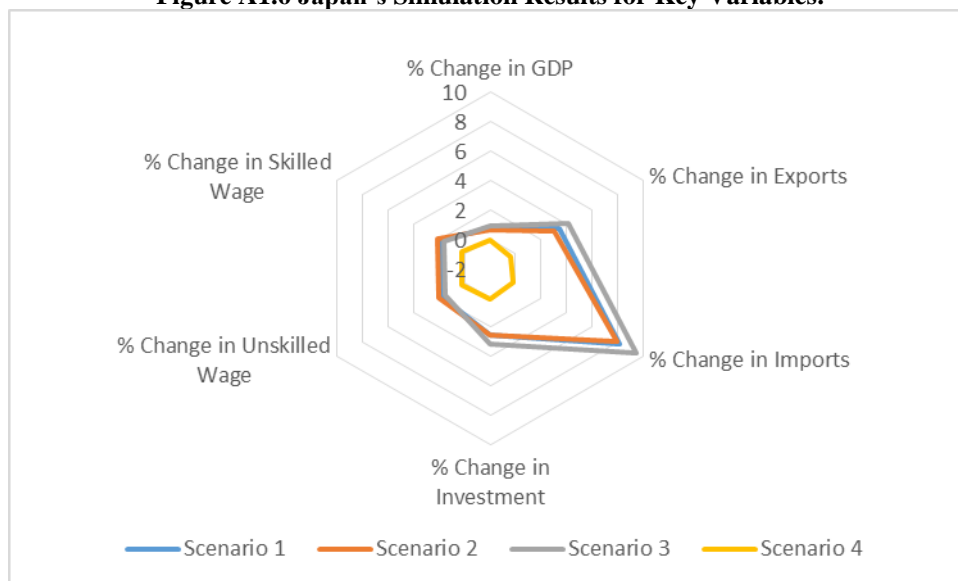
Indonesia experiences significant GDP gains under the first three scenarios, of between 1.1% and 2.2%. As is the case for other economies, trade gains are considerably larger than GDP gains. From a development and social inclusion perspective, the close correspondence between the wage pressures for skilled and unskilled workers is important. It is only in scenario 4 that there is a significant difference: unskilled wages remain essentially stagnant, while skilled wages grow by a little over 0.1%. Although the absolute numbers are small in this last case, the result emphasizes the negative development and social inclusion implications that negative external shocks can have on Asia-Pacific economies.

Figure A1.5 Indonesia's Simulation Results for Key Variables.

Source: Authors.

JAPAN

Japan's GDP changes are relatively small in all four scenarios. As for other economies, trade effects are considerably larger. In the first three scenarios, there are small differences in skilled and unskilled wage pressures, which could be associated with increasing wage inequality. The fourth scenario is the only one in which wages for the two skill categories change by approximately the same proportion. Of course, Japan's trade activities—particularly in value chains—are relatively skill intensive, so this result is perhaps to be expected.

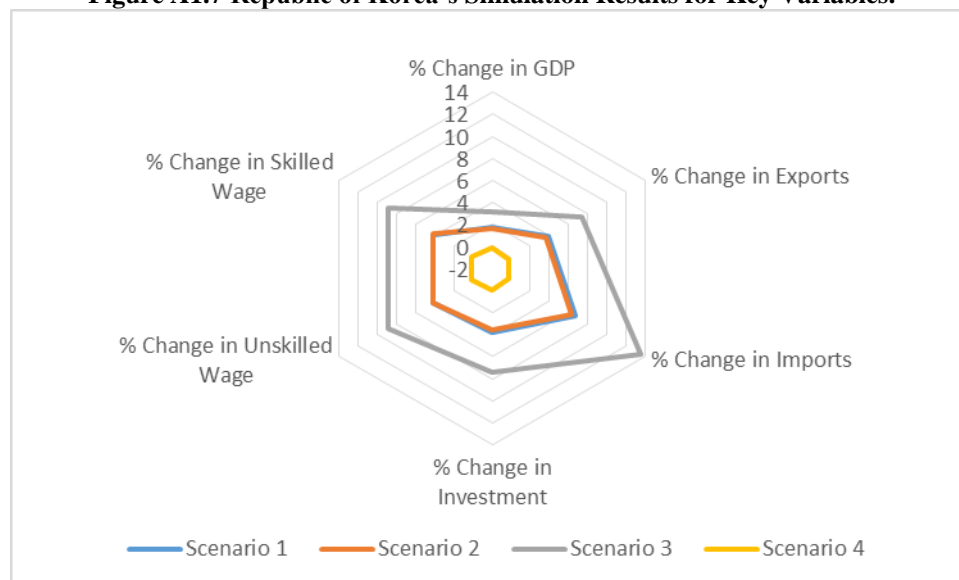
Figure A1.6 Japan's Simulation Results for Key Variables.

Source: Authors.

REPUBLIC OF KOREA

GDP changes are very similar for Republic of Korea under the first two scenarios—1.7% and 1.6% respectively—but considerably larger for scenario 3 (3.1%). This finding again reinforces the view that economic gains from trade reforms—including improvements in VCR—accrue most strongly to the economies that reform most. Another notable finding for Republic of Korea is the strength of the investment effect, especially for scenario 3 where it increases by 7.5%. Although FDI is not modeled in this case, this finding tends to suggest that significant improvements in VCR can promote investment flows as well as trade.

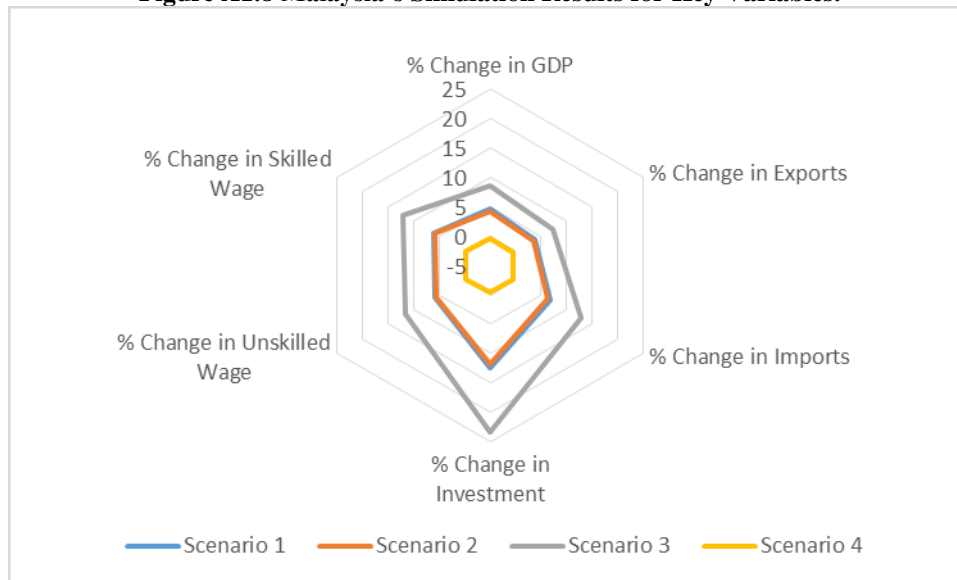
Figure A1.7 Republic of Korea’s Simulation Results for Key Variables.



Source: Authors.

MALAYSIA

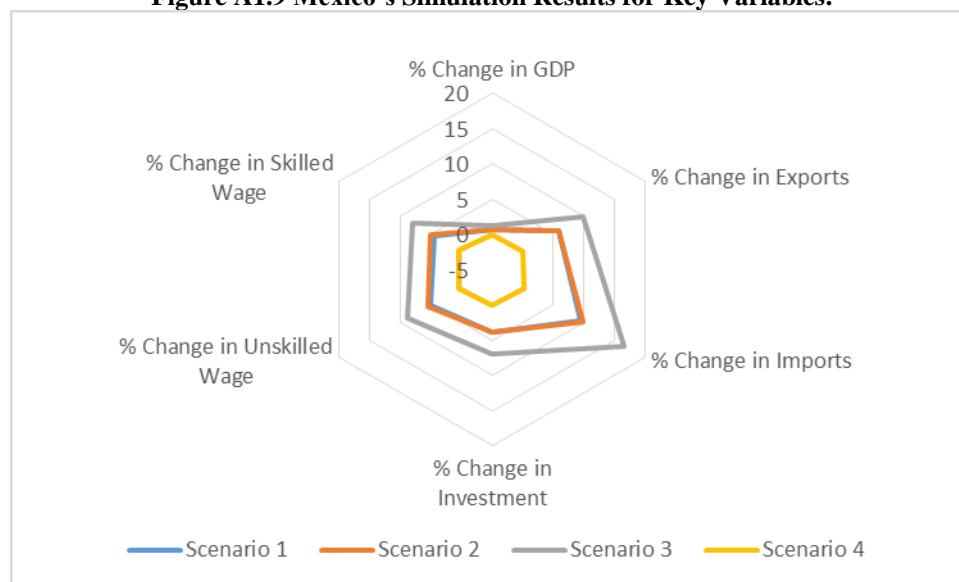
As a highly trade-dependent economy, Malaysia experiences large effects in each of the first three simulations. GDP changes range from 4.2% to 8.6%. It also sees very large changes in investment, particularly in scenario 3 where the increase is 23.4%. These results show that VCR improvements can have major impacts in a developing economy with a large traded goods sector. However, there are small differences in the upward pressures on skilled and unskilled wages in the first three simulations: skilled wages rise slightly faster, which could be suggestive of pressures towards an increase in wage inequality. The effect is reversed in scenario 4, however, where the evidence suggests that the wage distribution would tend to compress rather than expand.

Figure A1.8 Malaysia's Simulation Results for Key Variables.

Source: Authors.

MEXICO

Like China, Mexico's traded goods sector is split into processing and non-processing trade. The simulation results are driven most significantly by processing trade, as indicated by the substantial percentage changes in exports and imports. Processing trade is an important part of value chain activity, so findings for Mexico are strongly suggestive of the fact that VCR improvements can boost value chain trade specifically, as opposed to traditional forms of point-to-point interaction. Perhaps due to the relative intensity of processing trade in unskilled labor, Mexico experiences stronger upward pressure on unskilled relative to skilled wages in all four scenarios. The differences are significant in all cases except scenario 4, where the two figures are very close. This finding suggests that VCR improvements can potentially be a significant source of increased low-skilled jobs, which is important in a labor surplus developing economy, or alternatively a force acting in favor of compression in the wage distribution, i.e. greater wage equality. Again, this result highlights the positive potential of VCR improvements for social inclusion as well as economic development.

Figure A1.9 Mexico's Simulation Results for Key Variables.

Source: Authors.

PAPUA NEW GUINEA

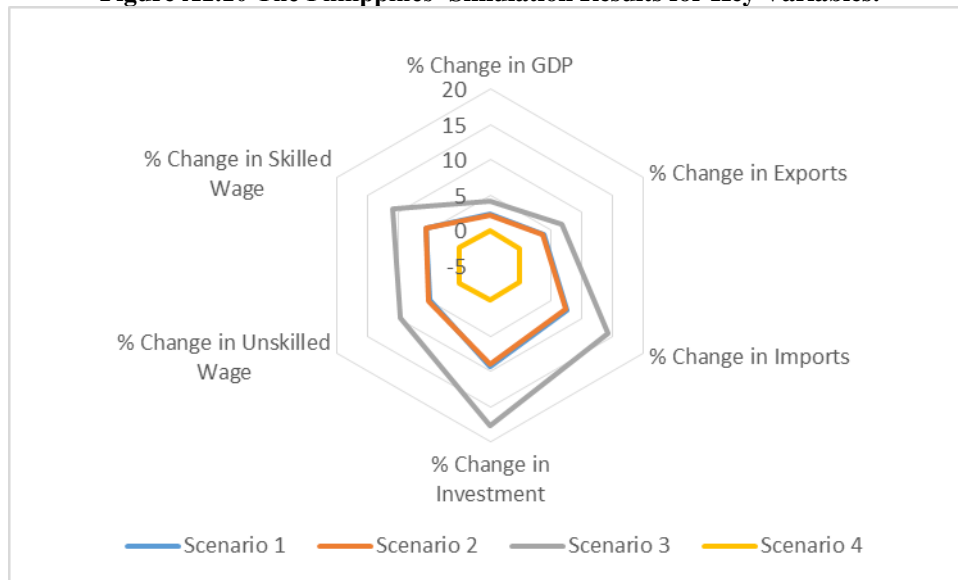
Not included in the model due to data unavailability.

PERU

Not included in the model due to data unavailability.

THE PHILIPPINES

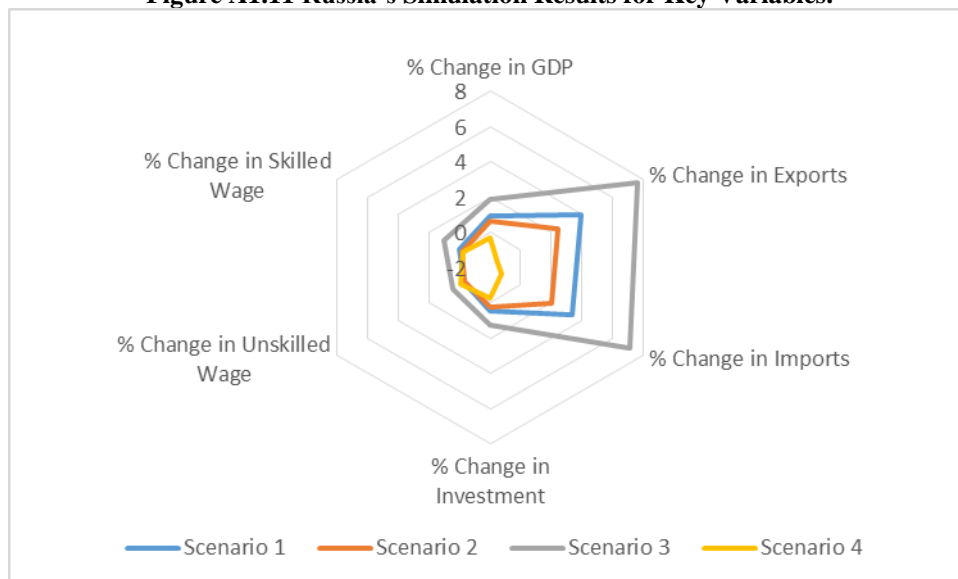
In line with results for other developing economies, the Philippines experiences significant changes in all key variables under the first three scenarios. The changes are largest for scenario 3, due to the fact that developing economies are assumed to improve VCR at a faster rate than other economies. Of particular significance is this economy's percentage change in investment, particularly under scenario 3. In practice, such a large change is unlikely to be financed uniquely from domestic savings, and so would be associated with significant FDI inflows; however, they are not modeled directly, and so no strong conclusion can be drawn. Nonetheless, the Philippines' results are suggestive of the capacity of VCR improvements to promote investment in value chains in addition to trade flows.

Figure A1.10 The Philippines' Simulation Results for Key Variables.

Source: Authors.

RUSSIA

Russia's simulation results contain relatively small changes in some key variables, such as GDP. Exports and imports increase more significantly, but still to a lesser extent than is the case for some other APEC economies. Interestingly, in Russia's case the difference between scenarios 1 and 2—non-discriminatory versus discriminatory changes—is significant: the trade gains from non-discriminatory reform are noticeably larger, which bolsters the case for VCR improvements that are open, rather than preferential, in nature.

Figure A1.11 Russia's Simulation Results for Key Variables.

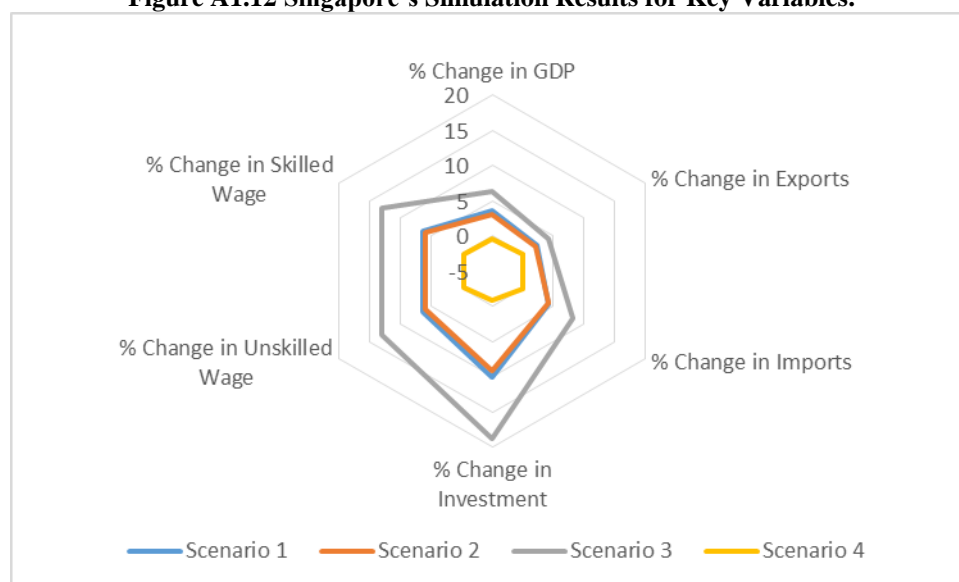
Source: Authors.

SINGAPORE

Like Hong Kong, China, Singapore is a small, open economy with a very important traded goods sector. As a result, the economic changes it experiences following improvements in

VCR are correspondingly large. The important role of trade in GDP means that increases in that variable are relatively large in the first three scenarios: from 3.0% to 6.4%. It also sees very large changes in investment, ranging from 9.2% to 18.9%, which is a very large change. Even though trade is a very important activity for Singapore, and it is well linked to many other economies around the world, the GDP impact of a negative external shock centered on the EU is still relatively limited, at -0.5%. This finding likely indicates that the diversity of Singapore's trade connections, as well as its relative proximity to other regions of the world, as a central point in the Asia-Pacific, stand it in good stead to withstand localized crises abroad.

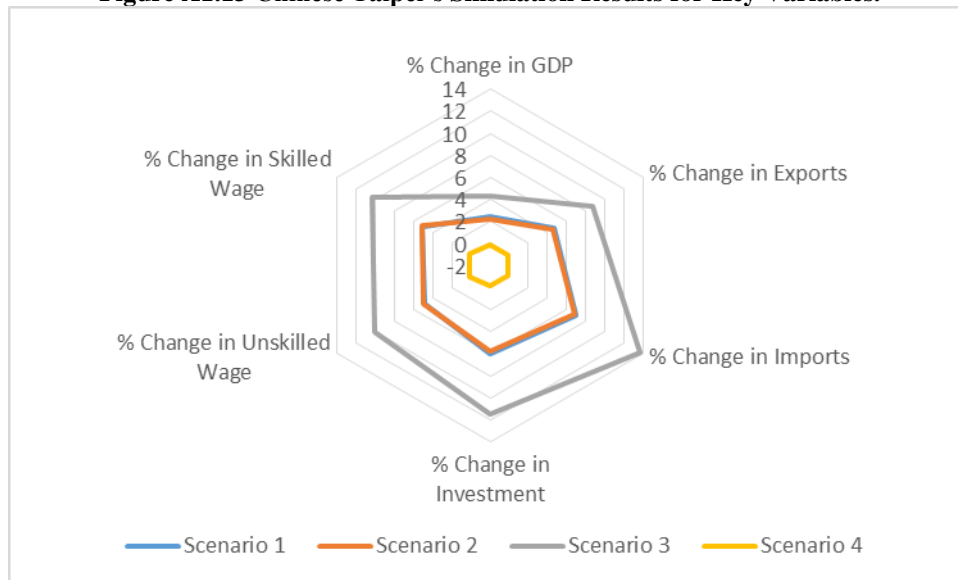
Figure A1.12 Singapore's Simulation Results for Key Variables.



Source: Authors.

CHINESE TAIPEI

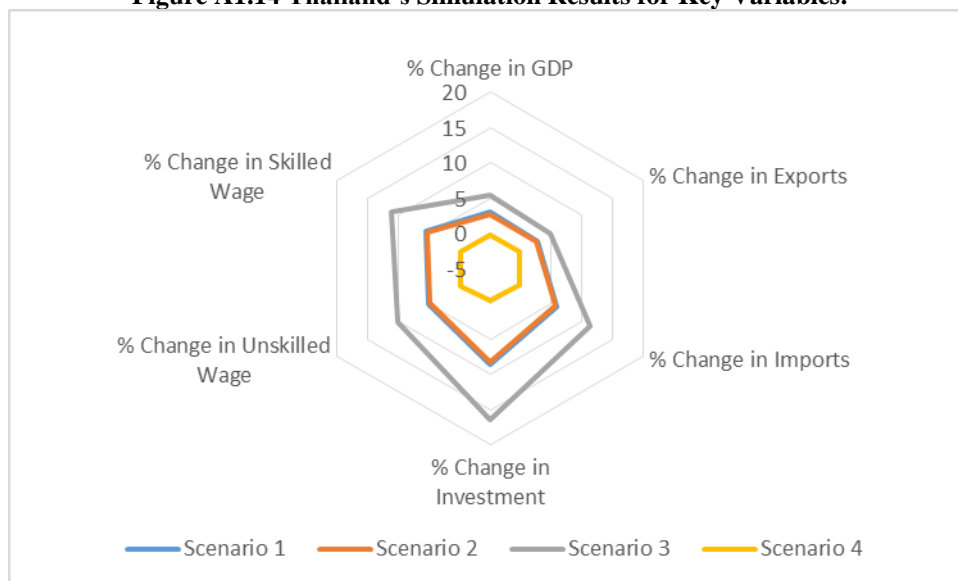
Simulation results for Chinese Taipei are nearly identical under the first two scenarios. The third scenario, however, results in much larger gains in all key variables. Again, this finding is in line with the view that trade reforms generally benefit reforming economies the most, so those economies that reform more experience larger gains. The significant changes in the trade variables reflect the importance of trade in Chinese Taipei's economy. Interestingly, the effects of a negative external shock in a relatively distant region are quite small for all key variables, on the order of 0.1%-0.2%. This economy is therefore well placed to demonstrate resilience in the face of a localized shock emanating from another region of the global economy.

Figure A1.13 Chinese Taipei's Simulation Results for Key Variables.

Source: Authors.

THAILAND

Thailand experiences significant changes in trade and GDP under the first three scenarios. Results for the first two scenarios are very close for this economy, which might be consistent with a relatively high level of reliance on trading partners in the Asia-Pacific region. This interpretation is consistent with the fact that Thailand's GDP falls only very slightly under scenario 4. As is the case for other developing economies, changes in all key variables are noticeably larger in the case of scenario 3, in which those economies are assumed to improve VCR at a more rapid rate than others.

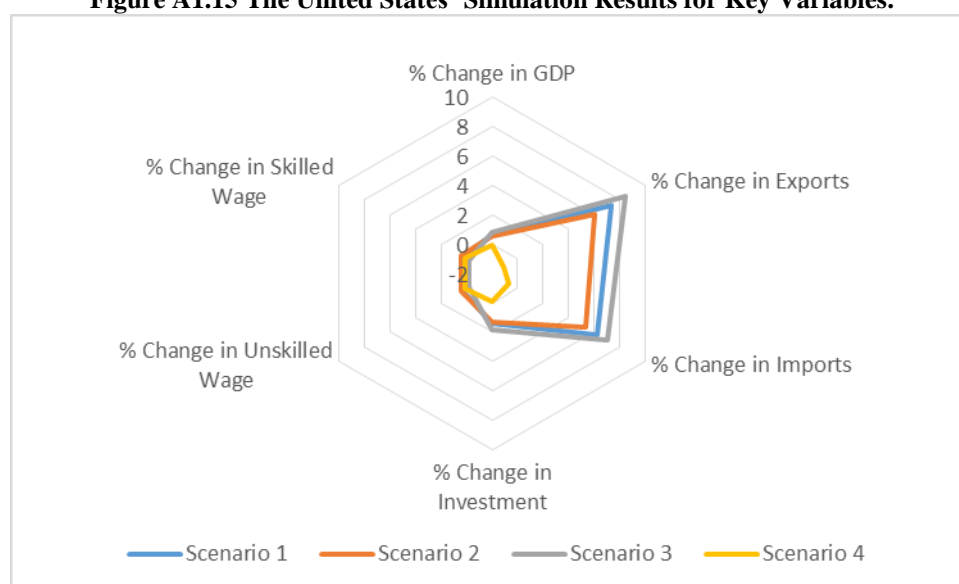
Figure A1.14 Thailand's Simulation Results for Key Variables.

Source: Authors.

UNITED STATES

The United States is a large economy, and so it is unsurprising that changes in the two trade variables are much larger than changes in GDP for all scenarios. Moreover, changes in key variables are closer together than is observed for other economies for scenario 3 as compared with scenarios 1 and 2. Although the largest gains in trade and GDP come from scenario 3, in which all APEC economies improve VCR but developing economies improve more rapidly, it is important to note that the gains from non-discriminatory improvements (scenario 1) are larger than those for discriminatory improvements in VCR (scenario 2). In terms of wages, results for the United States sound a note of caution for developed economies: skilled and unskilled wages both experience downwards pressure in scenario 3, but not in the first two scenarios. The implication is that in a competitive global and regional economy, it is important to prioritize improvements at home, in addition to benefitting from spillover effects from reform in other economies.

Figure A1.15 The United States' Simulation Results for Key Variables.

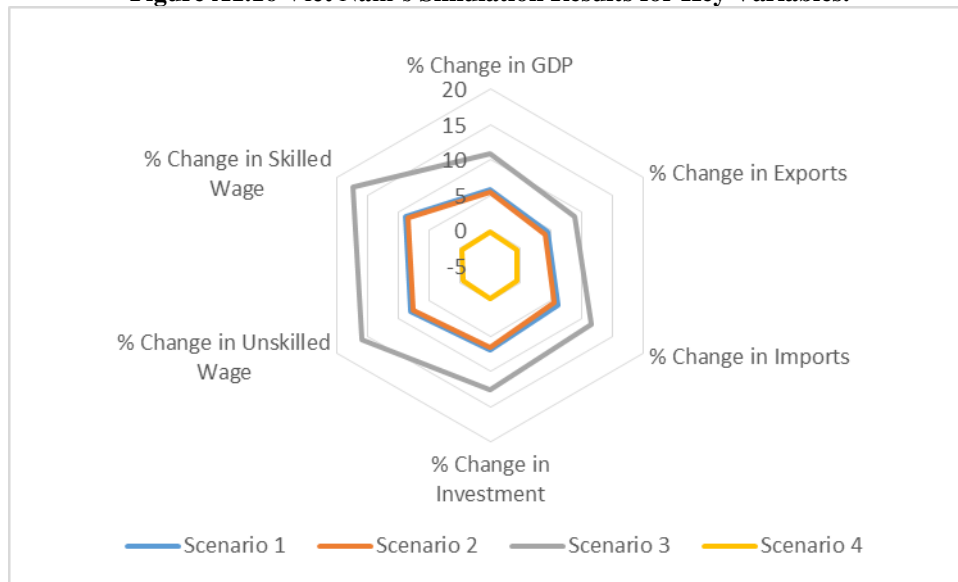


Source: Authors.

VIET NAM

Viet Nam experiences among the largest economic changes in the model's sample. For example, GDP increases by 5.3% to 10.8% in the first three scenarios. This finding demonstrates that developing economies stand to gain significantly from VCR improvements. Although changes in GDP, trade, and investment are relatively proportional, wages move differently in the first three scenarios: skilled wages experience significantly more upward pressure than do unskilled wages. This finding potentially has important implications from a social inclusion point of view. It suggests that attention could be paid to the composition of value chain activities in Viet Nam and their relative use of skilled and unskilled labor. In addition, there could be a case for using social protection mechanisms to ensure that the benefits of VCR improvements are spread widely among workers and consumers.

Figure A1.16 Viet Nam's Simulation Results for Key Variables.



Source: Authors.

APPENDIX 2: TECHNICAL DETAILS

As set out in the main text, this report follows a two-step methodology to examine the impacts of improvements in VCR on crucial economic indicators. The first step is to use econometric estimation to relate the three elements of VCR identified in the previous phases of this project to trade costs. The second step is to use counterfactual values of trade costs based on assumed improvements in VCR to shock a global CGE model.

The outputs of that exercise are discussed in detail in Chapter 4. This Appendix provides additional technical details, dealing with each step of the analysis separately.

ECONOMETRIC MODEL

The aim of using an econometric model as the first stage in the analysis is to obtain estimated elasticities of trade costs with respect to VC Risk, Strength, and Connectedness. This step is necessary because there is no global CGE model that directly incorporates those variables into its parameters. It is therefore necessary to go through trade costs as an intermediate variable closely associated with VCR to provide the motor for the counterfactual simulations.

Trade costs data are sourced from the UNESCAP-World Bank Trade Costs Dataset (Arvis et al., 2013). Trade costs are calculated using data on the observed pattern of trade and production across economies. Original sources are COMTRADE trade data, and national accounts. The trade costs calculation is set out in full in Arvis et al. (2013). It relies on an inverse gravity model that can be used to infer the level of trade costs. In this definition, trade costs are a “top-down” measure: instead of being built up from component parts, and thereby potentially understated, they are inferred from observed variables based on theoretical derivations. Trade costs in the UNESCAP-World Bank Dataset cover all factors that drive a wedge between export and import prices, including tariffs, non-tariff measures, trade facilitation and logistics, and other at- and behind-the-border measures. Trade costs are expressed as the ratio of international trade costs relative to intranational trade costs. Although trade costs can vary according to the direction of travel of goods, the model’s construction means that it is only possible to calculate a geometric average of trade costs in both directions. By construction, the trade costs index in the dataset is therefore identical for exports from economy A to economy B, and from economy B to economy A. The trade costs index is reported in percent ad valorem terms.

The UNESCAP-World Bank Trade Costs Dataset was released in 2012, and is updated annually. It covers up to 176 economies for the period 1995-2012. Three sectors are available: manufacturing, agriculture, and total trade (the sum of the other two sectors). Manufacturing is considered to be the most relevant sector for VC analysis, and so is used as the data source here.

Although the Trade Costs Dataset potentially has very wide coverage, late and/or incomplete reporting by many economies means that the data contain numerous gaps. It is therefore necessary to trade off the need for a recent sample year against the need for relatively comprehensive coverage. The optimal compromise is to use 2009 or the latest available year. In any case, the three VCR variables are only available for a single year—the latest available

based on a mix of data for VC Risk and Strength, and 2009 for Connectedness—so the regression can only proceed as a cross-section.

Arvis et al. (2013) draw on previous work to use an econometric model to decompose trade costs into their component parts. This report uses an adaptation of that approach, augmented to include data on VC Risk, Strength, and Connectedness. Trade costs vary by economy pair, so the three VCR variables need to be transformed to vary in the same way. That is achieved by taking the geometric average of importer and exporter index values. The three VCR variables are relatively strongly correlated, so they are entered separately into the regression equation. All regressions include standard gravity model control variables drawn from the CEPII Distance Dataset, a standard source in the trade literature. An additional variable is included to capture joint membership of a regional trade arrangement. It is sourced from De Sousa (2012). Regressions cover a total of 60 economies, based on results from the first three phases of this project. To avoid underestimated standard errors, one observation per economy pair is dropped due to the bilateral symmetry of all variables in the model. The estimation method is Ordinary Least Squares using a log-linear setup.

Results are in Table A2.1. Results on all control variable coefficients except the dummy variable for a common colonizer accord with expectations: distance increases trade costs, but common cultural or historical links tend to reduce them, as does membership of a regional trade agreement. Most of the control variable coefficients are statistically significant at conventional levels.

The three variables of interest are VC Risk, Strength, and Connectedness. All three coefficients have appropriate signs and magnitudes, and are 1% statistically significant. There is therefore a close relationship between VCR as captured by these variables, and trade costs: a lower level of VC Risk is associated with lower trade costs, and the same is true of higher levels of Strength and Connectedness. VC Strength has the strongest effect: a 5% improvement is associated with a 2.7% decrease in trade costs. 5% improvements in VC Risk and Connectedness are associated with decreases in trade costs of 1.5% and 1.4% respectively. Treating all variables as independent—which is an abstraction from reality—the total effect of a 5% improvement in all three simultaneously is a 5.6% reduction in trade costs. This effect is of a sensible magnitude from an economic perspective, and provides a sound basis for proceeding to calculate counterfactual values of trade costs that can then be used to shock the CGE model.

Table A2.1 Regression Results

	VC Risk	VC Strength	VC Connectedness
VC Risk	0.304***		
	(7.52)		
VC Strength		-0.538***	
		(-6.25)	
VC Connectedness			-0.278***
			(-26.83)
Geographical Contiguity	-0.289***	-0.275***	-0.248***
	(-3.82)	(-3.70)	(-3.53)
Common Language	-0.240***	-0.184***	-0.156***
	(-5.25)	(-4.06)	(-3.74)
Colony	-0.140*	-0.189**	-0.0487
	(-2.07)	(-2.83)	(-0.70)
Common Colonizer	0.437*	0.457**	-0.127
	(2.55)	(2.61)	(-0.90)
Same Country	-0.289	-0.295	-0.539*
	(-1.34)	(-1.35)	(-2.41)
Log(Distance)	0.288***	0.309***	0.261***
	(15.86)	(17.47)	(18.74)
RTA	-0.0262	-0.0341	-0.142***
	(-0.86)	(-1.17)	(-5.81)
Constant	2.049***	3.107***	3.048***
	(12.37)	(13.65)	(23.77)
Observations	1249	1283	1406
R2	0.454	0.446	0.638

Source: Authors. Note: P-values based on robust standard errors are reported in parentheses below the parameter estimates. Statistical significance is indicated by: * (10%), ** (5%), and *** (1%).

GLOBAL CGE MODEL

The global CGE model used in this report was developed by researchers at the U.S. International Trade Commission (Tsigas and Wang, 2010). It is based on the standard Global Trade Analysis Project (GTAP) framework (Hertel, 1997; and Narayanan et al., 2012)—the most commonly used dataset and model for applied international trade work—but has been specially modified to better capture the realities of VC trade. Two modifications are of particular relevance.

First, the CGE model used here departs from the standard GTAP framework in that it explicitly includes processing trade in China and Mexico, two APEC economies in which that activity is particularly important. The processing zones are modeled as separate economies, which makes it possible to tease out the implications of policy changes for processing and non-processing activities separately. This is an important advantage from the point of view of analyzing VCs, where processing plays an important role.

Second, although standard GTAP and this model both use gross value trade data, this model's assumptions bring it closer to the idea of VC trade. The key difference is in the implementation of the Armington assumption, i.e. the idea that goods are differentiated

according to their economy of origin. Conceptually, the standard GTAP model in effect assumes that a single firm imports a particular product from other economies, with sourcing based on relative prices. The importing firm “blends” the imported product into a composite, and supplies it to domestic producers and consumers.

The approach taken in this model is different. Additional data work undertaken in the course of the analysis of value added trade has made it possible to adopt an agent-based approach that better reflects the reality of VC trade. Each producer decides how much of a product to import, and where to import it from. The net result is that this model establishes potentially tighter linkages between sectors across economies, in the way that is indeed observed within VCs.

In other respects, this model follows standard GTAP assumptions. There is perfect competition and constant returns to scale. Labor is divided into two categories, skilled and unskilled, with wages adjusting to ensure market clearance. Total global savings are equal to total global investment, with investment in each economy determined by its propensity to save and the rate of return, which adjusts to maintain the global condition.

The CGE model’s regions and sectors are set out in the Tables A2.2 and A2.3.

Table A2.2 CGE Model Regions

Australia and New Zealand
Brazil
Canada
China
Chinese Taipei
EU12 and EU 15
Hong Kong, China
India
Indonesia
Japan
Korea
Malaysia
Mexico
Philippines
Rest of East Asia
Rest of High Income
Rest of South Asia
Rest of the Americas
Rest of World
Russian Federation
Singapore
Thailand
United States
Viet Nam

Source: Tsigas and Wang (2010).

Table A2.2 CGE Model Sectors

Apparel
Beverages and Tobacco
Chemicals and Rubber
Coal
Communications
Construction
Crops
Electricity
Electronic Equipment
Finance
Fishing
Forestry
Gas Distribution
Government Services
Insurance
Iron and Steel
Leather
Livestock
Lumber
Meats and Dairy
Metal Products
Motor Vehicles and Parts
Non-Ferrous Metals
Non-Metallic Minerals
Oil and Gas
Other Business Services
Other Foods
Other Machinery and Equipment
Other Manufacturing
Other Mining
Other Transport Equipment
Paper
Petroleum and Coke
Recreation Services
Retail and Wholesale Trade
Textiles
Transport
Water

Source: Tsigas and Wang (2010).

REFERENCES

- Arvis, J.F., Y. Duval, B. Shepherd, and C. Utoktham (2013), “Trade Costs in the Developing World 1995-2010”, *World Bank Policy Research Working Paper Series*, No. 6309, Washington, D.C.
- De Sousa, J (2012), “The Currency Union Effect on Trade is Decreasing Over Time”, *Economics Letters*, 117(3): 917-920.
- Hertel, T. (1997), *Global Trade Analysis: Modeling and Applications*, Cambridge, UK: Cambridge University Press.
- Koopman, R., M. Tsigas, D. Riker, and W. Powers (2013), “The Implications of Using Value-Added Trade Data for Applied Trade Policy Analysis”, in D. K. Elms and P. Low, editors, *Global Value Chains in a Changing World*, Fung Global Institute, Nanyang Technological University, and WTO.
- Mayer, T., and S. Zignago (2005), “Market Access in Global and Regional Trade”, Working Paper 2005-02, CEPII.
- Miroudot, S., R. Lanz and A. Ragoussis (2009), “Trade in intermediate goods and services”, *OECD Trade Policy Working Paper No. 93*, OECD Publishing.
- Narayanan, B., A. Aguiar, and R. A. McDougall (2012), “Global Trade, Assistance, and Production: The GTAP 8 Data Base”, Center for Global Trade Analysis, Purdue University.
- Sturgeon T. and O. Memedovic (2011). *Mapping Global Value Chains: Intermediate Goods Trade and Structural Change in the World Economy*, UNIDO: Vienna.
- Tsigas, M., and Z. Wang (2010), “A General Equilibrium Analysis of the China-ASEAN Free Trade Agreement”, Paper Presented at *13th Annual Conference on Global Economic Analysis*, Penang, Malaysia, June.
- World Economic Forum and World Bank (2013), *Enabling Trade: Valuing Growth Opportunities*, Geneva: WEF.