MACROECONOMIC IMPACTS OF SHUTTING DOWN THE U.S. BORDERS IN RESPONSE TO A SECURITY OR HEALTH THREAT

by

Adam Rose

Garrett Asay

Dan Wei

Center for Risk and Economic Analysis of Terrorism Events (CREATE)
University of Southern California
Los Angeles, CA 90089

Billy Leung

Regional Econometric Models, Inc.
Amherst, MA 01002

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I. INTRODUCTION

Several threats to the United States may raise the consideration of a partial or complete shutdown of our borders to people and goods. Such threats would include a coordinated terrorist attack or an influenza outbreak, and could last anywhere from just a few days to several months. Given that the U.S. economy is highly dependent on international mobility of goods and people, the economic impacts of a partial or total border closure are likely to be significant. Major economic impacts would stem from four factors. First, we import a significant amount of both intermediate and final goods, many of which either cannot be readily replaced or can be replaced only at a significantly higher cost of domestic substitutes. Second, export demand is an important stimulus to our economy, and we may face retaliation in the form of import bans on our goods if we impose restrictions on goods coming in from other countries. Third, international visitors inject a significant amount of spending into the U.S. economy. Fourth, migration provides workers at all skill levels.

We will analyze the impacts of the curtailment of all of these actions using the REMI Economic Simulation Model (REMI, 2006). The analysis is performed through a set of comparative static stimulations to isolate the impact of each aspect of a curtailment, as well as a comprehensive simulation to identify interaction effects. The extreme nature of the shock to the U.S. economy posed a major challenge to the REMI Model, which is typically applied to marginal policy changes. We explain the several major refinements we made to enable the model to be used for a policy simulation of a complete shutdown of the U.S. borders to goods and people. In various stages of the simulations, we analyzed the effects of resilient responses to the potential shock at both individual business and market levels. These include use of inventories, excess capacity, conservation, domestic input substitution in response to price changes, redirecting exports to domestic input needs, and rescheduling lost production to a later date (Rose 2007).

Our overall results indicate that a complete shutdown of the U.S. borders to people and goods for one year would result in a loss of GDP of about $1.4 trillion (2006$) and a loss of employment of more than 21 million. Most analysts, however, surmise that a shutdown is likely only to be implemented for three to six months, so these figures should be pro-rated accordingly. Moreover, for a policy decision, the costs of the shutdown need to be carefully weighed against the expected value of its benefits (avoided terrorist damage or health effects).

II. BACKGROUND

Only a limited number of studies have expressly analyzed the effects of major shut downs of the U.S. border to goods and/or people. The most comprehensive is that of Gordon et al. (2007), which parallels the analysis in this paper. That study used a sophisticated input-output approach to the problem, based on a 47-sector U.S. Table (MIG, 2006), including refinements to allow for price responses and supply-side multiplier effects, and their National Interstate Economic Model (NIEMO), capable of analyzing the impacts on all fifty states (Gordon et al., 2006). The simulations were performed in a comparative static mode for the following border closure components: imports, exports, air travel, in-migration (both legal and illegal), and cross-border shopping. Some forms of resilience to this shock were modeled, such as the diversion of exports to replace imports and the substitution of telecommunications for air travel. The major findings of the study are a projected reduction in U.S. GDP of $1.4 trillion (in 2001$), with international trade aspects accounting for about 95 percent of the total. This contrasts with our estimates of $1.2 to $1.8 trillion losses in GDP (2000$), 92 percent and 90 percent of which are trade-related, respectively. Though there are differences in some of the lesser types of factors modeled (e.g., we did not include cross-border shopping nor telecommunications substitution for international air travel, and Gordon et al. did not include utilization of excess capacity as we did), the data inputs were otherwise very similar, and the differences are mainly attributable to the type of model used. For example, an inherently linear model, such as I-O, is more likely to lead to higher estimates of a shock to the system than a non-linear model, in part because it stunts several types of adjustments. However, this difference wanes as the shutdown period decreases.

A closure of imports could involve restrictions on energy supplies, including oil and natural gas. While these restrictions are difficult to model, past oil shocks could provide some insights. The first contemporary oil price shock was instigated by the Arab country members of the Organization of Petroleum Exporting Countries (OPEC) in the form of an embargo that lasted from September to December 1973, during which these members reduced their production by 4.2 million barrels per day. With this reduction in quantity, price nearly tripled. There was also a second, larger, decrease in production from 1979 to 1980 during the Iranian Revolution. In general the impacts of the embargo are summarized in two ways (Greene et al., 1998). First, there is a transfer of national wealth to oil producing states. Second, there is a loss in potential GDP and accompanying unemployment increases. Greene et al. (1998) also use consumer and producer surplus models to estimate the impacts of a hypothetical 2005, 2- year reduction in oil output similar to the prior oil embargo shocks. They find a range of values from $720 billion to $1.14 trillion.[1] However, if the world is able to substantially increase short-term elasticity of supply and demand, these shocks can be cut by more than half. We should note that this case is not directly comparable to a complete shutdown of imports, because imports to the U.S. were offset somewhat by imports from non-Arab oil producing countries. Also, most of the impacts manifested themselves through increases in price, a combination of OPEC demonstrating its market power, an increase in tension in the oil markets, and irrational consumer behavior (e.g., hoarding of gasoline). A shutdown of all imports to the U.S., is similar, however, in that the market adjustment to the shortages would generally increase the price of domestic substitutes.

Other studies have empirically estimated the elasticity of oil price to GDP growth and inflation within the U.S. (Hunt et al., 2001; Dalsgaard and Ricardson, 2001; Jimenez-Rodriguez and Sanchez 2004; Abeysinghe 2001; and Ciscar et al., 2004) These estimates range from 0 to -0.17 percent change in GDP for a 10 percent permanent increase in oil prices (Schneider, 2004). Further, a 10 percent permanent increase in oil prices was associated with a 0.02 to 0.18 percent increase in inflation. Ciscar et al. (2004) use a Computable General Equilibrium model and find that the 10 percent permanent increase leads to a 0.09 percent decline in GDP.

III. REMI MODEL ANALYSIS

The Regional Economic Models, Inc. (REMI, 2006) Economic Simulation Model is the most widely used, packaged regional econometric model in the U.S.. At its core is an input-output (I-O) model, and choosing all the default options replicates a basic I-O analysis. However, the full REMI model includes many of the best features of I-O and incorporates non-linearities, substitution, and prices, as well as a forecasting ability. The overall structure is that of a macroeconometric model, but with features of a market equilibrium model for the labor sector, as well as features of the new economic geography related to interregional competitiveness. It is empirically calibrated on the basis of region-specific data. The reader is referred to Treyz (1993) and REMI (2006) for more details.

Unfortunately, the REMI model has several limitations in its application to estimating the economic impacts of a complete border closure. It should be noted, however, that practically all models would have trouble yielding credible estimates of such an extreme policy as this. In addition, REMI is generally oriented toward regional analysis within the U.S., as opposed to international analysis, and thus it has limited international trade features. Therefore, REMI does not include any explicit balance of payments or interest rate variables, nor does it measure international competitiveness. Moreover, it omits any explicit constraints on some major factors of production.[2] The model does not contain some key "price feedback loops" as well.

For example, an initial application of REMI yielded a positive economic impact of reducing U.S. imports to zero, because it held demand relatively constant and automatically simulated making up the shortfall by increasing domestic production and employment by more than 25 percent. It was necessary, therefore, to explicitly incorporate labor force constraints and a cost penalty for higher cost domestic production (net of transport cost savings) into the analysis. Different refinements were needed for other types of closures, as will be discussed below.

IV. SIMULATIONS AND COMPARATIVE STATIC RESULTS

A. Shutdown of Imports

1. Major Assumptions and Simulation Results

This simulation estimates the economic impacts on the U.S. economy of a one-year halt in all imports from the rest of the world in response to an external threat to the U.S. The simulation is run in a *comparative static* mode, meaning that this shock is analyzed in isolation, with business as usual proceeding in the rest of the economy with respect to exports, travel and migration. In 2005, U.S. imports reached $1.53 trillion (2000$), or 13.3% of GDP. Hence, we would expect an import ban to have significant impacts.

An initial application of REMI for a complete shutdown of all imports yielded high *positive* economic impacts for the U.S. The major reason for this counter-intuitive outcome is that the REMI model automatically offsets all import losses by domestic production increases. In actuality, given labor and production capacity limitations and imperfect substitution in many sectors, it is impossible to offset all import losses by increasing domestic production. In many sectors, domestic goods substitution can only be achieved at a relatively higher cost (e.g., Oil/Gas Extraction and Apparel Manufacturing, the majority of whose U.S. domestic consumption is produced abroad).

Therefore, it is necessary to incorporate constraints such as production cost differentials into the REMI model to reflect the difficulty in expanding domestic production. We first assume that excess capacity can be utilized to make up part of the import shortfalls. Of course, not all excess capacity can be accessed due to reasons such as maintenance downtime. However, we believe it is reasonable to assume that excess capacity of 20% can be accessed in our simulated case (U.S. Department of Commerce, 2006). We also assume that the utilization of excess capacity at this level will not result in noticeable production cost increases. Next we calculated the gap of import replacement for each REMI sector after the use of excess capacity. For those sectors that have a remaining import replacement gap, we incorporate a cost penalty into the model to reflect higher production cost domestic producers will face for further expansion of their production.

Table 1. Impacts of a Complete Import Shutdown in the U.S. for One Year
(assumes import replacement after the use of excess capacity at the level of 20% in each sector)

	Difference from Baseline	
Economic Indicator[a]	Level	Percent
Total Employment (thousands)	-1.90E+04	-10.99%
Total GDP (billion 2000$)	-666.3	-5.82%
Personal Income (billion nominal $)	-427.3	-4.14%
PCE-Price Index	32.33	29.02%
Real Disposable Personal Income (billion 2000$)	-2087	-25.54%
Demand (billion 2000$)	-2162	-11.89%
Output (billion 2000$)	-812.4	-4.60%
Labor Productivity Index	11.61	9.64%
Relative Delivered Price Index	0.4263	42.58%
Relative Cost of Production Index	0.3977	39.72%
Imports from Rest of World (billion 2000$)	-1525	-100.00%
Self Supply (billion 2000$)	-637.2	-3.82%
Exports to Rest of World (billion 2000$)	-175.3	-17.72%
Population (thousand)	0.5625	0.00%
Labor Force (thousand)	-2187	-1.47%

[a] All dollar estimates in billion constant Year 2000 terms unless otherwise noted.

Note that there is another likely adjustment to an import shock, and that is the diversion of exports as replacements. This strategy could be implemented whether U.S. exports were embargoed by other countries or not. It will be discussed at greater length in the following sub-section (Section V, sub-section A).

Major economic impacts of an import shutdown with loss replacement by the use of excess capacity include: a) a reduction of 666.3 billion in GDP, or a 5.8% decline from the baseline level in the year 2005; b) a decrease in employment of about 19 million jobs, or a reduction of around 11%; c) a decrease in total personal income of $427.3 billion, or 4.1%. These results indicate that a closure of all imports will cause significant negative impacts to the U.S. economy. Though the increased demand for domestic substitutes would stimulate the economy, the production cost increase more than offsets the positive impacts (see Table 1 for detailed simulation results).

2. Simulation Method and Data Inputs

Before running the REMI simulation, policy variables that represent the direct impacts of the simulated events are determined. To simulate a complete shutdown of the U.S. border to imports, the share of “Imports from Rest of World” for each sector is reduced by 100 percent for each of the relevant 66 REMI sectors. To incorporate the domestic production cost increases, we also changed the “Production Cost” variable for each REMI sector. Appendix A describes the methods and assumptions we followed to obtain the vector of sectoral production cost increases.

B. Shutdown of Exports

1. Results and Major Assumptions

This simulation estimates the economic impact on the U.S. of a one year border cessation of all its exports to rest of the world. The simulation was among the most straightforward of all to run with the REMI model, requiring only a constraint that exports of all sectors equal zero. This simply represents a downward shift in a major element of final demand in the model.

Table 2 presents major economic impacts on the U.S. economy: a) GDP declines about $1.36 trillion, or a decrease of 11.9% from the baseline level in 2005; b) employment is reduced by about 17.2 million jobs, or a decrease of 9.9%; and c) total personal income decreases $0.79 trillion, or 7.6%.

The simulation results indicate that the negative impacts on the U.S. economy from terminating the exports to rest of the world are sizeable. The contraction in GDP results from the loss of demand from the international market, which in turn reduces employment opportunities and total personal income. The simulation results also show a decrease in imports of nearly 12% when exports are completely shut down. The major reason could be that a decrease in production of exports reduces the demand for various production inputs from both domestic and international suppliers.

2. Simulation Method and Data Inputs

Again, policy variables that affect the direct impacts of the simulated events are first specified. In this case, “Industry Sales / International Exports (amount)” for each of the 66 REMI sectors are used to simulate the complete shutdown of exports to rest of the world. The 2005 base year export values are obtained from the REMI "control model" for each sector and are used as the initial input data. Several iterations are required, however, to achieve an equilibrium where all exports are zeroed out.

Table 2. Impacts of a Complete Export Shutdown for the U.S. for One Year

	Difference from Baseline	
Economic Indicator[a]	Level	Percent
Total Employment (thousands)	-1.72E+04	-9.92%
Total GDP (billion 2000$)	-1360	-11.89%
Personal Income (billion nominal $)	-787	-7.63%
PCE-Price Index	-0.817	-0.73%
Real Disposable Personal Income (billion 2000$)	-544.	-6.66%
Demand (billion 2000$)	-1832	-10.07%
Output (billion 2000$)	-2603	-14.74%
Labor Productivity Index	-4.12	-3.42%
Relative Delivered Price Index	-0.007752	-0.77%
Relative Cost of Production Index	-0.007759	-0.78%
Imports from Rest of World (billion 2000$)	-182	-11.94%
Self Supply (billion 2000$)	-1649	-9.90%
Exports to Rest of World (billion 2000$)	2.624	0.27%
Exogenous Industry Sales (billion 2000$)[b]	-956.2	n/a
Population (thousand)	-0.06	0.00%
Labor Force (thousand)	-1966	-1.32%

[a] All dollar estimates in constant (fixed) terms unless otherwise noted.
[b] "Exogenous Industry Sales" is used as the policy variable to zero out exports in the REMI model. The sum of "Exogenous Industry Sales" and "Exports to Rest of World" in Table 2 is -953.6 billion, which is equivalent to 97% reduction in total exports in 2005.

C. Shutdown of International Travel

1. Results and Major Assumptions

Assuming that the United States cuts off all international travel (outbound and inbound), we estimate economic impacts to be: a loss of about $128 billion in GDP and a reduction in employment of about 2.5 million jobs. We believe these results to be consistent with theory, in that a drop in international travel reduces demand for U.S. airlines as well as services and goods within the United States. This should reduce GDP as well as employment. A mitigating effect that we modeled is a change in destinations by U.S. residents, e.g., substituting domestic for foreign visitors. In order to capture this effect we assumed that those who would have traveled outside the U.S., instead traveled within the country. This slightly offsetting effect reduces the overall economic impact associated with the loss of international travel to the US.[3]

2. Inputs and Other Assumptions

Our input data comes from two sources: The Travel Industry Association of America (TIAA) (2002) and the Bureau of Transportation Statistics (BTS) (2005). The first source provides data on levels of tourism and total expenditure by international tourists within the United States, as well as a regional breakdown of expenditure statistics. Unfortunately, the statistics provided are for 2000, while the REMI base year is 2005. In order to scale the level of international travel from 2000 to 2005, we compared the number of international flights in 2000 to 2005 using the BTS, Airline Transportation Statistics, and found that international travel (inbound and outbound) grew by about 5.1% from 2000 to 2005. We then scaled the statistics provided by the TIAA by this growth rate to yield an estimate of 2005 expenditures (see Appendix B for detailed computations).

Finally, TIAA breaks the U.S. up into nine regions: New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific. Unfortunately, no state designation was provided for each region, so we assumed that the Pacific, South, Middle Atlantic, and New England regions would comprise the border states and the West North Central, East South Central, West South Central, and Mountain regions would comprise the rest of the United States. With this bifurcation, border states accounted for 79.3% of total spending of international travelers. For domestic travelers, this number is lower, with 55.90% of spending in Border States and the rest in the interior states.

D. Shutdown of Immigration

1. Results and Major Assumptions

a. Documented Migrant Simulation

Immigration is a politically charged component of the U.S. economy. Here we attempt to ignore politics and focus on some of the economic impacts associated with immigration, henceforth referred to as migration. First, documented migration provides the U.S. with skilled and unskilled labor, and this is reflected by the REMI model through its “international migrant” policy variable. In 2005, REMI predicted that roughly one million international migrants entered the U.S.. To implement this in REMI, we simply reduced documented international migration by one million workers. The results of this scenario were a drop in employment of 277.2 thousand, and a $17.7 billion reduction in GDP (see Table 4).

Table 3. Impacts of Complete Shutdown of International Travel with Domestic Substitution

	Difference from Baseline	
Economic Indicator[a]	Level	Percent
Total Employment (thousands)	-2,497	-1.44%
Total GRP (billion 2000$)	-133	-1.16%
Personal Income (Billion Nominal $)	-80	-0.78%
PCE-Price Index	-0.12	-0.11%
Real Disp Personal Income (billion 2000$)	-52	-0.63%
Demand (billion 2000$)	-25	-1.40%
Output (billion 2000$)	-23	-1.32%
Labor Productivity Index	0.47	0.39%
Relative Delivered Price Index	0	-0.12%
Relative Cost of Production Index	0	-0.12%
Imports from Rest of World (billion 2000$)	-21	-1.37%
Self Supply (billion 2000$)	-233	-1.40%
Exports to Rest of World (billion 2000$)	0.39	0.04%
Population (thousand)	-0.13	0.00%
Labor Force (thousand)	-284	-0.19%

[a]All dollar estimates in billion constant Year 2000 terms unless otherwise noted.

Figure 1 depicts how our policy simulation is incorporated into the REMI model. Circles, dotted lines, and shaded text depict our modifications and inputs into the REMI model. Starting with documented migration, we adjusted the international migration policy variables that feed into the "demographic block" of the REMI model.[4] Once this change is made to the demographic block, it is translated to the other REMI blocks through the functional relationships represented by the solid arrows in Figure 1. Eventually, linkages in the model (again represented by the solid arrows) translate our changes in migration (represented by the dashed arrows) to changes in output.

b. Undocumented Migrant Simulation

While documented international labor was relatively easy to implement in the REMI model, undocumented migration required some different assumptions. From an economic perspective, undocumented labor benefits the economy through lower wages. If the US government is able to reduce or cut-off this source of labor, we assumed that producers will hire documented labor, thereby paying a higher wage for services with two macroeconomic effects: a) demand is stimulated because labor has more income and b) production costs increase as wages increase.

Figure 1. Migration linkages (ovals, dashed lines and shaded text denote inputs and modifications to REMI)

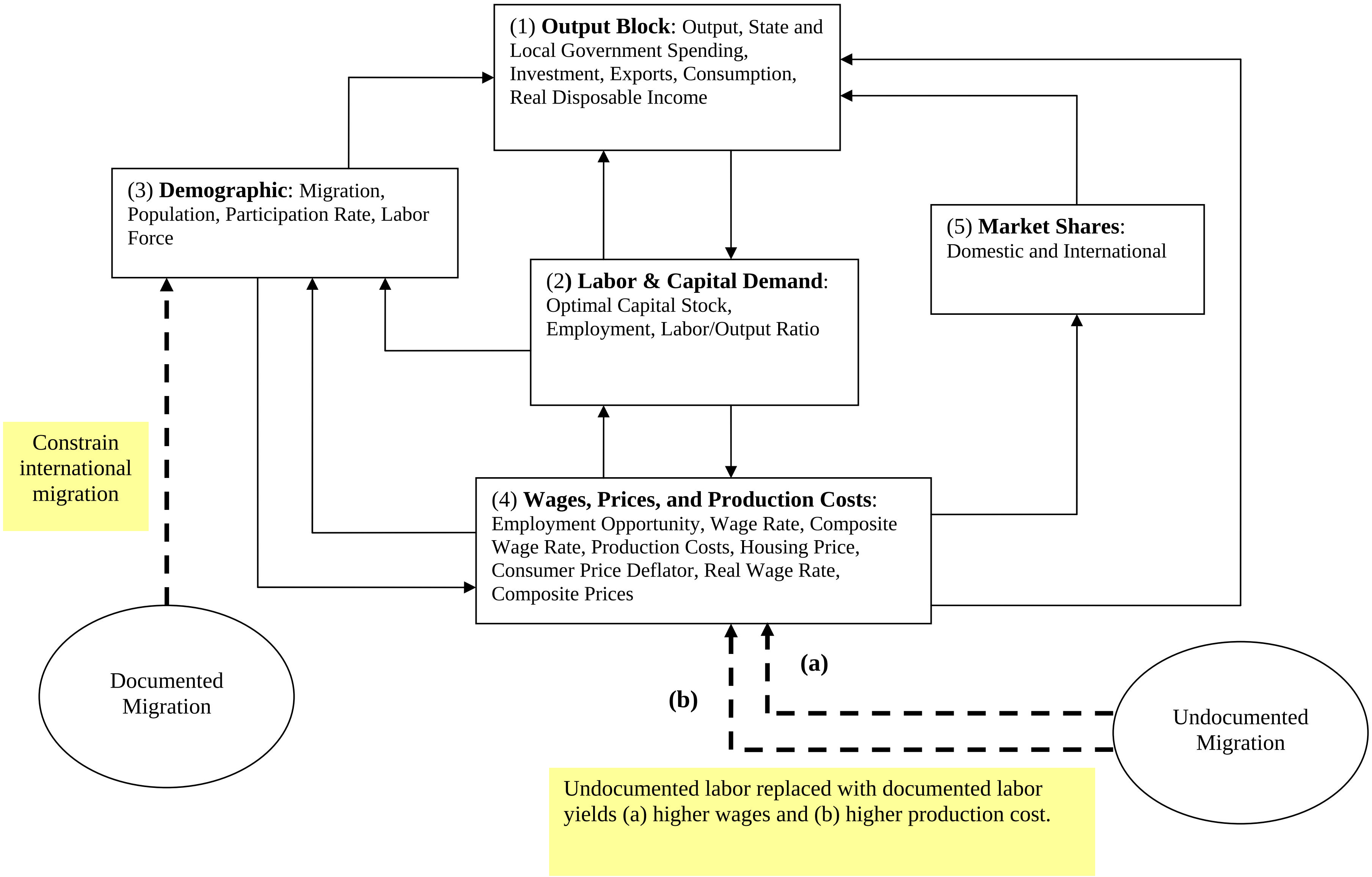


Table 4. Impacts of Shutdown of Documented and Undocumented Migrants in 2005

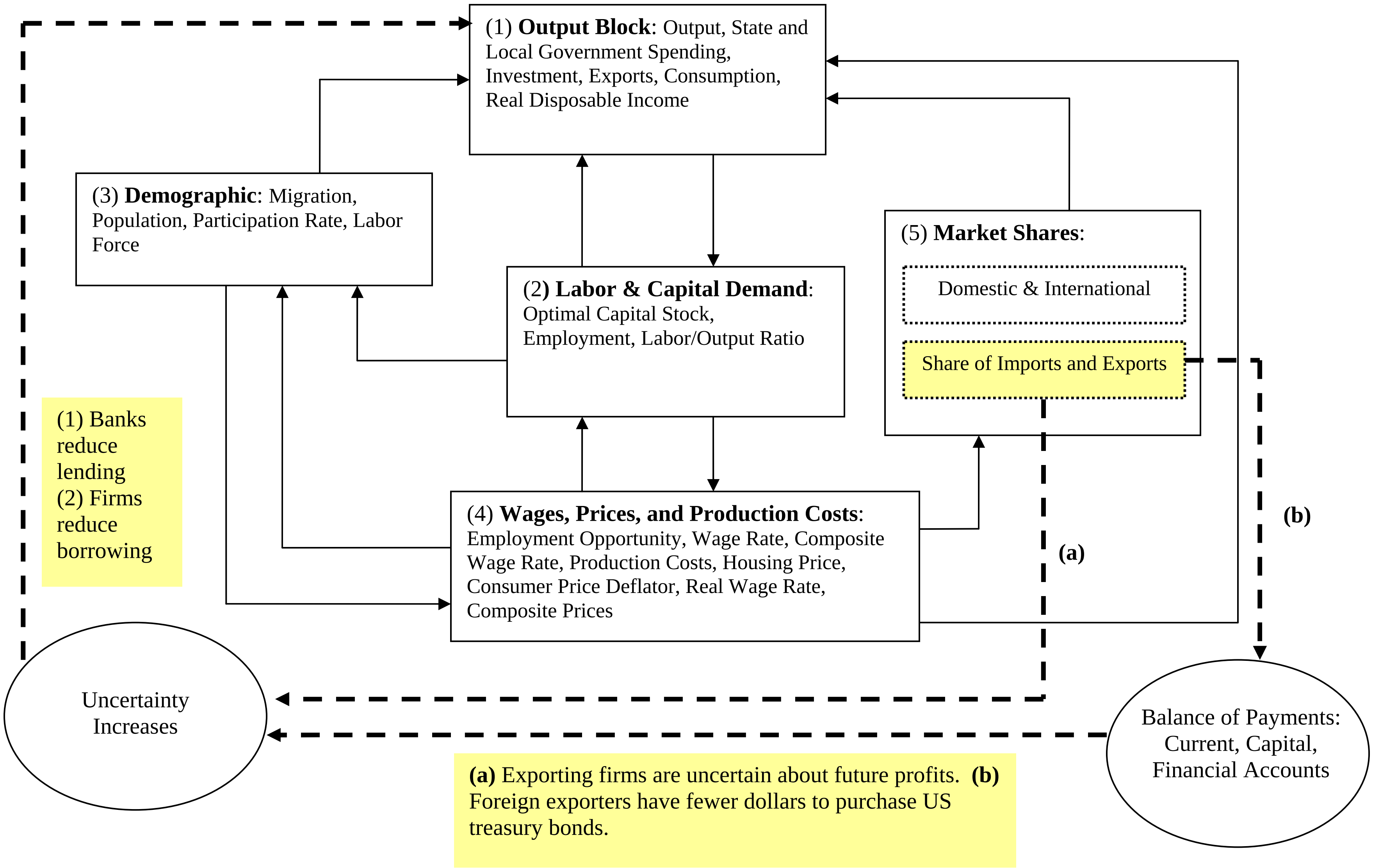
	Documented Migration Difference from Baseline		Undocumented Migration Difference from Baseline	
Economic Indicator[a]	Level	Percent	Level	Percent
Total Employment (thousands)	-277	-0.16%	-394	-0.23%
Total GDP (billion 2000$)	-18	-0.16%	-24	-0.21%
Personal Income (billion nominal $)	-17	-0.17%	-5	-0.05%
PCE-Price Index	0.02	0.02%	0.27	0.24%
Real Disposable Personal Income (billion 2000$)	-15	-0.19%	-23	-0.29%
Demand (billion 2000$)	-27	-0.15%	-46	-0.25%
Output (billion 2000$)	-26	-0.15%	-44	-0.25%
Labor Productivity Index	0	0.00%	0.02	0.02%
Relative Delivered Price Index	0	0.02%	0	0.25%
Relative Cost of Production Index	0	0.02%	0	0.25%
Imports from Rest of World (billion 2000$)	-2	-0.11%	-2	-0.16%
Self Supply (billion 2000$)	-26	-0.15%	-43	-0.26%
Exports to Rest of World (billion 2000$)	-0.06	-0.01%	-0.54	-0.06%
Population (thousand)	-1,012	-0.34%	-0.03	0.00%
Labor Force (thousand)	-548	-0.37%	-44	-0.03%

[a]All dollar estimates in billion constant Year 2000 terms unless otherwise noted.

Looking at Figure 1, two dashed arrows lead from the circle encompassing undocumented migration towards block number 4. The REMI model interprets an increase in wages as an increase in demand (the first effect we are modeling), but not necessarily an increase in production prices. For this reason we had to apply two sets of policy changes to the model, represented by the two dashed lines. The first policy change represents the increase in demand associated with replacing undocumented labor with documented labor. The second policy change represents the increase in production costs associated with replacing undocumented labor with documented labor.

To implement these changes, we made three major assumptions. First, we assume that 850,000 undocumented migrants must be replaced by documented labor. The number of undocumented migrants is based on the research by Passel (2006).[5] Second and third, we assume that undocumented labor earns about $330 per week (Passel 2006) and documented labor earns about $609 dollars per week (Census 2005, average wage of a high school graduate). Given these assumptions we find that a complete border closure is expected to reduce employment by 393 thousand jobs and GDP by $23 billion (see Table 4, "Undocumented Migration" for more detailed results).

Figure 2. Investment linkages (ovals, dashed lines and shaded text denote inputs and modifications to REMI model)



V. TOTAL IMPACTS

A. Shutdown of All Cross-border Activities--Simple Summation

In this and next section, we examine the total effects of shutting down all cross-border activities. Simple summations of the economic impacts of the four individual closure simulations presented in Sections IVA to IVD are summarized in Table 5. The impact summations show that the total effects of a border closure to both goods and people results in a reduction in GDP of about $2.2 trillion (or about 19%) and a reduction in employment of about 39.4 million jobs (or about 23%).

In a simultaneous shutdown of all cross-border activities, it is legitimate to assume export substitution for imports, i.e., goods originally intended for export would be diverted to substitute for the lack of corresponding imports. A country the size of the U.S. engages in a great deal of international "cross-hauling" (i.e., import and export of the same kinds of goods in the same period). When the U.S. border is shut down for international trade, it is reasonable to assume that the exporters would instead sell their goods to the importers as middlemen or directly to domestic customers. As an intermediate step to a simultaneous shutdown simulation that will be presented in next Section, we present a second version of simple summation which incorporates the consideration of exports substitution of imports. Recall that in Section A, we utilized a vector of sectoral production cost increase to reflect the difficulty in further expansion of domestic production beyond 20% excess capacity. Under an Import/Export substitution case, the vector of sectoral production cost change is adjusted downward because the import replacement gap for most sectors is reduced with export substitution.[6] The second version of simple summation of individual closures' impacts which is presented in Table 6 incorporates the effect of export substitution. The differences in economic impacts are reflected in the column of "Imports" and the "Sum" column. From the "Sum" column, we see that when we consider the resilience adjustment of export substitution, the overall negative impacts to the economy decrease. The second version of simple summation indicates a loss in GDP of $1.8 trillion and a reduction in employment of 33.5 million jobs.

Table 5. Simple Summation of Elements of Complete Shutdown of U.S. Borders--Version I (No Export Diversion)

	Difference from Baseline Level					
Economic Indicator[a]	Imports	Exports	Travel	Documented Migrants	Undocumented Migrants	Sum
Total Employment (thousands)	-19,040	-17,200	-2,497	-277	-394	-39,408
Total GDP (billion 2000$)	-666	-1,360	-133	-18	-24	-2,202.30
Personal Income (billion nominal $)	-427.30	-787	-80	-17	-5	-1,317
PCE-Price Index	32.33	-0.82	-0.12	0.02	0.27	32
Real Disposable Personal Income (billion 2000$)	-2,087	-544	-52	-15	-23	-2,721
Demand (billion 2000$)	-2,162	-1,832	-254	-27	-46	-4,321
Output (billion 2000$)	-812	-2,603	-233	-26	-44	-3,718
Labor Productivity Index	11.61	-4.12	0.47	0.00	0.02	7.98
Relative Delivered Price Index	0.43	-0.01	0.00	0.00	0.00	0.42
Relative Cost of Production Index	0.40	-0.01	0.00	0.00	0.00	0.39
Imports from Rest of World (billion 2000$)	-1,525	-182	-21	-2	-2	-1,732
Self Supply (billion 2000$)	-637	-1,649	-233	-26	-4	-2,588
Exports to Rest of World (billion 2000$)	-175	3	0.39	-0.06	-0.54	-173
Population (thousand)	0.56	-0.06	-0.13	-1,012	-0.03	-1,012
Labor Force (thousand)	-2,187	-1,966	-284	-548	-44	-5,030

[a]All dollar estimates in constant (fixed) terms unless otherwise noted.

Table 6. Simple Summation of Elements of a Complete Shutdown of U.S. Borders--Version II (Export Diversion)

	Difference from Baseline Level					
Economic Indicator[a]	Imports	Exports	Travel	Documented Migrants	Undocumented Migrants	Sum
Total Employment (thousands)	-13,110.00	-17,200	-2,497	-277	-394	-33,478
Total GDP (billion 2000$)	-278	-1,360	-133	-18	-24	-1,814
Personal Income (billion nominal $)	-200	-787	-80	-17	-5	-1,090
PCE-Price Index	27	-0.82	-0.12	0.02	0.27	26
Real Disposable Personal Income (billion 2000$)	-1,717	-544	-52	-15	-23	-2,351
Demand (billion 2000$)	-1,464	-1,832	-254	-27	-46	-3,623
Output (billion 2000$)	-80	-2,603	-232.50	-26	-44	-2,985
Labor Productivity Index	11	-4	0.47	0.00	0.02	7.60
Relative Delivered Price Index	0.35	-0.01	0.00	0.00	0.00	0.34
Relative Cost of Production Index	0.33	-0.01	0.00	0.00	0.00	0.32
Imports from Rest of World (billion 2000$)	-1,525	-182	-21	-1.70	-2.45	-1,732
Self Supply (billion 2000$)	61	-1,649	-233	-26	-43	-1,890
Exports to Rest of World (billion 2000$)	-142	3	0.39	-0.06	-0.54	-139
Population (thousand)	0.50	-0.06	-0.13	-1,012	-0.03	-1,012
Labor Force (thousand)	-1,503	-1,966	-284	-548	-44	-4,346

[a]All dollar estimates in constant (fixed) terms unless otherwise noted.

B. Shutdown of All Cross-border Activities--Simultaneous Simulation

1. Results and major assumptions

In the final scenario, we simulate a simultaneous shutdown of all cross-border activities to the U.S. for one year. We assume that import losses are replaced the use of excess capacity at a level of 20% and by export substitution. This simulation will be contrasted with the prior comparative static simulations to determine whether the "whole" is different from the "sum" of the parts, i.e., whether the economic impacts of a simultaneous border closure of goods and people would be different than the sum of individual shutdowns we simulated in Sections IVA to IVD and summarized in Section VA. Differences can arise from non-linearities and/or synergies. The latter would stem from complex functional relationships and non-linearities in the REMI Model. This is in direct contrast to an I-O model, which is linear and relatively simple in terms of structure (e.g., an absence of price-quantity interaction).

Simulation results for this "simultaneous" case are presented in Table 7. Major economic impacts include: a reduction in GDP of about $1.16 trillion, or 10.2% from the baseline level; and a reduction in employment of about 21.5 million jobs, or a decrease of 12.4%. These results indicate that a closure of U.S. border to both goods and people will result in considerable impacts to the U.S. economy. However, a comparison between the simultaneous simulation and the second version of simple summation (both of them incorporate the export substitution effects) shows that the simultaneous simulation yields smaller negative impacts to the economy. The difference between the comprehensive (simultaneous) simulation and the sum is due in part to the non-linearity and/or synergies of REMI model. With respect to the latter, the sectoral production cost increases affect all four factors (import, export, tourism, and immigration) in a simultaneous closure simulation, and their interactive effects may result in the different outcomes from the sum of individual simulations.

2. Simulation method and data inputs

Policy variables used in this simulation are a combination of all the variables we used in the previous four individual closure simulations: a) imports are constrained to zero by reducing 100% the share of "Imports from Rest of the World" for each sector; b) exports are constrained to zero by reducing the amount of "Industry Sales / International Exports" by the value of total exports to rest of world in each sector; c) a net loss in international travel is simulated by reductions in "Exogenous Final Demand"; d) the border closure of legal immigrants is simulated by a decrease in "International

Table 7. Simultaneous Simulation of Elements of a Complete Shutdown of the U.S. Borders to People and Goods

	Difference from Baseline	
Economic Indicator	Level	Percent
Total Employment (thousands)	-21,150	-12.42%
Total GDP (billion 2000$)	-1162	-10.15%
Personal Income (Billion Nominal $)	-693	-6.72%
PCE-Price Index	16.72	15.01%
Real Disposable Personal Income (billion 2000$)	-1524	-18.65%
Demand (billion 2000$)	-2262	-12.43%
Output (billion 2000$)	-1802	-10.21%
Labor Productivity Index	6.255	5.19%
Relative Delivered Price Index	0.218	21.77%
Relative Cost of Production Index	0.1826	18.24%
Imports from Rest of World (billion 2000$)	-1523	-99.89%
Self Supply (billion 2000$)	-738	-4.43%
Exports to Rest of World (billion 2000$)	-104	-10.46%
Exogenous Industry Sales (billion 2000$)	-960	n/a
Population (thousand)	-1012	-0.34%
Labor Force (thousand)	-2974	-1.99%

[a]All dollar estimates in constant (fixed) terms unless otherwise noted.

Migration of All Ages and All Groups" by one million; and e) the border closure of illegal immigrants is simulated by considering two effects in the model: i) the increase in "Wage Compensation" and ii) the "Production Cost" increase due to the higher labor costs. Also, in this comprehensive border closure case, we used the vector of sectoral production cost change that is derived under the assumption of both 20% excess capacity utilization and the diversion of exports to substitute for import shortfalls.

VI. INTERPRETATION OF THE RESULTS

A. Border Closure Duration

Thus far all of our simulations have been performed on an annual basis. This is due more to the standard features of the REMI Model than to policy considerations. That is, REMI as is the case with other models, is normally geared to simulating annual impacts. In fact, REMI projects impacts on an annual basis beyond the initial impact year, because some effects are dynamic or include lags. However, because these effects were less than a few percentage points different from those reported in Tables 1-7, they have not been presented here.

In all likelihood, a shutdown of the U.S. borders to a terrorist or health threat would not last as long as one year. More realistic are durations of three to six months. Accordingly, we have adjusted our major results to these time periods in Table 8. The figures represent an arithmetic interpolation of the annual results.

For a six-month shutdown, GDP impacts are estimated to be just under $600 billion, or a slightly over five percent downturn. Employment losses are estimated at just over ten million, or just over six percent. For the three-month shutdown, GDP losses are estimated at just under $300 billion, or about 2.5 percent. Employment losses are estimated to be just over five million, or slightly above 3 percent. To put these results in context, most post-World War II recessions resulted in unemployment increases of between two and four percent of base levels, so the 3-month shutdown would fall into the ordinary recession range if viewed in terms of an annual averaging. At the same time, the losses still represent a 12.42 percent reduction in employment during the 3-month period, and from that perspective comes close to what would be referred to as a brief "depression."

How realistic is our simple arithmetic adjustment of the annual REMI results for shorter timescales? It is likely to underestimate the impacts as the duration gets shorter, because there is less time to adjust to the dislocation. At the same time, various resilience adjustments to be noted below are likely to be more effect in the short-run. Still, we do not have sufficient information to know the extent to which these factors offset each other.

B. Investment Uncertainty

One source of realism that is not modeled by REMI is the financial market. REMI has an investment equation that is a function of last period's capital stock, the current demand for capital, the depreciation rate, and a measure of how quickly investment is turned into capital. This measure of investment ignores several major predictors of borrowing, namely the interest rate and uncertainty. A border closure could have many potential impacts on investment; here we discuss the impacts of two predictors of investment, uncertainty and interest rates.

First, large shocks create uncertainty. As uncertainty increases, firm's calculations of future profits become more difficult, making borrowing less attractive. For instance, currently China is the United States' fastest growing importer (Economist, 2007). A sudden cut in trade between these two countries would seriously harm the trade-related industries and their investment. Further, with higher uncertainty in the economy, asymmetric information increases thereby reducing credit and lending. Both of these effects reduce investment.

Table 8. Economic Impacts of a Complete Shutdown of the U.S. Borders for Various Time Periods (2006$)

Economic Indicator	Time Period: One Year Level	One Year Percent	Six Months Level	Six Months Percent	Three Months Level	Three Months Percent
Gross Domestic Product (billion 2006 constant dollars)	-$1,355	-10.15	-$677	-5.08	-$339	-2.54
Total Employment (thousands)	-21,150	-12.42	-10,575	-6.21	-5,288	-3.11
Personal Income (billion 2006 constant dollars)	-$808	-6.72	-$404	-3.36	-$203	-1.68

Second, the interest rate can be affected in a less obvious manner. If the government shuts down all imports and exports, it sets the current account deficit to zero. The current account is related to the capital and investment account through the balance of payments. Prior to the government shutdown, countries who sold goods in the United States recycled their dollars earned from sales by purchasing US government bonds, which in turn kept yields relatively lower. Cutting imports reduces this cycle, driving bond prices lower and yields higher.

Looking at Figure 2, we see that the import and export shutdown affects REMI's "market shares block". This activates the linkages within the model represented by the solid arrows (note, however, these exclude geographic linkages). As imports and exports fall, output and the balance of payments are affected. This is shown by the dotted lines leading from the "share of imports & exports" dotted block within the market shares box. As the current account deficit changes, uncertainty increases and foreigners have fewer dollars to invest in U.S. assets. Both of these factors decrease investment within the "Output" block.

The elasticity of investment in relation to uncertainty and the interest rate are not easy to calculate. However, in the REMI model, a one percent decline in investment leads to a 10 billion dollar decline in GDP. Assuming investment falls by between 5 and 10 percent, GDP would fall additionally between 50 and 100 billion.

C. Resilience Adjustments.

Resilience is increasingly used to describe how an economy withstands a major shock (see, e.g., Chernick, 2003). Unfortunately, it is rarely defined and risks becoming a vacuous buzzword, despite its importance in dampening extreme events like a complete border shutdown. Rose (2004; 2007) has defined economic resilience as the ability to maintain production levels when shocked (static resilience) and to recover quickly (dynamic resilience). Both of these types of resilience are measured in relation to a worst case scenario for output reduction and recovery time for a given shock.

Resilience applies at the level of the individual firm/household, the market, and the regional economy as a whole. Examples at the micro level include conservation of critical inputs, input substitution, use of inventories, business relocation, technological change, and rescheduling of lost production. Resilience at the market level emanates from the allocating mechanism of markets and prices, as well as adaptive responses such as information clearinghouses that match customers and suppliers to speed adjustment from dislocation of contracting arrangements. At the macrolevel, imports of goods and the overall diversity and strength of the economy are sources of resilience.

Only a few studies have actually measured resilience. Moreover, we know from the recent Hurricane Katrina experience that it can be severely eroded by a truly large shock to the system. The few cases where resilience has been measured relate to economic impacts of water and power system outages due to earthquakes or terrorism. Though limited, some of these are more applicable to a border shutdown case than would be the Hurricane Katrina example, because the utility shutdown involves damage to only one system, but leaves the rest of the economy unscathed. That is, in the case of the utility shutdown, factories are not damaged and can soon begin normal operation. This is also the case when a self-imposed embargo is lifted. Estimates of the business resilience to a water outage by Tierney (1997) following the Northridge Earthquake are about 75 percent (i.e., the economic impacts are about 75 percent lower than a linear model would predict). Analysis by Rose et al. (2007) of a hypothetical terrorist attack on the Los Angeles power system of a 2-week duration found resilience to be on the order of 90 percent. The major factors of business resilience in the Tierney study were substitution and conservation, while in the Rose et al. study the major resilience option was production rescheduling.

In the analysis in this paper, we have incorporated several aspects of resilience. Foremost, is the potential diversion of exports to substitute for lack of imports. This analysis also includes an adjustment for excess capacity to help produce import replacements. Yet another source of resilience was the substitution of domestic vacations for international destinations on the part of American tourists. The export diversion and excess capacity options were by far the most effective and resulted in dampening the negative shock by several hundred billion dollars.

What remaining source of resilience might have a strong effect on the results? It is unlikely that conservation would be able to reduce the impacts by more than a few percent points. Labor-capital substitution is modeled in REMI, but we were not able to perform a test of the extent of its effectiveness. Other types of input substitution could not be modeled, but still again they are unlikely to be able to reduce the shock by more than a few percent. The same is true of the use of inventories. Moreover, business relocation is a very limited option in this case, despite the increasing trend toward "offshore" production.

Perhaps the largest single source of resilience we did not formally model is production rescheduling. For short duration business disruptions, there is no reason that factories cannot work overtime or extra shifts to make up a good deal of lost production (Sheffi, 2006). Production rescheduling is less likely to be effective in service sectors because of a falloff in demand (e.g., entertainment, cleaning), but these are not typically imported goods and are only likely to suffer supply-side constraints if faced with limits on energy use. Overall, it is not unreasonable to estimate that the negative impacts of a complete shutdown could be reduced by 25-50 percent for cases of short duration. Another factor lending to this conclusion is the pent-up demand that has stimulated expansion following instances where consumption was restrained for a lengthy period, such as just after World War II. Of course, in the case of a border closure, there is also a decrease in income, so the pent-up demand is not as great.

The final point is how resilience is affected by the duration of the event. Some resilience options wane with time (e.g., inventories, conservation), while other improve over time (e.g., input substitution, technological change). It is likely that the potential for production rescheduling will also decrease over time, as customers (in this case, international ones) will find other suppliers, and many of them likely to do so on a permanent basis. Hence, one might expect production rescheduling to decay by 50 percent each three-month period. Thus, for a six-month embargo, the major remaining resilience option not explicitly modeled in this paper would, as a lower bound, only reduce the economic impacts of a complete border shutdown presented in Table 8 by little more than ten percent.

D. Macro Policy Mitigation

Another reason that impacts of a complete border shutdown might be mitigated stems from counteracting government policies. These would include a combination of fiscal and monetary policies, as well as other forms. Some of the policy adjustments are automatic, as in the case of unemployment benefits. Others, such as interest rate and money supply adjustments would be deliberate. Past experience during (and after) the Arab Oil Embargo indicate that such policies might be of only limited success. Other policy responses would include accessing the U.S. Strategic Petroleum Reserve, but indications are that this is rarely done, because of the priority of using this back-up source of supply for times of military tensions rather than countercyclical economic needs. Yet another set of policies might include government facilitation of customers who have lost suppliers with suppliers who have lost customers during the turmoil of a complete border shutdown.

VII. CONCLUSION

Our simulations of a complete shutdown of the U.S. borders to both trade and people for one year predict a reduction in GDP of as much as $1.4 trillion measured in 2006 dollars, or slightly more than 10 percent of GDP. Employment losses are predicted to be over 21 million, or more than 12 percent. In consideration of several relevant factors, we suggest that these figures can be linearly adjusted for more likely shorter time span. The estimates should be considered upper bounds. We included several aspects of inherent and adaptive resilience, such as input substitution and domestic excess capacity, but we did omit several others. Moreover, we did not include the effects of counter-acting government policies to cushion the shock.

Thus, our results do not incorporate all potential shocks and countervailing factors, and the REMI model (as with most models) was not designed to handle such large shocks. Nevertheless, this study should prove useful in that it investigates the major channels through which a border closure would affect the U.S. economy (trade, migration, travel) and offers results from enhancing a well regarded and widely used model.

Finally, it should be noted that we focused entirely on the cost side of the ledger. A complete assessment of the decision to close the U.S. borders needs to also consider the benefits of that action (avoided losses from a terrorist attack or health emergency), and with due consideration of the risk involved (the probability of occurrence of the threat).

ENDNOTES

* The authors are, respectively, Research Professor, School of Policy, Planning, and Development (SPPD) and Coordinator for Economics, Center for Risk and Economic Analysis of Terrorism Events (CREATE); Post-doctoral Fellow, CREATE; Post-doctoral Fellow, SPPD; and Senior Economist, regional Econometric Models, Inc (REMI). The research in this paper was supported by a contract from the U.S. Department of Homeland Security. The authors wish to thank Eric Schneider, George Treyz and Fred Treyz of REMI for their help in developing the scenarios and for running some of the model simulations. We also wish to thank our colleagues, Bumsoo Lee, Peter Gordon, and Jiyoung Park for helpful suggestions and data. Any views expressed in this paper are solely those of the authors and do not represent the views of the funding agency or any of the institutions with which the authors are affiliated. Also, any errors or omissions are solely the responsibility of the authors.

[1] The lower bound impact was found by increasing oil prices slowly over two years. The upper bound involves a sharp price increase.

[2] These limitations are also applicable to input-output models, and most of them are applicable to computable general equilibrium models as well.

[3] If the US shuts down the border in response to an external threat, it is likely that domestic tourism will increase as those who would have traveled outside the country substitute for domestic destinations. However, if the border closure is in response to an outbreak of avian influenza, then this mitigating scenario is less likely. We also ran this scenario without domestic substitution and found that GDP fell by $151 billion and employment fell by 2.85 million.

[4] The REMI model is comprised of five main "modeling blocks." They are "Output, Labor and Capital", "Demographic", "Wages", "Prices, and Production Costs", and finally "Market Shares." Each of these blocks is related mathematically, with this relation represented by the solid arrow. The direction of the arrow denotes causality. For instance, the labor and capital demand block affect output, and output in turn affects the labor and capital demand block. This is represented by the two arrows pointing in opposite directions between the blocks.

[5] Further, we assume some of these migrants do not work, and we make additional assumptions on the industrial sectors they work in. (see appendix C for more detail).

[6] For sectors where exports are diverted to replace imports, this is not an expansion of production, but simply a re-routing of existing production. Therefore, these substitution actions will not yield production cost increases.

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Appendix A. Detailed Derivation of Sectoral Production Cost Increase

In our study, we assume that as much of the shortfall of imports as possible would be replaced by the use of domestic excess capacity. Further production expansion is possible under extreme conditions as this, as evidenced by U.S. experience during World War II but not with many hardships. For one, expansion of production beyond the use of 20% excess capacity would cause significant cost increases in production because domestic substitutes are generally more expensive than imported goods. Moreover, supply curves slope upwards, so that production cost differentials increase with expanded production. In order to estimate the sectoral production cost increase to be used in REMI, we undertook the following calculations: 1) estimate the import replacement gap in each sector; 2) estimate the price differentials between imported goods and their domestic substitutes; 3) calculate production cost increase to serve as input in REMI.

1. Import Replacement Gaps

The import replacement gap for each sector is calculated under two different replacement scenarios. In the first scenario, we only allow the utilization of excess capacity of domestic production at the level of 20% to make up the loss in import. The second scenario is an import/export interactive case, which allows not only the use of excess capacity, but also the full use of export as substitution of imports.

The calculation of the import replacement gap was undertaken at a disaggregated sectoral level, based on 2004 U.S. 509-sector Input-Output Table. Then we aggregated the results to the sectoral classification of the REMI model. Appendix Table A1 presents the import replacement gap computed under the two replacement scenarios. The table only presents sectors that have a replacement gap. For those sectors that have zero import replacement gap, we assume that there would be no noticeable production cost changes in the sector.

2. Price Differentials

Shutting down imports from rest of the world to the U.S. would cause price increases in the domestic market due to the price differentials between imported goods and their domestic substitutes. Given a shortage of imported goods, domestic production needs to be increased to meet the demand of the consumers. Though comparative advantage does not necessarily mean *all* imports are cheaper than domestic counterparts, in most sectors domestic substitutes are more expensive. Production cost increases even further as producers move along upward sloping supply curves.

The data source for the price of imported goods is Foreign Trade Statistics of the U.S. Census Bureau. Unit prices of imported products are not directly reported in this database, however. In order to estimate the unit price, we accessed the import data at the HTS (Harmonized Tariff Schedule) 10-digit level in terms of both quantity and value. Unit price is computed by dividing the total value (including tariff) of one imported commodity by its total imported quantity. Several sources are used to obtain the price of domestic commodities, which include U.S. Department of Agriculture, U.S. Census Bureau, and Energy Information Administration. We used the *Current Industrial Reports* of Census Bureau as the major source for manufacturing goods. Again in many cases, prices are derived from quantity and value data.

Because of data availability and time manageability, it is impossible for us to estimate sectoral price differentials based on every commodity produced by each sector. Instead, we collected data for sample commodities for most sectors that have an import replacement gap, and used the price differentials of the individual commodities to represent. For sectors where more than one commodity's price differential was tabulated, a weighted average level is computed for the sector, using total import values of each commodity as weights. Appendix Table A2 presents the price differentials for imports and their domestic substitutes.

3. Sectoral Production Cost Increase

The final step is to determine the effect of the import substitutes on the sectoral production cost increase, which will be used as input in the REMI model. This cost increase is computed by multiplying the price differential of the sector by the proportion of total import value to the gross output of the sector. Taking Motor Vehicle Manufacturing sector as an example, the price differential we calculated for this sector is 8.2%. Imports equal to 53.8% of total gross output in this sector. Therefore, the production cost increase are computed as 8.2% × 53.8% = 4.4%. Further, we assume that the production cost increases 50 percent for every additional 20 percent of the import replacement gap (i.e., a stepwise supply curve), and use 200% as a cap on sectoral production cost increase. For Motor Vehicle Manufacturing, after the use of excess capacity (at a level of 20%) and export diversion, the import replacement gap is 23%. Thus, the final production cost increase we used in REMI for this sector is 4.4% × (1+50%) = 6.6%. Appendix Table A3 presents the vector of sectoral production cost changes we used in the REMI model for both of the two import replacement scenarios.

Appendix Table A1. Sectoral Import Replacement Gap

REMI Sector[1]		Scenario I [2]		Scenario II [3]	
		Import Replacement Gap (million $)	Domestic Production Level (percent) Gap	Import Replacement Gap (million $)	Domestic Production Level (percent) Gap
1	Forestry, Fishing	7,560	19.19%	4,705	11.94%
3	Oil & gas extraction	110,907	76.71%	108,545	75.08%
4	Mining (except oil & gas)	1,233	2.62%	944	2.01%
8	Wood product mfg.	4,693	4.82%	1,787	1.84%
9	Nonmetallic mineral product mfg.	5,674	5.22%	5,091	4.68%
10	Primary metal mfg.	13,545	8.54%	8,025	5.06%
11	Fabricated metal product mfg.	8,559	3.40%	5,838	2.32%
12	Machinery mfg.	19,786	6.76%	8,990	3.07%
13	Computer & electronic mfg.	81,542	15.97%	48,498	9.50%
14	Electrical equip. & appliance mfg.	22,803	19.33%	11,157.	9.46%
15	Motor vehicle mfg.	111,719	22.89%	84,234	17.26%
16	Transportation equip. mfg. excl. motor vehicles	4,122	2.03%	2,922	1.44%
17	Furniture & related product mfg.	14,051	17.58%	12,406	15.52%
18	Miscellaneous mfg.	44,430	35.39%	34,782	27.70%
19	Food mfg.	3,559	0.62%	2,001	0.35%
20	Beverage & tobacco product mfg.	4,989	3.38%	3,706	2.51%
21	Textile mills	3,410	7.38%	247	0.53%
22	Textile product mills	4,158	11.66%	2,931	8.22%
23	Apparel mfg.	75,567	158.70%	71,406	149.96%
24	Leather & allied product mfg.	23,902	317.51%	22,980.	305.26%
25	Paper mfg.	987	0.56%	350	0.20%
26	Printing & related support activities	637	1.35%	475	1.01%
28	Chemical mfg.	1,413	0.23%	1,394	0.22%
29	Plastics & rubber products mfg.	2,888	1.68%	435	0.25%

[1] Those sectors that have zero import replacement gaps are not included.
[2] This replacement scenario allows the use of excess capacity at the level of 20%, but no export diversion for imports.
[3] This replacement scenario assumes the use of excess capacity at the level of 20% plus full export diversion for imports.

Appendix Table A2. Price Differential of Imports and Their Domestic Substitutes

Sector/ Commodity	Domestic Price		Import Value	Import Price		Price Differential
Farm (agricultural products)						
Beef	4.09	$/lb	28,110,339	3.74	$/lb	9.48%
Tomato	0.91	$/kg	192,156,743	0.85	$/kg	8.03%
				weighted avg		**7.23%**
Forestry & logging; Fishing, hunting, & trapping						
Wood of Oak	143.60	$/m3	2,430,074	157.58	$/m3	**-8.87%**
Oil & gas extraction						
Crude Oil	56.64	$/barrel	184,428,952,900	49.9	$/barrel	**13.51%**
Mining (except oil & gas)						
Copper	3.35	$/ckg	460,051	2.07	$/ckg	**62.17%**
Nonmetallic Mineral Product Manufacturing						
Brick, building or common and facing	0.23	$/brick	14,876	0.30	$/brick	-24.94%
Clay floor and wall tile	14.00	$/sq meters	2,257,926	9.21	$/sq meters	51.99%
				weighted avg		**51.49%**
Primary Metal Manufacturing						
Steel Mill Products	830.99	$/tonne	34,194,305,000	809.21	$/tonne	**2.69%**
Machinery Manufacturing						
Powered lawn and hedge trimmers	86.49		200,014,000	70.01		23.53%
Pneumatic fluid power valves	38.40		410,818,000	11.26		241.10%
				weighted avg		**169.86%**
Computer and Electronic Product Manufacturing						
Computers, digital, analog, hybrid, and other	1538.67	$/unit	29,089,923,000	720.08	$/unit	113.68%
Nonimpact laser printers	182.26	$/unit	3,260,091,000	311.63	$/unit	-41.52%
Point-of-sale terminals and funds-transfer devices	1703.47	$/unit	745,106,000	310.91	$/unit	447.90%
				weighted avg		**105.92%**
Electrical Equipment, Appliance, and Component Manufacturing						
Microwave ovens	269.50	$/unit	1,134,877,000	62.36	$/unit	332.19%
Gas ranges, ovens, and surface cooking units	410.89	$/unit	1,312,463,000	208.63	$/unit	96.95%
Electric fans (except industrial)	18.44	$/unit	1,043,141,000	37.81	$/unit	-51.24%
Air space heaters, portable, fan-forced type	34.47	$/unit	374,819,000	0.02	$/unit	81.50%
				weighted avg		**124.53%**

Appendix Table A2. Price Differential of Imports and Their Domestic Substitutes (continued)

Sector/ Commodity	Domestic Price		Import Value	Import Price		Price Differential
Motor Vehicles						
Motor vehicles (for the transport of persons)	16,491	$/per vehicle	128,501,545,296	15,071	$/per vehicle	9.42%
Motor vehicles (for the transport of goods)	23,313	$/per vehicle	17,140,810,674	23,569	$/per vehicle	-1.09%
				weighted avg		**8.19%**
Apparel Manufacturing						
	6.88	$/pair	250,880,000	4.01	$/pair	71.52%
gloves and mittens	14.15	$/pair	130,081,000	7.48	$/pair	89.23%
	12.26	$/pair	53,020,000	7.20	$/pair	70.27%
Men's and boys' apparel:						
Suits	159.62	$/unit	742,986,410	54.88	$/unit	190.85%
Dress and sport coats	134.85	$/unit	797,625,979	32.04	$/unit	320.82%
Other coats, jackets, vests, and ski apparel	40.16	$/unit	3,020,047,293	10.82	$/unit	271.04%
Tops	3.61	$/unit	8,013,942,351	4.03	$/unit	-10.54%
Bottoms	10.84	$/unit	5,086,446,191	6.21	$/unit	74.60%
Swimwear	11.40	$/unit	180,170,763	4.35	$/unit	161.85%
Women's and girls' apparel:						
Dresses	26.07	$/unit	2,193,972,715	10.61	$/unit	145.76%
Tops	8.74	$/unit	10,665,442,816	4.67	$/unit	86.99%
Skirts	11.34	$/unit	2,455,317,826	6.90	$/unit	64.47%
Bottoms, except skirts	12.75	$/unit	7,480,456,770	6.27	$/unit	103.41%
Suits	30.91	$/unit	728,081,650	8.96	$/unit	245.11%
Swimwear	17.44	$/unit	778,062,418	5.76	$/unit	202.78%
Foundation garments	7.64	$/unit	2,351,810,753	3.99	$/unit	91.51%
				weighted avg		**95.81%**
Textile mills						
Carpet and other textile floor coverings	69.76	$/sq yd	596,636,651	41.18	$/sq yd	**58.03%**
Plastics & rubber products mfg.						
Plastics and articles thereof	0.53	$/lb	228,738,589,556	0.66	$/lb	**-8.61%**

Sources: U.S. Census Bureau (2006a and 2006b); USDA (2007a); USDA (2007b); U.S. Census Bureau (2004); EIA (2006); BLS (2006); and BEA (2007).

Appendix Table A3. Sectoral Production Cost Increase

	REMI Sector[1]	Scenario I [2] (percent)	Scenario II [3] (percent)
1	Forestry, Fishing	-2.57	-2.29
3	Oil & gas extraction	44.82	44.09
4	Mining (except oil & gas)	5.28	4.81
8	Wood product mfg.	11.64	11.04
9	Nonmetallic mineral product mfg.	8.41	7.94
10	Primary metal mfg.	0.73	0.66
11	Fabricated metal product mfg.	0.43	0.40
12	Machinery mfg.	70.56	50.74
13	Computer & electronic mfg.	59.61	43.42
14	Electrical equip. & appliance mfg.	62.39	50.63
15	Motor vehicle mfg.	6.60	3.73
16	Transportation equip. mfg. excl. motor vehicles	2.09	1.57
17	Furniture & related product mfg.	18.22	17.66
18	Miscellaneous mfg.	58.97	48.04
19	Food mfg.	3.76	3.56
20	Beverage & tobacco product mfg.	5.77	5.58
21	Textile mills	16.98	14.09
22	Textile product mills	17.70	16.63
23	Apparel mfg.	200.00	200.00
24	Leather & allied product mfg.	200.00	200.00
25	Paper mfg.	8.25	7.55
26	Printing & related support activities	2.37	2.29
28	Chemical mfg.	-1.97	-1.63
29	Plastics & rubber products mfg.	-1.42	-1.28

[1] Those sectors that have zero import replacement gaps are not included.
[2] This replacement scenario allows the use of excess capacity at the level of 20%, but no export diversion for imports.
[3] This replacement scenario assumes the use of excess capacity at the level of 20% plus full export diversion for imports.

Appendix B. Detailed Derivation of Input Values for Tourism Shutdown Simulation

1. Total Expenditure

The Travel Industry Association of America publishes an Expenditure Patterns of Travelers in the U.S. for 2002 with the latest data for 2000. In order to relate 2000 data to REMI's latest base year (2005), we use 2005 statistics on international travel.

Number of international passengers in 2000 (Bureau of Transportation Statistics): 141,288,690

Divide by two for round-trip statistics = 70,644,345

Number of international passengers in 2005 (Bureau of Transportation Statistics): 148,609,042

Divide by two for round-trip statistics = 74,304,521

Ratio of 2005 to 2000:

74,304,521 / 70,644,345 = 1.051

Expenditure of international travelers to the U.S. in 2000 (Travel Industry Association of America): $83.8 billion. Using the multiplier calculated above to obtain estimated 2005 expenditure:

1.051*$83.8 billion = $88.1 billion

Further, we find that this number does not include purchases of airline tickets. Assuming 2/3 of tickets are bought from US airlines and 74,304,521 million travelers at $1,000 per ticket: $49.5 billion

Total estimated expenditure by international travelers: $88.1 + $49.5 = $137.6 billion

2. Expenditure in Border States

According to TIA, the Pacific, South, and Middle Atlantic regions of the United States account for 76% of total spending of international travelers. If we add New England the total spending for Border States would be approximately 79.3% and Interior States would be approximately 20.7%.

Expenditure for Border States: $137.6* 0.793 = $109.12 billion

3. Expenditure in interior states: $137.6 – 109.12 = $28.48 billion
Also, REMI removes retail sales figures to track production costs directly. This results in about a 17.3 percent reduction in input values.

4. International travel substitution towards domestic travel:

Transport Mode	Travelers (000s)	Per Person Expenditure (including transport)	Expenditure (millions)
Car/Truck/RV	16,434.414	$265	4,355.12
Air	5,430.294	$1,283	6,967.07
Other	2,057.292	$286	588.39
			7,555.45

Total expenditures adjusted to 2005 dollars: $8.808 billion.

5. Spending Patterns

TIAA also offers spending patterns for domestic travelers. Domestic tourism expenditure for North East, Middle Atlantic, South Atlantic, and Pacific regions totaled 55.90% of total domestic tourism expenditure. We applied the 55.90% of the $8.808 billion to border states and the rest to interior states. Using REMI's tourism translator, we derived the following sectoral inputs for the REMI Model.

	Border States	Rest of US
Retail trade	$344.57	$271.84
Air transportation	810.01	639.02
Rail transportation	7.88	6.22
Water transportation	99.96	78.86
Transit, ground pass transp	80.26	63.32
Scenic, sightseeing transp	24.62	19.42
Rental, leasing services	125.07	98.67
Administrative, support services	305.29	240.85
Performing arts, spectator sports	154.62	121.98
Amusement, gambling, recreation	697.25	550.07
Accommodation	493.39	389.24
Food services, drinking places	821.34	647.96
Repair, maintenance	116.21	91.68
Total	$4,080.47	$3,219.12

Appendix C. Detailed Derivation of Unauthorized Worker Scenario

Because undocumented workers receive lower wages, we expect that closing the border to them would increase the equilibrium wage. As the wage increases, two effects become apparent. First, there is an income effect, in that as laborers are paid more, they have more to spend. Second, as labor is paid more, production cost increases.

To calculate the increase in the wage bill and production costs, we start with the number of undocumented laborers that will not be allowed into the country. According to Passel (2006), from 2000 to 2005 undocumented workers entered the country at a rate of about 850,000 per year. Further, Passel estimates that there are roughly 11 million undocumented workers in the United States as of 2005. In order to calculate the fraction of labor that will need to be paid, we first compute the total labor supply including undocumented workers. To do this, we multiply the labor in each sector by the undocumented percent of total labor estimated by Passel (2006) and add this to REMI's labor sector. Then we find the quantity of undocumented labor by multiplying the new total labor number by the percent of undocumented labor (see Appendix Table 2 below). Finally, we multiply this number for each sector by the fraction not allowed to enter the country (850,000/11,000,000). This gives the quantity of undocumented labor that will have to be replaced by documented labor in each sector. However, using REMI's labor numbers underestimated the amount of undocumented labor that is listed in Passel 2006. So we doubled the estimated undocumented labor calculated from REMI. We then multiply by the difference in wages of an average high school graduate, $609 per week (2005 US Census) and a short-term undocumented laborer, $330 per week (Passel 2006), yielding a cost differential of 279 per week. Finally, we assumed that workers in the hotel and farming industries worked 75% and 66.7% of the year respectively. All other sectors work full-time.

To calculate the increase in production cost by sector, we first calculate the total wage bill with no policy change (i.e., with undocumented migrants for 2005). Then we calculate the total wage bill where undocumented migrants for the year 2005 are replaced by documented labor. We compute the percent change in wage bill by sector and then multiply by the percent of production cost (value added) that is labor cost. This yields a sectoral increase in production cost associated with cutting off undocumented migration in 2005 (see Appendix Table 2 for input values).

Appendix Table C1. Undocumented Labor Sectoring Scheme and Inputs

REMI Sector	Labor Cost as a % of Total Cost[a]	% Undocumented Labor of Total Labor[b]	% Production Cost Increase
Accommodation	50	10	0.4052
Admin Support	68	11	0.5539
Agriculture	90	13	0.7358
Construction	80	12	0.6489
Food mfg	46	14	0.3767
Food services	64	12	0.5238
Furniture, mfg	66	13	0.5354
Miscellaneous mfg	59	6	0.4773
Private households	100	21	0.8166
Textile mills	76	12	0.6151

[a] Labor Cost as a Percent of Total Cost is derived from REMI's Input-Output Table.
[b] From Passel (2006) adapted to fit REMI sectors