The Modeling of an Open Regional Economy: Effects of Imports and Trade Liberalization[1]

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Abstract

This paper focuses on the import side of a regional economy quantifying the economic impact of import levels and trade liberalization. An innovation represents the linkage of a regional with a national model by combining two separate Computable General Equilibrium models into one framework. This allows for import price formation in liberalization scenarios on the national level and subsequent incorporation of these nationally simulated prices into the regional model.

The regional model is applied to Washington State, one of the most trade dependent states of the U.S, the national model to the U.S. Data for the two identically structured models origin from the IMPLAN database which divides the U.S. and Washington economy into 509 industries. For both models, Monte Carlo techniques are used to mitigate parameter uncertainty inherent in CGE specifications. Two scenarios are simulated that differ in the assumptions about the macroeconomic and factor market adjustment options of the economies.

Overall, value added of the national and regional economies increase and positive import developments are recorded. The results indicate that across all industries in Washington State, around $5,500 million of value added are supported by imports as well as around 65,000 jobs.

Keywords: Computable General equilibrium, regional modelling, trade liberalization

JEL classification: C68, R13, F17

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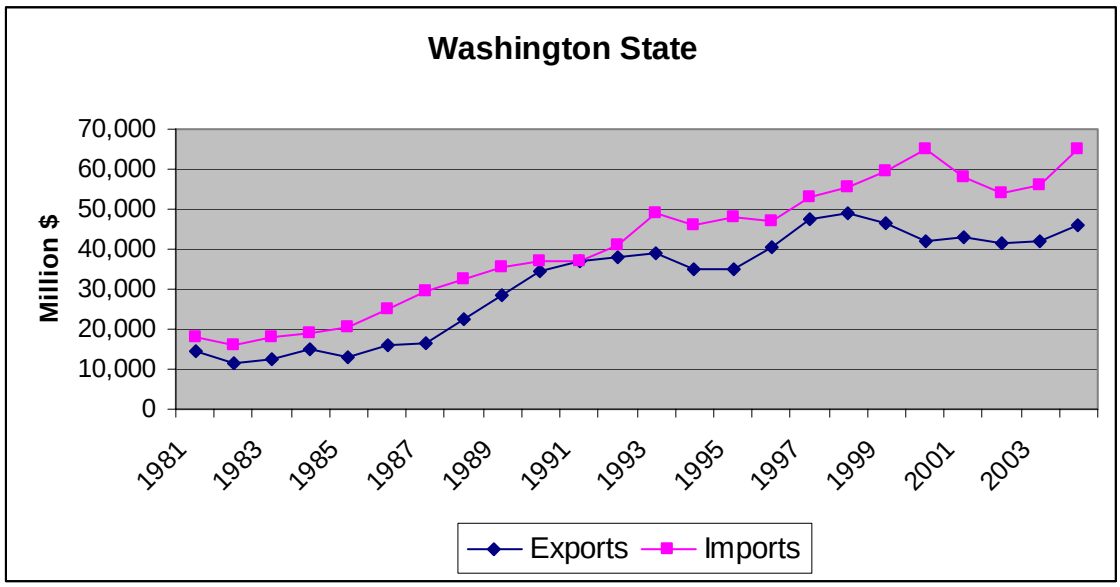
1 Introduction

The trend towards more integrated economies that depend on the international exchange of goods has been accelerated over the past decades. Between 1980 and 1998, the worldwide trade volume increased at an average annual growth rate of 5.6%, much higher than the 3.3% growth rate for global production (OFM, 2000). Washington State is one of the most trade dependent states of the U.S., consistently ranking in the top five states in exports during the last decade (OFM, 2005). Due to its geographical location, Washington State serves as one of the nation's gateways to East Asia. The ports of Tacoma and Seattle are the second largest container load centers in the U.S., ahead of New York/New Jersey and second only to Los Angeles/Long Beach (WITC 2003). The value of imports and exports that were processed through the port system of Washington State continuously increased over the past decade and accounted for $98 billion in the year 2003 (Figure 1).

Figure 1 Value of imports and exports ("Pass-through")



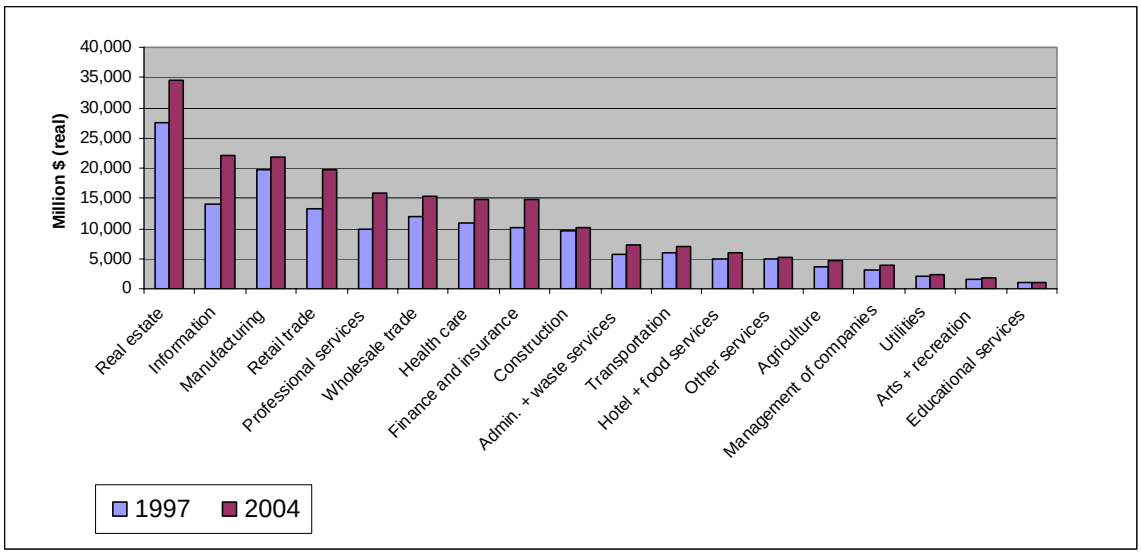
Note: All data are based on goods laded or unladed in Washington State regardless of goods origin or destination. Nominal values.

Source: Department of Community, Trade and Economic Development, Washington State.

With a Gross State Product (GSP) of around $262 billion in the year 2004, Washington State rank 14 in the U.S. in absolute terms. Important contribution to the state GSP are provided by the real estate sector, information, manufacturing, retail and wholesale trade,

and the professional and technical service sectors as Figure 2 indicates. The comparison of figures over time shows that overall contribution to the total GSP increased for the information sector by 1.8% to 9.2% in 2004 of total state GSP, as well as the retail trade (+1.1% to 8.2% in 2004), professional and technical services (+1.4;6.6%), and health care sectors (+0.4;6.2%). For manufacturing we observe a decrease by -1.4% to 9.1% in 2004 as well as for the contribution of the government sectors to total GSP by around 1.8% (to 13.4% in 2004).[3]

Figure 2 Value added of private industries in Washington State: Development over time



Note: Real values in 2000 dollars.

Source: Bureau of Economic Analysis (BEA).

In terms of employment, the statistics reveal that in 2004, manufacturing contributes to 16% of total employment and various service sectors (including government) account for the rest. Among the service sectors, retail trade (12% in total employment), education and health (12%), and the leisure and hospitality sector (10%) capture most of the employment. A view on the trend shows that the importance of the service sectors increased over time (+3.6%) on the costs of manufacturing jobs.

[3] All numbers in this paragraph rely on information drawn from the BEA Regional Economic Accounts website.

Past bilateral, regional, and multilateral trade agreements have expanded both export opportunities and import competition. Further future trade liberalization under the Central American Free Trade Agreement and the Doha Round of the World Trade Organization is expected to come and will intensify this trend. Conceptually, one may expect that rising exports would help the state economy while rising imports would hurt it. However, in fact, the situation is more complex affecting both manufacturing and services, and previous studies (e.g. Chase and Pascall, 1999) indicated that also rising imports contributed to economic growth in certain industries and that the impact of trade liberalization will depend on the character of the regional industries.

The growth of imports over the last decade affected the regional economy both directly and indirectly. From a consumer's point of view, these are positive developments given that the availability of imports increases the variety of products and services available for purchase and may reduce their costs. On the production side, the rise of imports can be seen both, positively and negatively. To the extent that imports are used in the production process, an increase in availability at a potentially lower price decreases production costs and enable the firm to remain competitive. On the negative side, imports may have an dampening effect on the economic development of industries if they become a new source of competition and substitute for goods and services that otherwise would have been produced regionally. In addition, an economy like Washington State that is an important gateway for im- and exports, benefit from increased trade volumes through all services that are required for the processing of the shipments. Impacts of imports on employment are most likely to fall on sectors that have a heavy component of imports as part of total final consumption and where the industries are relevant to the regional economy. Economic effects of these developments will include changes in production and consumption pattern, factor valuation, employment, and state GSP.

Over the last decade, research has been done on several aspects of the importance of foreign trade for regional economies. Recent work on determinants foreign trade earnings is provided by Leichenko and Silva (2004) whereas several other studies quantify the importance of imports (Chase and Pascall, 1999) or exports (Gosh and Holland, 2004) for the regional economy and trade liberalization (Dixon et al., 2006) using mostly input-output or Computable General Equilibrium (CGE) models.

Leichenko and Silva (2004) studied the effect of international trade on rural manufacturing communities in the U.S. using a regression model where manufacturing earnings and employment is explained by regional endowment factors, exchange rates and indicators of regional export and import orientation. Their model suggests that the regional impacts of trade are complex and must be differentiated for rural and urban counties and dependent on the import or export orientation of the regional communities.

Chase and Pascall (1999) analyze the importance of imports for the Washington State economy. First, they provide a description of trends and current situation of pass-through trade and imports with Washington as final destination, and highlight the most import dependent sectors and major trading partners. Afterwards, they use a model ("Washington Input-Output model") to estimate both, the economic impacts of pass-through trade, i.e. all trade that is e.g. handled by the ports of Seattle and Tacoma but further shipped to destinations mainly in the Midwest, and the economic impacts of imports terminating in Washington State. They conclude that 7% of all employment in Washington is import-related and that the entire trade-related employment base is around 32%.

Gosh and Holland (2004) analyze the role of agriculture and food processing exports on the Washington economy using a social accounting matrix for 2000 that is based on IMPLAN data. Their results indicate that there are significant indirect and induces effects of non-agriculturally related service sectors like wholesale and retail trade, and business, health, banking and insurance services.

Dixon et al. (2006) use a detailed U.S. CGE model to analyze the impact of the removal of major tariffs and quotas. In addition, they implement an approach to regionalize the national results. Using regression analysis they search for further explanatories that beyond the regional break-down of national indicators may explain regional differences. Their results indicate that further import liberalization would have only small long-run effects on the U.S. economy. For most industries output changes are in the range -/+ 1%, however there are a few industries (sugar, butter, textile) where larger negative output changes can be expected. State employment effects are estimated to be in the range of -0.5% to +0.2% with Idaho and North Carolina being at the negative end of these effects and Washington State at the positive end of employment

developments. These state results are mainly influenced by the trade orientation of important regional industries.

As a reason of the widespread use of input-output models and the underlying economic base theory approach, most work in this area focused on the assessment of the export base of a regional economy.[4] However, this paper aims at expanding this picture to the import side quantifying the economic importance of current impact levels as well as prospects under further trade liberalization. Therefore, this study is driven by the following research questions:

- How dependent is the regional economy on imports?
- What is the effect of the removal of import restraints on WA?

The analysis is undertaken using a CGE modeling framework. However, an innovation in this approach represents the integration of the regional economy into the national picture by combining two separate models that represent the regional economy of Washington State and the national economy of the U.S. into one modeling framework In addition, in both models, Monte Carlo techniques will be used in order to address parameter uncertainty inherent in the specification of CGE models.

The remainder of the paper is organized as follows: In the next section, indicators regarding the regional economic importance of imports are analyzed. In the third section an import restraint liberalization scenario using CGE methodology is simulated. The last section concludes.

2 The import picture of the regional economy

Imports of goods (or services) into an economy mainly serve two purposes: they either enter the production chain of the regional economy as inputs in the manufacturing process or enter the marketing or transportation chain to satisfy final consumption or service demands by household or other institutions.[5] The following graphs and tables will

[4] An approach that is extended by Waters et al. (1999) including service export, extraregional income, and government transfers into the economic base estimation and related industry importance indicators.

[5] This also holds for so-called "pass-through" imports that are landed at a port and then transported to a final destination that is outside of the regional economy. In this case, these imports make use of warehouse, transportation, and processing services provided by the region.

provide an overview on the import picture in Washington State. Year of presentation is 2003, the most recent data set available from IMPLAN (Impact Analysis for Planning)[6].

2.1 Value added and employment

Overview

Table 1 provides an overview on aggregated economic indicators for Washington State as represented in the IMPLAN database for the year 2003. Around 3.5 million jobs in Washington State generate a value added of nearly $240 billion. Imports in the value of $157 billion arrive in Washington State of which around $19 billion originate from foreign destinations. Total factor return for labor ("labor earnings") for the 3.5 million jobs account for around $142 billion.

Table 1 Value added, employment, and imports for Washington State

State aggregate		Value
Value added	*Million $*	238,633
Employment	*# of jobs*	3,541,345
Total WA imports	*Million $*	157,360
Foreign imports	*Million $*	137,455
Imports from rest of the U.S.	*Million $*	19,905
Total labor earnings	*Million $*	141,662

Source: Own representation based on IMPLAN data.

Breakdown by industries

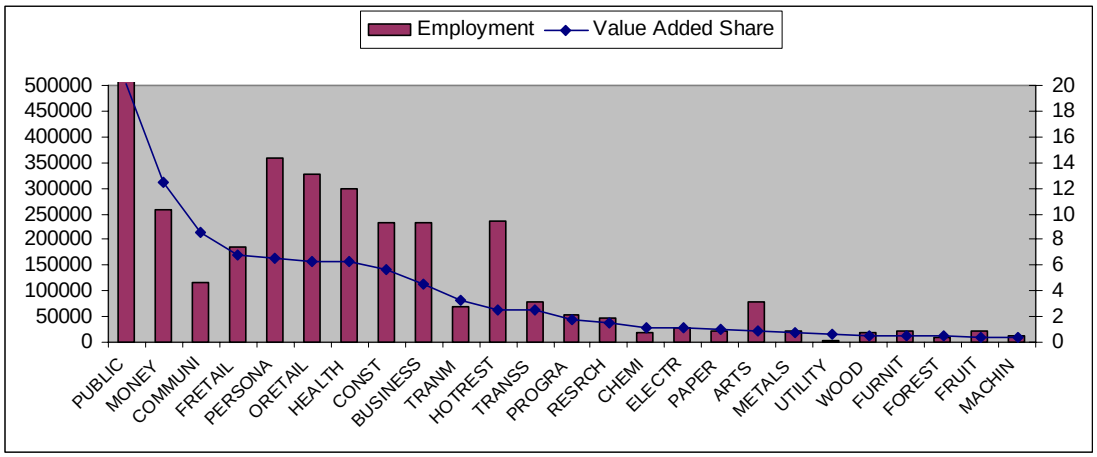
Figure 3 provides an overview on the importance of the difference industries in terms of share in value added[7] in total state value added and share of employment in total state employment in the respective industries. While the public sectors (e.g. education, military, waste management) accounts for both the highest value added share and employment, other industries such as money and banking, communication also contribute significantly to the GSP but show less importance in terms of employment. Here, personal services (e.g. rental, legal, repair, or personal care services), other retail stores,

[6] IMPLAN provides regional input-output tables for all counties and states of the U.S. consistent with the accounting conventions used by the BEA and the rectangular format recommended by the United Nations.

[7] Value added for an industry is defined as the gross output minus intermediate inputs, i.e. it is the value added of labor and capital in that industry. The sum over all industries gives the Gross State Product, i.e. the value added of the state economy.

health care, construction, other business services (e.g. management and administrative services, office support service) and hotels and restaurants also are important employers in Washington State.

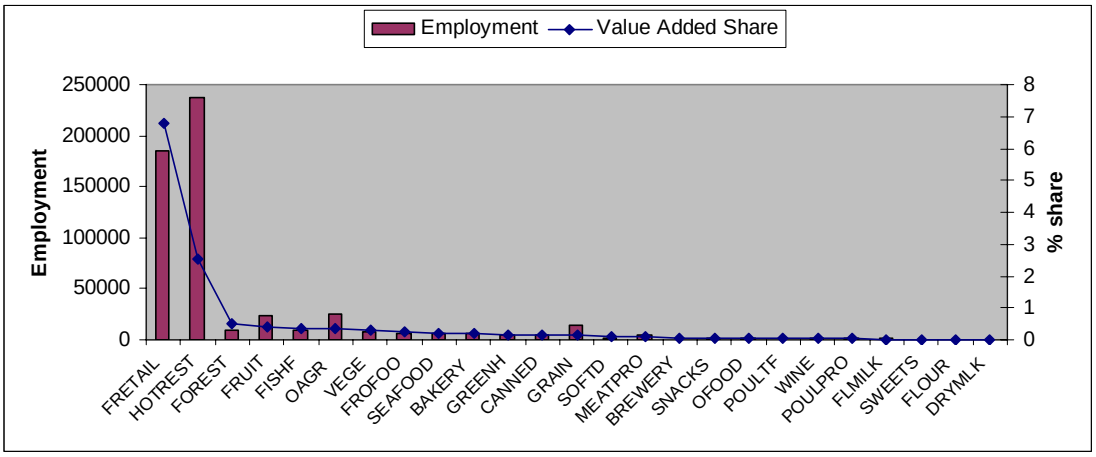
Figure 3 Employment and value-added share, Top 25



Note: Employment in public sector: 656904. Value added share in public sector is 20%.
Source: Own representation based on IMPLAN data.

In Figure 4, the same indicators are displayed but for agricultural and food related industries. Food retail and hotel and out-of-house food services and drinking places have by far the most importance for the state in terms of value added and employment, but all other activities in the food production and processing sector sum up to around 136,000 employees and a value added share of around 3.5%.

Figure 4 Employment and value-added share for food and agricultural industries, Top 25



Source: Own representation based on IMPLAN data.

2.2 The relevance of imports

Table 2 provides an overview on the impact of imports on the economy of Washington State. Around 2.3% of the statewide value added, or $5.4 billion, are supported by foreign imports. Similarly, 64,000 jobs, 1.8% of the total job base, benefits from international trade. This generates over-proportional labor earnings of approximately $3,7 billion, indicating that part of these jobs must be in the industries with higher than average factor returns.[8]

On industry level, we observe an average import share of about 9%. Value added generated from imports is around $97 million for the average industry, and the average employment effect results in around 1150 jobs and provides labor factor returns of around $66 million.

[8] Compared to the estimate of about 117,000 jobs supported by imports by Chase and Pascall (1999) for 1997, import supported employment seem to have decreased over time. In addition, the breakdown by industry indicates a shift in sector importance. Chase and Pascall identified wholesale and retail trade as the sectors where most of the jobs were originated whereas, in the present study, most of the jobs seem to be located in the manufacturing industries. Interestingly though, the labor earning generated by imports remained stable over time with around $3.6 billion. In order to further investigate this shift in size and relevance, more information on the used methodology of the Chase and Pascall study as well as consistent time series information would be necessary.

Table 2 Value added, employment, and labor earnings supported by imports

State aggregate		Value
Value added supported by imports	*Million $*	5,450
Share in total value added	*%*	2.28
Employment supported by imports	*# of jobs*	64,477
Share in total employment	*%*	1.82
Labor earnings supported by imports	*Million $*	3,696
Share in total labor earnings	*%*	2.61

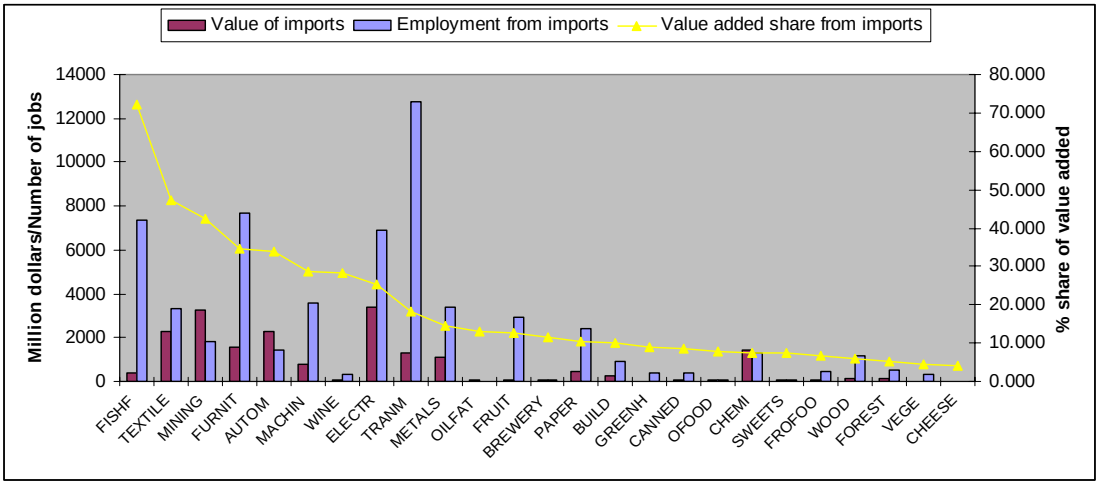
Industry level		Value
Average import share	*%*	8.78
Average value added supported by imports	*Million $*	97
Average employment supported by imports	*Million $*	1,151
Average labor earning supported by imports	*Million $*	66

Source: Own representation based on IMPLAN data.

The next two figures disclose the value of imports broken down to industry level together with the share of imports in value added and proportionate employment levels. Figure 5 shows that the commercial fishing industry, followed by the textile manufacturing, mining, and furniture production have the highest share of imports in value added, whereas imports to transportation equipment manufacturing, electronics and computer manufacturing, furniture production and commercial fishing again, have the highest impact on employment.

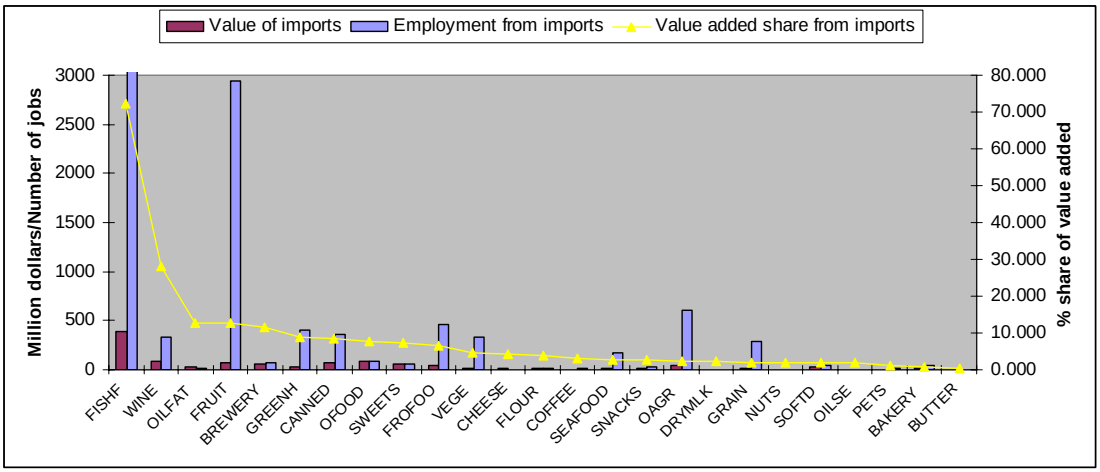
In Figure 6 the same information is displayed, but focusing on the top 25 industries in agricultural and food processing with high import shares. Besides commercial fishing, the wine industry, and oil and fat production are characterized by high import shares in value added, where in terms of employment generation from imports, the fruit industry, greenhouses, canning, and the frozen food industry benefit significantly.

Figure 5 Value of imports, employment and value added share related to imports, Top 25



Source: Own representation based on IMPLAN data.

Figure 6 Value of imports, employment and value added share related to imports for food and agricultural industries, Top 25



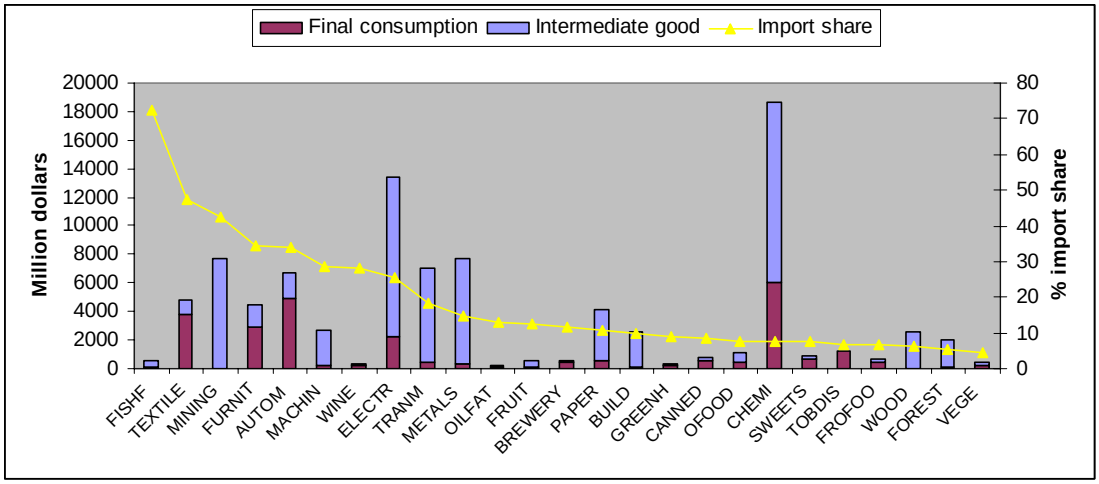
Note: Commercial fishing: employment 7381; value added share 73%.
Source: Own representation based on IMPLAN data.

Finally, Figure 7 shows the use of goods disaggregated at industry level. The industries are ranked by their share of imports in total consumption.[9] In addition, we display the use of the good, that is, if it is mainly used as a final consumption good for households and

[9] Total consumption is defined as the sum of final consumption plus intermediate use of goods. In CGE this term usually further includes investment demand and government consumption. These two items are displayed in the above table but not considered in the calculations here.

institutions or as an intermediate input in the production process.[10] This distinction may hint at industries and consumers that will be affected by changes in trade policy.

Figure 7 Import shares and use of commodities as final consumption good or intermediates in manufacturing, Top 25



Source: Own representation based on IMPLAN data.

Commercial fishing, textile, and the mining industries show the highest import shares with around 40%-80%. Textile products, automobiles, and furniture as well as the food and beverage products brewery, canned food, sweets, tobacco and distilled items, and frozen foods are mostly destined for the final consumption whereas for the other listed industries intermediate use of the products in other production processes prevails.

3 The regional effects of import liberalization

In this chapter, the effects of the removal of tariffs and other import restraints on the Washington economy will be presented. For this purpose, two CGE models, representing the U.S. and the Washington economy are constructed and linked to each other. Next, model, data, and scenario design will be discussed, followed by the presentation of results for both, the U.S. and the Washington economy.

[10] Final consumption goods are defined as goods that are directly consumed by households or institutions. Intermediate inputs are industry outputs or imported goods that are accounted as inputs in a production process of a state industry. Goods may serve as both, final consumption good and intermediate input. e.g. fruits and vegetables that can be consumed fresh or be used as an input in the canning industry.

3.1 Model description

In order to perform the analysis, CGE models for both, the U.S. and the Washington economy were developed that are similar to standard CGE methodology provided by Lofgren et al. (2002). A CGE model mathematically represents the inner working of the economy with Walrasian market clearing in all sectors. Representative agents for producers and consumers in the various sectors apply microeconomic behavior, i.e. maximize an objective function (profit/utility) subject to certain constraints. All markets are interconnected and consistent. Endogenous equilibrium prices ensure that that commodity and factor markets clear and that macroeconomic identities hold. By Walras law, all prices and exchange rates are normalized to one in the base period. The consumer price index (CPI) is set to be the numeraire. Because of the inter-linkages of the sectors, shocks in any sector will seep through the economy and impact the other sectors. Given that we use a derivative of a standard CGE model, and the basic structure is thus familiar, in the following the specification of only some of the agents will be briefly explained.

A linear expenditure system, generated by a Stone Geary utility function is used to model *consumer behavior* where we assume utility maximization subject to a budget constraint. We consider nine different household categories whose demand is determined by available net income[11], and several "institutional" categories (e.g. investment and government). After allocation of the household expenditure to the different consumption goods, an Armington specification based on a constant elasticity of substitution (CES) function determines the composition of demand from domestically produced and *imported goods*. In the regional model, the Armington aggregator applies to two levels – in the first stage the substitution between domestic goods (produced in Washington) and imported goods is allowed; in the second stage domestic imports (imports from rest of the U.S.) and foreign imports are differentiated (imports from rest of the world), and substitution between them may take place.

Each *economy* is assumed to be composed of a set of competitive industries, where each industry uses the given endowments of primary factors of production and intermediate inputs that are outputs of other industries, in a Leontief-cum-constant

[11] Net income is defined as gross income less household savings or borrowing.

elasticity of substitution (CES) production function to produce primary and secondary commodities. The Leontief part of the production function ensures "weak separability" between primary (labor and capital) and intermediate factors.

The produced commodities can be either *exported* (with the same distinction as on the import side: domestic, i.e. to the rest of the U.S., and foreign exports) or domestically consumed with the transformation between the two being defined by a constant elasticity of transformation (CET) function. The world price of imported goods is held constant. In the U.S. model, the price of exported goods is derived from a constant elasticity of demand (CED) function representing export demand of the rest of the world whereas in the regional model export prices are defined exogenously.

Choice of exogenous parameter values in the behavioral functions and the closure rules governing this modeling system will be further discussed in the scenario description in the following section. The model is implemented in levels form in the software GAMS and solved with the PATH solver. An overview of the equation system can be found in Stodick et al. (2004).

3.2 Base year social accounting matrices

For the empirical analysis, social accounting matrices (SAM) were constructed for both, the U.S. and the Washington State model. The data in the SAM captures a detailed and consistent representation of the economic interaction of various activities at a certain point in time. Thus, the SAM includes the complete circular flow of all the transactions in the production, factor, household, government and rest of the world sector. The data source of the SAM for our economic model is the IMPLAN data base of the year 2003. IMPLAN divides the economy into 509 industries that may be aggregated according to the needs of the researcher. In the current application, we divide the U.S. and Washington economy into 56 sectors with special focus on the agricultural and food industries (see Appendix 6.1 for the sectoring scheme).

Table 3 represents an overview on the base year data of the Washington SAM. As usual for SAM accounts all industries are represented only in monetary terms and no physical indicators for inputs, outputs, or activity levels are available. The commodity accounts are import ridden. That is, use of commodities by activities or institutions,

includes both imported commodities and domestically produced commodities. The value added of the economy consists of factor bill plus indirect business taxes and accounts to $238 billion. The SAM shows a slightly positive foreign trade balance (+ $3 billion), and a negative one for imports from the rest of the U.S (- $15 billion). Total trade, i.e. imports and exports add up to roughly half of the value of commodities produced within Washington State underlying again the importance that trade plays in this state. Roughly two thirds of household income results from labor and capital payments with the remainder coming mostly from government transfers and borrowing. In terms of saving and investment, government is shown to have a positive budgetary balance, and household saving is slightly less than corporate saving.

Table 3 Overview of the base year SAM of Washington State in the year 2003 (million $)

				Expenditures					
Receipts	**Activities**	**Commodities**	**Factors**	**Households**	**Government**	**Savings/ Investment**	**Rest of the US**	**Rest of the World**	***Total***
Activities		Commodities 419,186							419,186
Commodities	Intermediate inputs 180,554			Private consumption 169,080	Government consumption 46,233	Investment 50,436	Exports 112,687	Exports 23,073	582,064
Factors	Capital+labor 222,017								222,017
Households		Commodities 239	Factor income to households 156,153	Interhousehold transfers 4,154	Transfers to households 45,357	Borrowing 16,017	Transfers to households 3,939		225,858
Government	Indirect taxes 16,616	Commodities, tariffs 3,812	Factor taxes 18,739	Income taxes 13,026	Intergovern-mental transfers 33,845	Borrowing 41,024			127,061
Savings/ Investment		Inventory change 1,467	Corporate savings 48,907	Household savings 38,697	Governent savings 1,003	Balance 5,790	Net earnings on US investments 19,000		114,864
Rest of the US		Imports 137,455	Factor income to RUS -1,829						135,626
Rest of the World		Imports 19,905	Factor income to ROW 48	Transfers to ROW 902	Transfers to ROW 623	Borrowing 1,597			23,073
Total	419,186	582,064	223,846	225,858	127,061	114,864	135,626	23,073	

Note: ROW = Rest of the World

Source: Own aggregation based on IMPLAN (2003).

3.3 Scenario description

The objective of this modeling exercise is to quantify the effects of the reduction of U.S. import tariffs and constraints on the Washington economy. Given the proliferation of U.S. bilateral trade agreements and the developments on international scale, further liberalization of the import regime is about to happen in the near future. As discussed in the introduction of this work and given the importance of imports in the regional economy, this will result in positive and negative effects for certain sectors of the economy. Information on sector specific U.S. import restraints (tariffs and other non-tariff barriers calculated as export tax equivalents) originate from work undertaken at the U.S. International Trade Commission and reported in Dixon et al. (2006). According to the sectoring scheme of the model, these tariffs and other barriers are implemented in both modeling frameworks. Given that no consensus has been reached yet in the Doha negotiations of the WTO and the often sector specific bilateral agreements, we assume a 50% reduction of the current tariff and quota levels. An overview on specific tariff and quota levels before and after the tariff cut can be found in Table 7.

The reduction of import restraints will be analyzed under two different U.S. macroeconomic scenarios (Table 4). The two scenarios allow for a gradually more flexible adjustment of factor markets and macroeconomic indicators In the first scenario, a neoclassical type, more short term closure is defined where production factors are mobile across the sectors but supply is fixed and the wage/interest rate adjusts to maintain the given total supply level. Investments in the economy are savings driven, i.e. savings are fixed and investment adjusts in order to balance the investment-savings account. In the second scenario, a more flexible specification following a Johansen type closure is chosen, where capital and labor are mobile across all sectors and supply of both factors is elastic. However, the market clearing for labor happens through an adjustment of jobs, i.e. wages are fixed which implies that unemployment in the economy is possible. The savings-investment account is closed by an adjustment of the CPI so that savings and investment are exogenous and fixed at the base year level.

Table 4 Factor market specification, macroeconomic closures, and price framework

	Scenario 1 Neoclassical type closure, more short term		**Scenario 2** Johansen type closure, more flexible	
	U.S. model	**WA model**	**U.S. model**	**WA model**
Factor market assumptions				
Capital	- Mobile across sectors - Supply is fixed	- Mobile across sectors - Supply is fixed	- Mobile across sectors - Supply is elastic	- Mobile across sectors - Supply is elastic
Labor	- Mobile across sectors - Supply is fixed	- Mobile across sectors - Supply is fixed	- Mobile across sectors - Supply elastic - Market clears through job adjustment	- Mobile across sectors - Supply elastic - Market clears through job adjustment
Definition of macroeconomic closures				
Government	- Revenue (taxes) and investment are fixed, savings adjust			
Savings/ Investment	- Investment is savings driven	- Investment is savings driven	- CPI adjusts	- CPI adjusts
External balance (rest of the World)	- Exchange rate adjusts	- Foreign savings adjust	- Exchange rate adjusts	- Foreign savings adjust
Balance with rest of the U.S.	- n/a	- U.S. savings adjust	- n/a	- U.S. savings adjust
Price framework				
Price for imports from rest of U.S.	- n/a	- Composite demand price vector (PQ) from U.S. model	- n/a	- Composite demand price vector (PQ) from U.S. model
Price for imports from rest of the World	- Tariff liberalization implemented	- Import price vector (PM) from U.S. model	- Tariff liberalization implemented	- Import price vector (PM) from U.S. model
Price for exports to rest of U.S.	- n/a	- Composite demand price vector (PQ) from U.S. model	- n/a	- Composite demand price vector (PQ) from U.S. model
Price for exports to rest of the World	- n/a	- Export price vector (PE) from U.S. model	- n/a	- Export price vector (PE) from U.S. model

Source: Own representation.

For both scenarios hold that the current account is fixed (at the benchmark year level) so that the foreign exchange rate fluctuates to maintain the current account balance. Hence, depreciation or appreciation of the domestic currency unit (the dollar) may occur in order to correct the external balance. This would simultaneously result, in the case of depreciation, in a reduction of imports (reduction of spending) and an increase of exports (increase export earnings). Government expenditure and investment are exogenous in the model.

The regional open economy of Washington State is modeled in the first scenario, as one where only short term adjustment are allowed, whereas the second scenario allows for longer term adjustment to the changes in trade policy and represents a probably more realistic picture. The factor market assumptions in the regional model follow U.S. specifications. For the closure of the savings/investment balance, the state CPI is allowed to adjust so that endogenous state savings may balance investment (fixed in real terms). This seems a reasonable assumption in terms of regional macro behavior since there is no mechanism to regulate the current account balance at the state level. This means that policies or shocks at the state level that are inflationary will set off CPI changes that reduce consumption and regulate state saving and investment. As a closure for the external balance, the foreign exchange rate is kept fixed so that the state current account has to adjust. This is a plausible assumption on regional level given that a regional economy usually cannot influence foreign exchange rates. For the closure of the current account balance with the U.S., a similar assumption is chosen where U.S. savings may adjust.

With respect to the price framework that is relevant in the regional model, we assume that it is determined by national market developments. Hence, in both scenarios, national price effects of the tariff removal are estimated with the national CGE model and these prices then are implemented and treated exogenously in the Washington model. This step reflects the assumption that a regional economy embedded in a national context, should face prices and macroeconomic conditions that follow national (U.S.) developments. The endogenous market clearing implies that policy changes such as import restraint liberalization, or movement in the exchange rate or CPI are indirectly included in the prices. Consequently, we use the U.S. price vectors in the regional model

as displayed in Table 4. Different choices can be made regarding the import/export price to and from the rest of the U.S. The national producer price (PX) can be used under the assumption that all of Washington's imports from the rest of the U.S. are strictly U.S. produced. But, if some of Washington's rest of the U.S. imports involves goods that were originally imported from third countries, then the blended (composite) U.S. price (PQ) is the appropriate measure. We opted for the latter one given that the U.S. in overall is a very open economy running a trade deficit since many years.[12]

After the decision on model closure and exogenous elasticity values, the model is solved initially to appropriately calibrate all the behavioral functions of the model to the respective base year SAM. Empirical estimates of the Armington elasticities are used in this model and are reported in Appendix 6.2 for both models. For the U.S. model, the Armington elasticities show values in the range of 1.9-5 and result from work done by the International Trade Commission (Donnelly et al., 2004). For the regional model, lower substitutability is reported from empirical estimation (Bilgic et al., 2001). This reflects the understanding that commodity imports and domestic production for a given commodity at the national level cover more product varieties within that commodity than is the case on a regional level. Hence, more substitution is expected among imports and domestically produced products on the national level for a given commodity than is the case for that same commodity at the regional level.

In order to address the uncertainty about the exogenous model parameters we implement a sensitivity analysis based on Monte Carlo techniques as described in Abler et al. (1999) or Gilbert (2003). The use of the Monte Carlo approach of repeated randomized samples is only one method to systemize the uncertainty that is introduced in the model via the parameter choices. Other possible methods include Gaussian quadrature that approximate the underlying parameter distributions (Arndt 1996, Abler et al. 1999), and so-called conditional (Harrison et al. 1993, Abler et al. 1999) or unconditional systematic sensitivity analysis (Harrison and Vinod 1992, Abler et al. 1999) where only a

[12] Note that in both simulations the average U.S. producer price is slightly higher than the U.S. composite price (e.g. PX=1.001% against PQ=0.997% in scenario 1) so that a small underestimation of the export effect from Washington State to the U.S. as well as a small overestimation of the import effect from the U.S. to Washington State may occur.

selected number of alternative values one-by-one or jointly will be tested. However, given that these methods require either a still very high computational burden (Gaussian quadrature) or are inferior with respect to the validity of the results, we follow Abler et al. (1999) and Gilbert (2003) in the pragmatic approach using Monte Carlo simulation.

Hence, in the present study, we specify a prior distribution for the above listed parameters, and sets of parameter values are drawn at random from these distributions assuming that the parameters vary simultaneously and independently. We assume that each parameter is independently normally distributed with mean values as indicated in Table 5 and a standard deviation of 15% of the mean.[13] Given that we treat the exogenous parameters as random, all the model results subsequently are thus also random. We draw 5,000 sets of pseudo-random parameter values from their respective distribution, subsequently solve the model with this parameter vector, and store the simulation results. Each outcome is an independent observation and we can estimate the expected outcome (mean value), sensitivity of that outcome (standard deviation) and significance (t-value) of each outcome variable.

Table 5 Initial exogenous parameter vector

Parameter	**Mean-value** μ	**Standard deviation** σ	*Range of variation (+/- 3σ) in Monte Carlo drawings assuming a normal distribution*
Elasticity of capital-labor substitution	0.99	0.15	0.54 – 1.44
Elasticity of transformation between domestic and foreign destination (CET)	2	0.30	1.1 – 2.9
Elasticity of substitution between domestic output and imports (Armington)	1.9 to 5.0	0.29 to 0.75	1.01 – 2.76 to 2.75 – 7.25
Elasticity of demand of world export function (CED)	-2	0.30	-1.1 - -2.9
Income elasticity	1	0.15	0.55 – 1.45

Note: Armington elasticities are commodity specific.

Source: Own compilation.

[13] In the choice of these values we follow Gilbert (2003). The advantage of this specification lies in the fact that virtually all variation will lie within 50% of the mean in either direction.

3.4 Results

The result section is divided into two parts. First, a brief overview on the impact of tariff reduction in the U.S. model is given. Afterwards, a more detailed presentation of the regional impact of trade liberalization under the two different scenarios is provided. All following tables present changes from the baseline values for selected variables. As indicated before, all values are the mean outcomes of the respective model variables from the 5,000 model repetitions in each scenario. Standard deviations[14] for each mean outcome are reported in italic and a star behind the variable indicates that it is significantly different from zero at the 5% level. Most mean outcomes are robust with respect to variation in the exogenous parameter values and only small standard deviations of the results can be observed. This indicates that magnitude and sign of the simulated results are rather reliable under the given model specifications. In Appendix 6.3, an overview is given for selected variables on the variation in model variables under different drawings from the exogenous parameter vector.

3.4.1 U.S. model

As expected, the liberalization of the trade regime brings a stimulation of imports by around +1.1% - +1.5% for the overall U.S. economy in the two scenarios (Table 6). Individual sector import stimulation is much higher as can be seen in Table 7. The increased import volume affects the average price level of composite demand (-0.002%) and slightly stimulates demand (-0.08% - +0.87%). Given the fixed external current account balance, the import increase makes an exchange rate adjustment necessary. We observe a slight real devaluation of the domestic currency (+3.1% - +3.7%) which induces an increase in exports by around +3.2% - +4.3%. The sector specific effect of this exchange rate adjustment is displayed in Table 8 for the most export dependent products. On the factor markets we observe a small increase in factor returns. In the second scenario where total employment is allowed to adjust, we observe a slight stimulation of the job market with a plus in employment of +1.2% or 1.1 million new jobs created. These jobs are mainly created in the export oriented sectors as well as the

[14] Not reported in this draft version.

service industries. This positive demand for services results mainly from the increase in equivalent variation, i.e. household income, which is with an average +$178 - $649 positive across all household categories (not presented here).

Table 6 Macroeconomic and factor market changes: U.S. model

	Scenario 1	Scenario 2
Savings/Investment balance		
Savings	-2.48% *	-
CPI	-	0.09% *
External balance		
Exchange rate	3.09% *	3.69% *
Imports	1.11% *	1.49% *
Exports	3.15% *	4.30% *
Factor markets		
Labor		
Factor return	0.32% *	1.31% *
Wage rate	0.23% *	-
Total employment	-	1.20% * (+1,994,100 *)
Capital		
Factor return	0.26% *	1.26% *
Interest rate	0.26% *	0.70% *
Total capital demand	-	0.56% *
Total demand	-0.08%	0.87%
GDP at market costs	0.3% * (+ $33,289 *)	1.29% * (+ $142,013 *)
Equivalent variation	$18,861 *	$68,525 *

Source: Own calculations.

In total, the value added of the economy (GDP at market costs), is positive in both scenarios (+0.3% - +1.3%) where the gains result mainly from increased factor returns and household income, and a slight decrease in the composite demand price level. The overall picture under the two macroeconomic scenarios leads to the conclusion that the

neoclassical type, short term closure allows for less adjustment of the economy to the changes in the trade pattern compared to the more flexible specification.[15]

The following tables contain a more detailed sector specific breakdown of the developments on the output, import, and export side. In particular for sweet product manufacturing (sugar) and butter processing (Table 7), the two sectors with the highest import restraints in the benchmark, we observe a strong increase in imports that go along with a significant output reduction. For the other products, we still observe significant import surges, but the impact on domestic production is less pronounced.

Table 7 Sectors with import restraints and the effect of reducing these: U.S. model

					Scenario 1		Scenario 2	
	Tariff rate	Export tax equivalent	Total import restraint	Reduced import restraint	Imports	Output	Imports	Output
	%	%	%	%	%	%	%	%
SWEETS	1.02	107.10	108.12	54.06	857.66 *	-48.68	853.32 *	-47.97
BUTTER	19.46	33.94	53.40	26.70	282.77 *	-8.15	275.98 *	-7.32
CHEESE	11.42	25.65	37.07	18.54	51.29 *	-2.07	50.74 *	-1.35
DRYMLK	4.48	29.21	33.69	16.85	92.80 *	-7.05	90.77 *	-6.25
TEXTILE	10.88	9.93	20.81	10.41	10.33 *	-3.79	10.48 *	-2.76
ICEDES	10.37	8.73	19.10	9.55	36.91 *	0.33 *	34.75 *	1.03 *
FURNIT	6.26	12.45	18.71	9.36	6.14 *	-1.17	6.76 *	-0.03
FLMILK	13.65		13.65	6.83	21.49 *	-0.95	19.51 *	-0.32
CHEMI	11.78		11.78	5.89	5.37 *	-0.56	5.63 *	0.43 *
OILSE	1.79	9.96	11.75	5.88	14.62 *	1.91 *	14.55 *	2.76 *
BUILD	8.45		8.45	4.23	1.87 *	-0.88	2.58 *	0.71 *
FROFOO	4.21		4.21	2.11	-3.35	0.47 *	-4.80	1.22 *

Source: Own calculations.

On the other hand, we have a number of sectors that already display high export shares in the base year and that benefit in the simulation from the enhanced export opportunities due to the currency devaluation (Table 8). For most sectors, we observe export increases in the magnitude of +3% - +6%. For both tables hold, that the second scenario displays generally the less drastic changes.

[15] Findings on exchange rate, GDP, import and export volume are roughly similar to what has been simulated by Dixon et al. (2006) in a very comparable exercise with the USAGE-ITC model.

Table 8 Export dependent sectors: U.S. model

		Scenario 1		Scenario 2	
	Export share	Output	Exports	Output	Exports
	%	%	%	%	%
FISHF	82.74	6.07 *	5.97 *	7.07 *	6.89 *
COTT	57.06	1.76 *	3.84 *	2.83 *	4.77 *
OILSE	36.46	1.91 *	3.89 *	2.76 *	4.58 *
MACHIN	28.09	1.51 *	3.36 *	3.55 *	4.90 *
ELECTR	25.61	2.93 *	4.03 *	4.70 *	5.42 *
TRANM	25.06	1.42 *	3.34 *	2.37 *	4.33 *
GRAIN	19.13	-1.97	1.92 *	-1.15	2.62 *
NUTS	17.75	-2.51	1.57 *	-1.90	2.23 *
FRUIT	17.29	3.47 *	4.65 *	4.64 *	5.66 *
AUTOM	15.13	2.12 *	3.50 *	3.79 *	4.81 *
TRANSS	12.56	0.54 *	3.10 *	1.57 *	4.17 *
FURNIT	12.52	-1.17	2.54 *	-0.03	3.63 *
CHEMI	11.82	-0.56	2.47 *	0.43 *	3.38 *
TEXTILE	11.80	-3.79	2.28 *	-2.76	3.26 *
VEGE	10.57	2.10 *	3.91 *	2.80 *	4.57 *
FLOUR	10.34	0.30 *	3.16 *	1.11 *	4.00 *
DRYMLK	10.28	-7.05	-0.32	-6.25	0.49
SOYOIL	10.03	1.37 *	3.94 *	2.13 *	4.70 *

Source: Own calculations.

3.4.2 Washington State model

The macroeconomic variables in the Washington State model (Table 9) behave similar to the developments observed at national level. However, trade flows show a more pronounced reaction with imports[16] in the short term model even slightly decrease while in the second, more flexible scenario increase by around +2.2%. Exports in both scenarios are stimulated by the currency deflation that took place in the U.S. model and rise around +8.9% - +9%. In order to equilibrate the foreign external balance, strong adjustments in the rest of the world savings have to be made (+152% - +113%). In line with the import development, demand for final consumption and intermediate inputs is slightly decreased in the first scenario (-1.2%), whereas it increases by +2.6% in the second scenario. Even tough we observe a slight increase in factor returns and wages and capital interests, the household gains are apparently not strong enough in the first scenario to trigger strong demand.

[16] In this section, the term "imports" always refer to imports from the rest of the world. If we talk about imports from rest of the U.S. this is explicitly stated.

Table 9 Macroeconomic and factor market changes: Washington State model

	Scenario 1	Scenario 2
Savings/Investment balance		
Investment	-13.07% *	-
CPI	-	0.32% *
External balance		
Imports	-0.52% *	2.20% *
Exports	8.89% *	8.95% *
ROW savings	152.53% *	113.21% *
U.S. savings	-23.18% *	-3.07% *
Factor markets		
Labor		
Factor return	0.34% *	1.12% *
Wage rate	0.23% *	-
Total employment	-	2.48% * (+ 87,890 *)
Capital		
Factor return	0.41% *	2.64% *
Interest rate	0.41% *	1.75% *
Total capital demand	-	0.87% *
Total demand	-1.22%	1.75% *
GDP at market costs	0.38% * (+ $921 *)	2.67% * (+ $6,375 *)
Equivalent variation	$443 *	$2,626 *

Source: Own calculations.

Though aggregate equivalent variation increases by +$443 million, the distribution across the household categories shows (Table 10) that gains per household are very low with $0 - $10 dollars in the first scenario (compared to $1 - $63 in the second scenario).

Table 10 Equivalent variation for household classes: Washington State model

		< 10K	10-15K	15-25K	25-35K	35-50K
	Households (#)	10,067,027	6,657,228	13,536,965	13,519,242	17,446,272
Scen. 1	Change in equivalent var. (Mill $)	3.79 *	8.22 *	23.42 *	30.43 *	63.00 *
	Per household ($)	0.38	1.23	1.73	2.25	3.61
Scen. 2	Change in equivalent var. (Mill $)	7.13 *	34.73 *	119.06 *	160.85 *	364.21 *
	Per household ($)	0.71	5.22	8.79	11.90	20.88
		50-75K	**75-100K**	**100-150K**	**150K+**	
	Households (#)	20,540,604	10,799,245	8,147,826	4,824,713	
Scen. 1	Change in equivalent var. (Mill $)	109.83 *	80.82 *	74.65 *	48.60 *	
	Per household ($)	5.35	7.48	9.16	10.07	
Scen. 2	Change in equivalent var. (Mill $)	669.08 *	498.15 *	466.78 *	306.23 *	
	Per household ($)	32.57	46.13	57.29	63.47	

Note: Number of households and categories according to IMPLAN.
Source: Own calculations.

Table 11 and Table 12 show the detailed development in the industries with import restraint reduction as well high export shares. Similar to the U.S. developments, we observe a significant to strong increase in imports for most of the industries, with output reducing accordingly. Composite demand reacts not uniformly, but consistent with price developments. Contrary to the U.S. model, no distinction between the two scenarios regarding the absolute size of the changes is possible.

Table 11 Sectors with import restraints and the effect of reducing these: Washington State model

	Scenario 1					
	Imports	Output	Composite demand	Import price	Output price	Composite demand price
	%	%	%	%	%	%
OILSE	4.70 *	-7.43	-0.36	-2.97 e	0.31 *	-0.53
SWEETS	212.92 *	-61.06	22.06 *	-52.64 e	-3.17	-22.92
FROFOO	-0.71 *	2.52 *	0.62 *	0.92 e	0.19 *	0.23 *
FLMILK	7.04 *	-1.34	-1.36	-3.95 e	0.13 *	0.10 *
BUTTER	67.31 *	-11.96	-1.34	-24.43 e	0.32 *	1.01 *
CHEESE	38.74 *	0.70 *	1.43 *	-16.02 e	-0.18	-1.71
DRYMLK	29.41 *	2.30 *	0.06 *	-14.27 e	-0.20	-1.36
ICEDES	13.78 *	0.56 *	0.52 *	-6.75 e	-0.71	-0.75
TEXTILE	7.60 *	-12.80	4.14 *	-7.64 e	-1.39	-5.68
CHEMI	5.48 *	-1.44	-0.36	-2.98 e	0.96 *	0.12 *
BUILD	-2.25 *	-2.28	-4.42	-1.26 e	0.38 *	-0.11
FURNIT	5.91 *	-12.30	-0.60	-6.55 e	-0.02	-2.77
	Scenario 2					
	Imports	Output	Composite demand	Import price	Output price	Composite demand price
	%	%	%	%	%	%
OILSE	5.88 *	-6.42	1.15 *	-2.40 e	1.21 *	-0.14
SWEETS	215.30 *	-60.62	23.47 *	-52.36 e	-2.76	-22.62
FROFOO	-0.37	2.94 *	1.76 *	1.51 e	0.58 *	0.44 *
FLMILK	7.49 *	-0.13	-0.12	-3.38 e	0.47 *	0.38 *
BUTTER	68.10 *	-11.06	-0.05	-23.99 e	0.54 *	1.25 *
CHEESE	39.27 *	1.82 *	2.64 *	-15.53 e	0.15 *	-1.52
DRYMLK	30.18 *	3.19 *	1.19 *	-13.77 e	0.37 *	-0.89
ICEDES	14.31 *	1.79 *	1.81 *	-6.21 e	-0.32	-0.46
TEXTILE	8.96 *	-11.28	5.66 *	-7.10 e	-1.01	-5.23
CHEMI	7.18 *	0.29	1.70 *	-2.41 e	1.40 *	0.50 *
BUILD	3.06 *	0.34	1.43 *	-0.69 e	0.73 *	0.22 *
FURNIT	8.82 *	-10.07	2.53 *	-6.01 e	0.29 *	-2.40

Note that import prices are exogenous (e) and the changes here reflect the changes that were simulated in the U.S. model.

Source: Own calculations.

For the export dependent sectors, the picture is more uniform compared to the last table. We observe export increases in the range of 2% - 25%. However, these export increases seem not always be driven by domestic output increases but may also result from a shift in the demand pattern (reduced composite demand). No clear impact distinction between the two scenarios can be made.

Table 12 Export dependent sectors: Washington State model

	Scenario 1						
	Export share	Exports	Output	Composite demand	Export price	Output price	Composite demand price
	%		%	%	%	%	%
FISHF-C	82.74	2.54 *	7.96 *	8.46 *	-0.26 e	0.26 *	2.97 *
ELECTR-C	37.36	6.02 *	2.63 *	-1.29	0.91 e	0.58 *	1.32 *
TRANM-C	26.81	9.49 *	3.57 *	-4.86	0.94 e	0.37 *	0.18 *
MACHIN-C	21.27	8.73 *	3.12 *	-4.86	1.05 e	0.51 *	0.98 *
GRAIN-C	19.12	13.56 *	-0.10	0.23 *	1.61 e	0.29 *	-0.14
AUTOM-C	18.35	8.17 *	4.74 *	-1.55	1.03 e	0.70 *	1.78 *
NUTS-C	17.75	15.03 *	0.12 *	-3.53	1.70 e	0.28 *	-0.15
FRUIT-C	17.29	8.10 *	11.82 *	3.63 *	-0.10 e	0.25 *	0.41 *
TRANSS-C	14.28	10.13 *	2.00 *	0.14 *	1.05 e	0.26 *	0.16 *
TEXTILE-C	11.52	13.39 *	-12.80	4.14 *	1.28 e	-1.39	-5.68
VEGE-C	10.57	8.02 *	4.55 *	1.12 *	0.64 e	0.31 *	0.28 *
DRYMLK-C	10.38	25.37 *	2.30 *	0.06 *	1.88 e	-0.20	-1.36
MEATPRO-C	10.31	9.42 *	1.46 *	0.33 *	1.03 e	0.26 *	0.21 *
FURNIT-C	10.22	7.64 *	-12.30	-0.60	2.09 e	-0.02	-2.77
	Scenario 2						
	Export share	Exports	Output	Composite demand	Export price	Output price	Composite demand price
	%		%	%	%	%	%
FISHF-C	82.74	1.23 *	7.67 *	10.93 *	0.29 e	0.92 *	3.58 *
ELECTR-C	37.36	5.30 *	5.03 *	3.08 *	0.87 e	0.84 *	1.73 *
TRANM-C	26.81	10.62 *	7.54 *	2.95 *	0.93 e	0.64 *	0.69 *
MACHIN-C	21.27	8.08 *	7.51 *	2.31 *	0.84 e	0.78 *	1.41 *
GRAIN-C	19.12	12.40 *	0.24	1.62 *	2.30 e	1.11 *	0.27 *
AUTOM-C	18.35	7.54 *	6.67 *	0.54 *	1.03 e	0.95 *	2.17 *
NUTS-C	17.75	14.73 *	0.44 *	-2.38	2.27 e	0.89 *	0.10 *
FRUIT-C	17.29	8.14 *	14.07 *	4.89 *	0.09 e	0.63 *	0.76 *
TRANSS-C	14.28	9.79 *	3.12 *	2.30 *	1.24 e	0.59 *	0.48 *
TEXTILE-C	11.52	13.39 *	-11.28	5.66 *	1.49 e	-1.01	-5.23
VEGE-C	10.57	7.42 *	5.37 *	2.19 *	1.28 e	1.08 *	0.94 *
DRYMLK-C	10.38	24.81 *	3.19 *	1.19 *	2.32 e	0.37 *	-0.89
MEATPRO-C	10.31	9.67 *	2.48 *	1.54 *	1.32 e	0.63 *	0.53 *
FURNIT-C	10.22	7.80 *	-10.07	2.53 *	2.15 e	0.29 *	-2.40

Note that export prices are exogenous (e) and the changes here reflect the changes that were simulated in the U.S. model.

Source: Own calculations.

Finally, Table 13 shows how the reduction of import restraints affects the demand for primary factors of production (labor and capital) and how they ripple through the economy. Note that only the fifteen sectors with the largest absolute changes in labor return are displayed. In scenario two, market clearance was achieved through job

adjustment (which implies fixed nominal wages). The last column of Table 13 shows the change in the number of full- and part-time jobs.

Table 13 Sector specific changes in factor bill and employment: Washington State model

	Scenario 1				
	Labor		Capital		Employment
	%	absd	%	absd	absd
SWEETS	-69.02	-15.40	-69.02	-22.37	-523.45
OILSE	-42.70	-0.01	-42.70	-0.59	-18.71
WINE	15.76 *	6.67 *	15.77 *	1.89 *	184.86 *
MINING	14.50 *	28.28 *	14.50 *	37.48 *	613.03 *
BUTTER	-13.93	-1.02	-13.93	-0.07	-23.74
SEAFOOD	13.30 *	52.21 *	13.31 *	16.61 *	850.52 *
TEXTILE	-12.95	-30.62	-12.95	-17.96	-927.42
FURNIT	-12.41	-107.80	-12.40	-43.75	-2807.64
FRUIT	12.15 *	67.70 *	12.15 *	44.49 *	2771.49 *
CONST	-8.79	-795.59	-8.79	-373.88	-20970.74
FISHF	8.32 *	23.99 *	8.33 *	43.08 *	826.23 *
METALS	7.99 *	95.92 *	7.99 *	37.15 *	1791.29 *
BREWERY	6.53 *	2.47 *	6.54 *	4.56 *	40.89 *
CANNED	6.27 *	10.07 *	6.28 *	11.30 *	250.80 *
PAPER	5.67 *	77.62 *	5.68 *	47.93 *	1227.93 *
	Scenario 2				
	Labor		Capital		Employment
	%	absd	%	absd	absd
SWEETS	-68.41	-15.26	-68.41	-22.18	-518.37
OILSE	-36.04	-0.01	-36.03	-0.50	-15.75
WINE	18.44 *	7.81 *	18.47 *	2.21 *	219.76 *
MINING	17.64 *	34.42 *	17.67 *	45.66 *	759.00 *
SEAFOOD	15.70 *	61.65 *	15.73 *	19.64 *	1023.08 *
FRUIT	14.84 *	82.73 *	14.87 *	54.43 *	3455.61 *
BUTTER	-13.12	-0.96	-13.10	-0.06	-22.06
TEXTILE	-11.12	-26.28	-11.10	-15.39	-784.64
FURNIT	-9.98	-86.67	-9.96	-35.12	-2223.45
METALS	9.78 *	117.44 *	9.80 *	45.57 *	2259.21 *
FISHF	8.86 *	25.55 *	8.89 *	45.97 *	905.35 *
BREWERY	8.37 *	3.16 *	8.39 *	5.86 *	54.29 *
MACHIN	7.99 *	54.82 *	8.01 *	17.18 *	999.11 *
TRANM	7.74 *	534.42 *	7.77 *	50.50 *	5464.53 *
CANNED	7.63 *	12.25 *	7.65 *	13.77 *	316.62 *

Note: The 15 sectors with the largest absolute changes in the labor returns are displayed. The employment column contains actual number of jobs. In scenario 1, total change in number of jobs adds up to zero, since labor supply was assumed fixed.

absd = absolute difference against benchmark.

Source: Own calculations.

For the sectors that are most impacted by the removal of the import restraints, such as candy production or textile manufacturing, we observe large job displacement. However,

on the other side, we see sectors that benefit significantly, as e.g. the fruit industry, where the currency devaluation boosted exports. In scenario one, we observe the largest employment decrease in the construction sector. This is because construction is considered an investment good that reacts to changes in net income. Given that we only see a very small change in net income, and decreasing savings on state level, the construction sector is negatively impacted in the first scenario. Regarding job creation in second scenario, we see an overall positive effect of around 2.5% increase in jobs, or about 88000 jobs in absolute terms.[17]

Table 14 Value added, employment, and labor earnings supported by imports: Washington State model simulation results

State aggregate		Benchmark	Scenario 1	Scenario 2
Value added supported by imports	*Million $*	5,450	5,327	5,524
Share in total value added	*%*	2.28	2.22	2.26
Employment supported by imports	*# of jobs*	64,477	62,921	65,195
Share in total employment	*%*	1.82	1.78	1.80
Labor earnings supported by imports	*Million $*	3,696	3,562	3,716
Share in total labor earnings	*%*	2.61	2.51	2.55

Industry level		Benchmark	Scenario 1	Scenario 2
Average import share	*%*	8.78	8.82	8.84
Average value added supported by imports	*Million $*	97	95	99
Average employment supported by imports	*Million $*	1,151	1,124	1,164
Average labor earning supported by imports	*Million $*	66	64	66

Source: Own calculations.

The economic indicators calculated in Section 2.2 have been recalculated with the simulated mean outcomes (Table 14). As expected and in line with the macroeconomic results presented in Table 9, we observe a slight decrease of value added, employment, and labor earnings supported by imports in the first scenario, whereas the trend is reversed in the second scenario. Here, we observe an increase in these three indicators, indicating that cheaper imports, in the long-run benefit the economy and are integrated into the intermediate and final consumption structure.

[17] These employment results are in line with the findings in Dixon et al. (2006) who identify a positive but small employment effect (0.214%) for Washington State.

4 Conclusions

This paper focuses on the import side of a regional economy quantifying the economic impact of import levels and trade liberalization. Analyzing the benchmark situation in the year 2003, across all industries in Washington State around $5,500 million of value added are supported by imports as well as around 65,000 jobs. When reducing import barriers in the form of tariffs and quotas, value added of the national and regional economies increase and positive import developments are recorded. However, for the sectors that are most impacted by the reduction of the import restraints, such as candy production or textile manufacturing, we observe large job displacement. Nevertheless, under the given model assumptions, these employment effects are offset by positive job developments in other industries that, due to the currency devaluation, benefit from a more competitive export environment. So in a scenario where the supply of labor was considered to be variable, around 88,000 additional jobs are created.

Several extensions of this study are possible. One would be to move to industry level to analyze how more competitive imports affect the production process and substitution with domestically produced goods. Another way of adding on to this work may be, to have a closer look in the spatial dimension of the impact, i.e. to analyze which regions and counties are positive and negatively affected by trade liberalization.

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6 Appendices

6.1 Sectoring scheme

Coding	Sector	Coding	Sector
OILSE	Oilseed farming	BREWERY	Breweries
GRAIN	Grain farming	WINE	Wineries
SUGARF	Sugarcane and sugar beet farming	PETS	Pet food
VEGE	Vegetables	MINING	Minerals mining
NUTS	Tree nuts	CONST	Construction and Maintenance
FRUIT	Fruit farming	TEXTILE	Textile apparel leather
GREENH	Greenhouse And Nursery Products	WOOD	Wood products
POULTF	Poultry And Eggs	PAPER	Paper manufacturing
OAGR	Other agricultural activites (cattle, other crops, other animals)	CHEMI	Chemical plastic rubber manufacturing
FOREST	Logging and Forest stuff	BUILD	Construction material manufacturing
FISHF	Commercial Fishing	METALS	Metals and metal products
FLOUR	Milled flour products	MACHIN	Machinery and equipment manufacturing
SOYOIL	Soybean processing	ELECTR	Electronics and computer manufacturing
OILFAT	Oils and fats	AUTOM	Automobile manufacturing
SWEETS	Breakfast and sweets	TRANM	Transportation equipment manufacturing
FROFOO	Frozen food manufacturing	FURNIT	Furniture luxury personal items manufacturing
CANNED	Fruit and vegetable canning and drying	TRANSS	Transportation Services
FLMILK	Fluid milk manufacturing	UTILITY	Utilities
BUTTER	Creamery butter manufacturing	FRETAIL	Food Retail trade
CHEESE	Cheese manufacturing	ORETAIL	Other Retail trade
DRYMLK	Dry condensed and evaporated dairy products	COMMUNI	Communication activities
ICEDES	Ice cream and frozen dessert manufacturing	MONEY	Money real estate related services
MEATPRO	Meat processing excluding poultry	PERSONA	Personal services

Coding	Sector	Coding	Sector
POULPRO	Poultry Processing	PROGRA	Computer related services
SEAFOOD	Seafood product preparation and packaging	RESRCH	Consulting and research services
BAKERY	Baked stuff	BUSINESS	Business related support services
SNACKS	Snacks	PUBLIC	Public service
COFFEE	Coffee and tea manufacturing	HEALTH	Health services
OFOOD	Other manufactured food	ARTS	Art sports culture
SOFTD	Soft drink and ice manufacturing	HOTREST	Hospitality services

Source: Own compilation based on IMPLAN sectoring scheme.

6.2 Armington elasticities

Coding	U.S. model	Washington State model	Coding	U.S. model	Washington State model
OILSE	5.0	1.48	CANNED	4.2	0.52
GRAIN	5.0	1.48	POULPRO	2.7	0.52
TOBA	2.4	1.48	SEAFOOD	4.2	0.52
COTT	5.0	1.48	BAKERY	4.2	0.52
SUGARF	5.0	1.48	SNACKS	4.2	0.52
OCROPS	4.4	1.48	OFOOD	4.2	0.52
VEGE	3.9	1.48	BREWERY	3.5	0.52
NUTS	3.9	1.48	WINE	3.5	0.52
FRUIT	3.9	1.48	TOBDIS	3.5	0.52
GREENH	3.9	1.48	PETS	4.2	0.52
CATTLE	3.2	1.48	TEXTILE	2.3	0.63
POULTF	3.2	1.48	CHEMI	2.0	1.34
OANIM	3.2	1.48	METALS	3.5	1.75
OAGR	3.2	1.48	MACHIN	2.2	0.85
FOREST	3.9	1.43	ELECTR	2.6	0.56
FISHF	2.8	1.48	AUTOM	2.7	0.84
SOYOIL	5.0	0.52	TRANM	1.7	0.6
OILFAT	5.0	0.52	TRANSS	1.9	0.5
SUGARM	5.0	0.52	UTILITY	2.6	0.5
FROFOO	5.0	0.52	FRETAIL	1.9	0.5
FLMILK	5.0	0.52	ORETAIL	1.9	0.5
BUTTER	5.0	0.52	COMMUNI	1.9	0.5
CHEESE	2.5	0.52	MONEY	1.9	0.5
DRYMLK	5.0	0.52	PERSONA	1.9	0.5
ICEDES	5.0	0.52	PROGRA	1.9	0.5
MEATPRO	2.7	0.52	RESRCH	1.9	0.5
COFFEE	1.1	0.52	BUSINESS	1.9	0.5
SOFTD	5.0	0.52	PUBLIC	1.9	0.5
MINING	2.0	1.84	HEALTH	1.9	0.5
WOOD	2.6	1.43	ARTS	1.9	0.5
PAPER	4.0	1.18	HOTREST	1.9	0.5
FURNIT	1.2	0.93	CONST	1.9	0.5
FLOUR	4.2	0.52	BUILD	2.0	0.5
SWEETS	4.2	0.52			

Note: U.S. elasticities result from Table 1, 3, 4 of Donnelly et al. (2004). Elasticities for Construction and building are guessed based on the values in the other sectors.

Source: Own compilation based on Donnelly et al. (2004) and Bilgic et al. (2001).

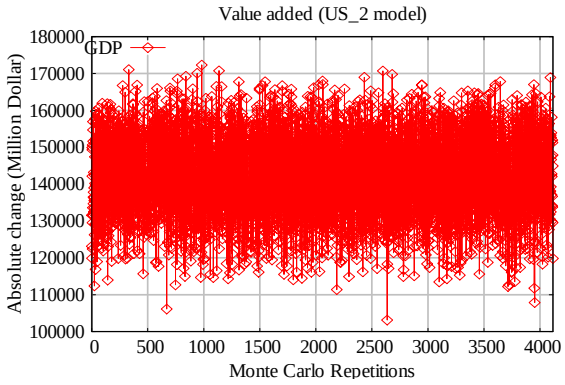
6.3 Variation in model variables under different exogenous parameter assumptions

6.3.1 U.S. model variables – Scenario 2

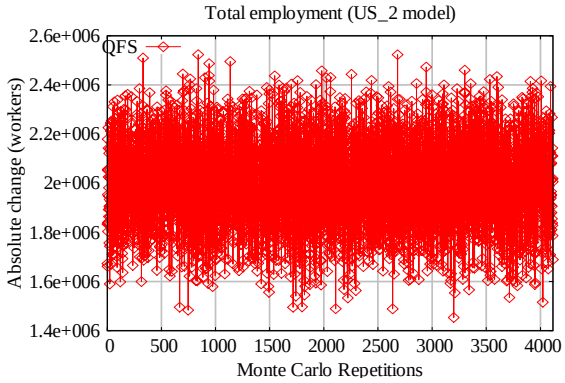
Note: 82.6% of the models have been successfully solved, e.g. around 4,100 outcomes of the each result variable are available.

Source for all figures: Own calculations.

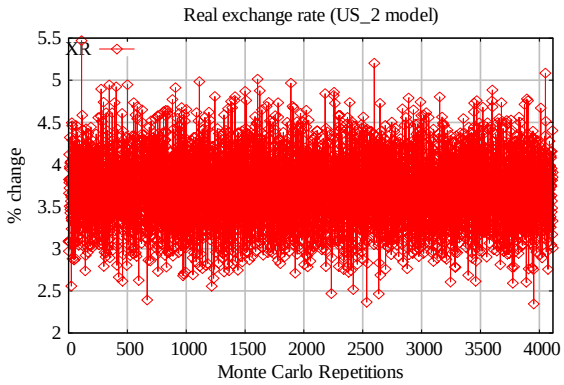
Absolute change in value added



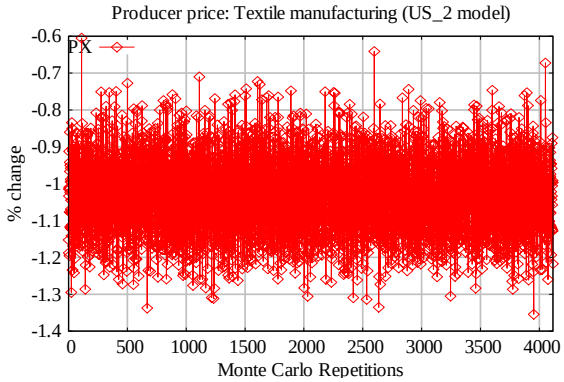
Absolute change in total employment



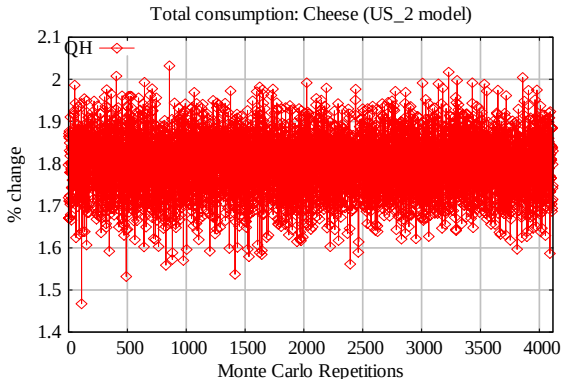
Percentage change in real exchange rate



Percentage change in producer price of textile manufacturing



Percentage change of total final demand for cheese

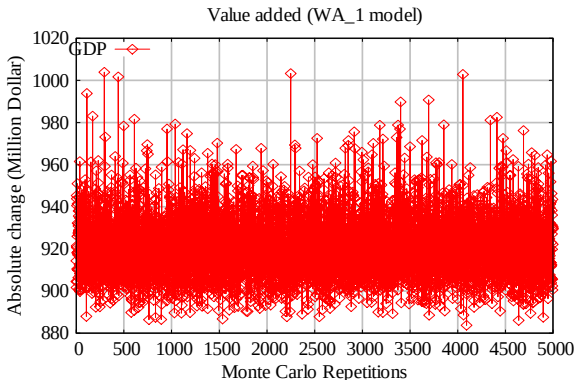


6.3.2 Washington State model variables – Scenario 1

Note: 96.8% of the models have been successfully solved, e.g. around 4,900 outcomes of the each result variable are available.

Source for all figures: Own calculations.

Absolute change in value added



Percentage change in factor return