Economic Model Methodology

Economic and Air Quality/Climate Impacts of Delays at the Border

San Diego, CA
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Contents

Introduction

The California – Baja California border region is one of the most important and dynamic economic zones in North America. While border crossings have become a critical element of the bi-national region's economic integration and competitiveness, growing trip demand has led to increased congestion at land ports of entry (POEs) and generated delays and unreliable crossing times for cars, trucks, and pedestrians. These delays and travel time unreliability at the border have the potential to reduce the region's economic competitiveness and attractiveness to businesses, which can translate into lower levels of economic activity and growth.

In 2006, SANDAG and Caltrans completed a study that showed how border delays cause significant reductions in economic output and employment. The study highlighted the need for improving border crossings and helped make the case for developing a third crossing between San Diego and Tijuana (the planned Otay Mesa East-Mesa de Otay II POE). Similarly, in 2007, the former Imperial Valley Association of Governments (IVAG) and Caltrans conducted an economic delay study for Imperial County POEs. Much has changed since these earlier studies: the regional economy has rebounded from the Great Recession and there are new emerging industry clusters that depend on cross-border trade. As a result, SANDAG has commissioned the HDR team (led by HDR Inc., and supported by T. Kear Transportation Planning and Management, Inc., Crossborder Group, and Sutra Research) to conduct the study on Economic and Air Quality/Climate Impacts of Delays at the California-Baja California Border.

This memorandum presents the proposed methodology to estimate the economic impacts of delays at land POEs along the California – Baja California border. It builds upon the methodology implemented for the original studies commissioned by SANDAG and IVAG. The memorandum includes a review of the most recent and relevant literature on the topic. The methodological framework distinguishes the impacts of border delays for personal trips (i.e., personal vehicles and pedestrians) and those for freight movements (i.e., commercial trucks).

Literature Review

In developing the proposed methodology, HDR conducted a brief literature review that updates earlier reviews conducted as part of the study on the *Economic Impacts of Wait Times at the San Diego–Baja California Border* for SANDAG (2006) and the *Imperial Valley – Mexicali Economic Delay Study* for IVAG (2007). The review focused on the economic impacts of delays on personal trips and freight movements at the U.S. borders with Mexico and Canada. Five directly relevant studies published since 2010 were identified:

- Avetisyan, M., Heatwole, N., Rose, A., and Roberts, B., (2015) "Competitiveness and Macroeconomic Impacts of Reduced Wait Times at U.S. Land Freight Border Crossings". *Transportation Research Part A, 78*, 84-101.
- Brown, W. M., (2015) *How Much Thicker is the Canada-U.S. Border? The Cost of Crossing the Border by Truck in the Pre- and Post 9/11 Eras*. Statistics Canada, Economic Analysis Research Paper Series, 11F0027M No. 99.
- Koopman, R., Powers, W., Wang, Z., and Wei, S., (2010) *Give Credit Where Credit is Due: Tracing Value Added in Global Production Chains*. National Bureau of Economic Research, Working Paper 16426.

- Rajbhandari, R., Saman, S., Vadali, S., and Kang, D., (2012) "Dashboard Tool to Communicate Delays and Economic Cost of Delays at International Border Crossings". *Transportation Research Record: Journal of the Transportation Research Board, 2285*, 135-144.
- Roberts, B., Rose, A., Heatwole, N., Wei, D., Avetisyan, M., Chan, O., and Maya, I., (2014) "The Impact on the U.S. Economy of Changes in Wait Times at Ports of Entry". *Transport Policy,* 35, 162-175.

These studies are summarized in the sections that follow. It is surprising that so few papers have been published in freight and border issues over this period, but the topic may have become less popular in the research community as a result of the Great Recession.

Roberts, B., Rose, A., Heatwole, N., Wei, D., Avetisyan, M., Chan, O., and Maya, I. (2014)
Roberts et al. (2014) measure the economic impact of reduced wait times during border crossings due to increases in U.S. Customs and Border Protection (CBP) staffing. The study covers 17 land POEs at the U.S.-Canada and U.S.-Mexico borders (including Calexico West, Calexico East, and San Ysidro) and four U.S. airports. The authors quantify the reduction in wait time for passenger vehicle traffic at land POEs, passenger flows at international airports, and commercial vehicle traffic at land POEs. They then monetize the reduced wait times and estimate the impact of reduced wait times on the U.S. economy. Overall, their analysis shows that adding one customs officer to each crossing would result in an annual increase in GDP of $64.8 million and 1,084 jobs.

To determine the monetary value of reductions in wait times during border crossings, the authors multiply estimated wait time reductions by the value of (wait) time for passenger vehicle traffic and passenger flows at international airports following the U.S. Department of Transportation methodology for valuing travel time.[1] Additionally, they use separate values of time for business and leisure travelers, and set higher values of time for air travel than for ground travel. For commercial vehicles, they use the findings of a 1999 study sponsored by the National Cooperative Highway Research Program (NCHRP).[2]

The authors also determine the economic impact of reductions in wait times on GDP and employment levels for passenger and commercial vehicle traffic at land POEs. For passenger vehicle traffic, they estimate the expenditures arising from additional tourist visits for various consumption categories (food, retail, banking, etc.). They also use the elasticity of cross-border trips with respect to wait time measured during an experiment conducted at the San Ysidro POE to determine the impact of wait time reductions on the number of crossings. Then they use an input-output model to determine the net increase in GDP and employment levels due to

[1] Belenky, P., (2011) *Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis*. U.S. Department of Transportation, Office of Economic and Strategic Analysis.
[2] Small, K., Noland, R., Xuehao, C., and Lewis, D., (1999) *Valuation of Travel-Time Savings and Predictability in Congested Conditions for Highway User-Cost Estimation*. Transportation Research Board, National Cooperative Highway Research Program Report 431.

increased consumption, taking into account the decrease in domestic spending resulting from the increased number of tourists travelling to Mexico and Canada.

For commercial vehicle traffic, the authors assume that a reduction in wait times does not lead to an increase in the number of trips. Instead they evaluate the economic impacts of reductions in transportation costs from reduced wait times. The authors use a statistical model to estimate transportation cost reductions and an economic model to determine changes in net export values, GDP, and employment.[3]

Avetisyan, M., Heatwole, N., Rose, A., and Roberts, B. (2015)
A similar study was conducted by Avetisyan et al. in 2015. The authors analyze the impacts of reducing wait times by adding one customs officer at each of the twelve major land freight crossings of the U.S. (including Calexico East and Otay Mesa). The change in wait time stemming from staffing changes is first estimated on the basis of primary data and then translated into changes in freight costs through a logistical model. The transportation cost changes are then fed into a multi-country computable general equilibrium model. The authors find that adding one customs officer at each land border crossing would, on average per crossing, generate an increase in U.S. GDP of $350 thousand and 3.58 additional jobs.

Rajbhandari, R., Saman, S., Vadali, S., and Kang, D. (2012)
Rajbhandari et al. (2012) discuss the development of a dashboard that presents information on delays at the land border crossing in El Paso, Texas and the related economic cost to commercial vehicles. The authors focus on the contents of the dashboard, in particular the user interface, and also provide a summary of other transportation dashboards in use in the U.S.

The target audience of the dashboard includes freight companies operating in border regions and policy makers. Freight companies can use the dashboard to make planning decisions. For example, they can obtain information on average delays for a time period and determine how much buffer time to schedule. Policy makers can use the dashboard to assess policy decisions related to delay times and evaluate results of past decisions. The dashboard presents trends in multiple timeframes (annual, monthly, weekly, as well as user-specified time periods). This functionality allows users to customize the information to their needs.

The dashboard presents the following information:

- <u>Performance measures that convey information</u> on delays such as the buffer index, which captures uncertainty of crossing times and is a top concern to freight companies. The dashboard calculates delay times in three ways:
    - Additional time over average crossing time;
    - Additional time over median crossing time; and
    - Additional time over the 95th percentile crossing time.

  It uses data captured from radio frequency identification (RFID) transponders installed in commercial vehicles that cross the border. However, there are limitations to this data:

[3] HDR will refer to Roberts et al. (2014) to validate some of the inputs used in the economic impact model (such as cross-border wait time elasticity, average spending levels, and truck operating costs).

failure to identify responders before and after crossing the border means that crossing times cannot be calculated. Furthermore, the data is not broken down by lane or by Free and Secure Trade (FAST) or non-FAST status.

- Direct costs to shippers related to delays include inventory costs, such as damage costs for perishable goods. Direct costs also include the operating costs of commercial vehicles, such as fuel and maintenance costs and driver wages. The dashboard does not include indirect economic costs such as the costs of vehicle emissions issued during delays and wider effects to the regional and national economies of higher freight costs due to delays.
- Volumes of commercial vehicles presented on a monthly basis for individual POEs. Sources of data include the Bureau of Transportation Statistics and the Texas Department of Transportation.
- Economic information includes data on volumes and monetary values of trade broken down by commodity and trading partner. The dashboard also presents information on daily exchange rates. Sources of information include the Bureau of Transportation Statistics and the Center for Border Enterprise and Economic Development.

The dashboard can serve as a source of information to estimate truck operating costs and to calculate the impact of higher wait times on transportation costs. One can also calculate performance measures included in the dashboard, such as the buffer index, to convey complementary information on the impact of delays at the California-Baja California border.[4]

Koopman, R., Powers, W., Wang, Z., and Wei, S. (2010)

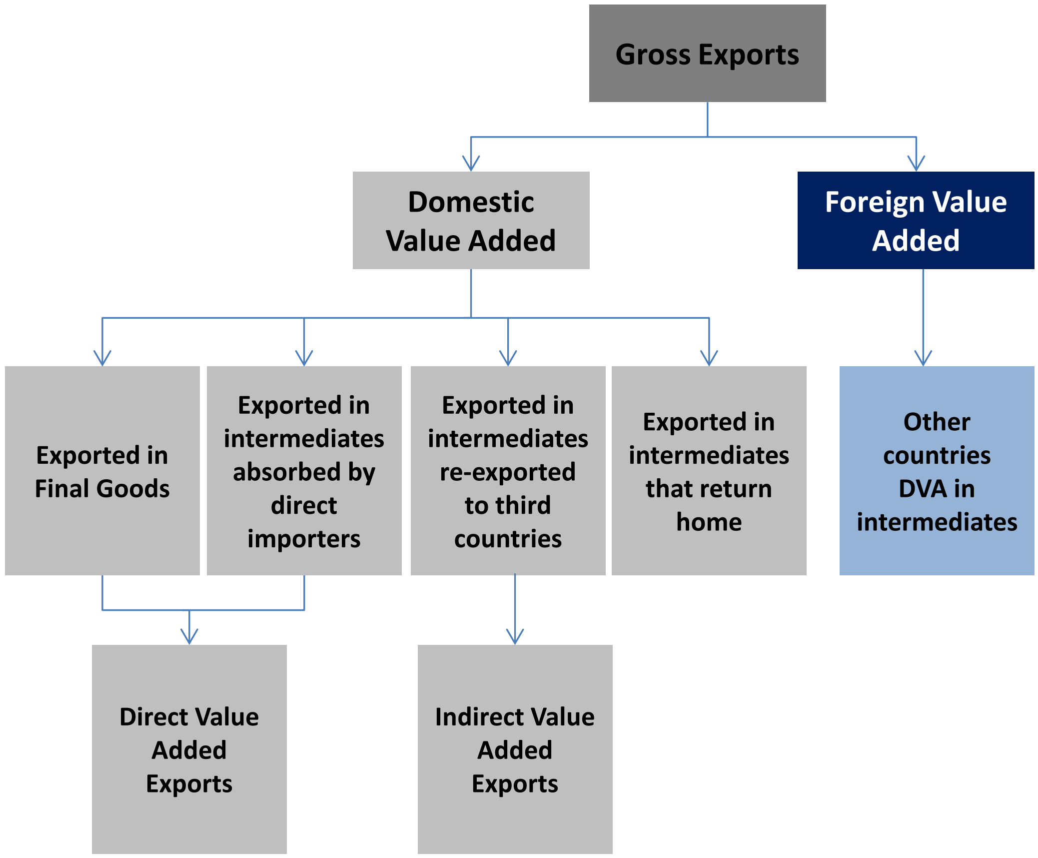
Official trade statistics do not present an accurate representation of the value that countries contribute to goods produced through international supply chains. They are measured in gross terms – that is, a country's official trade statistics include the value of the intermediate goods imported to the country and the value the country adds. As such, official trade statistics double count the value of intermediate goods that cross international borders more than once.

Koopman et al. (2010) address this problem by tracing the value each country adds in international trade (i.e., the domestic value added). Specifically, they break down the value of gross exports into its underlying components, foreign value added and domestic value added (DVA). Figure 1 below provides a representation of the components that make up gross exports. It also shows the conceptual framework used to carry out this exercise and explains how the results of the analysis can be used to illuminate issues in international trade.[5]

[4] The dashboard can be accessed on the Texas A&M Transportation Institute website at: http://bcis.tamu.edu/Commercial/en-US/index.aspx

[5] Though our proposed methodology to estimate the economic impacts of border delays on freight movements does not look into the origin of the value added of goods, it includes an adjustment factor to avoid double-counting of effects (percentage of export volume that is affected by a loss in competitive advantage and higher transportation costs caused by delays).

Figure 1: Breakdown of Gross Exports



Source: Koopman, 2010

To carry out the analysis, the authors develop an inter-country input-output (ICIO) table covering 26 countries and 41 sectors. Determining the value added by each country across sectors is accomplished in two steps. First, they separate intermediate goods from final goods in the imports of different countries. Specifically, they apply United Nations Broad Economic Categories (BEC) to detailed trade data to identify intermediate goods in each bilateral trade flow. Second, they allocate intermediate goods from a particular country to the sectors where they are used within all destination countries. The ICIO table uses data from the 2007 Global Trade Analysis Project (GTAP) database, the United Nations Comtrade database, and two input-output tables for major emerging economies that have large amounts of intermediate exports.

The results the analysis have wide-ranging applications. The authors provide examples of these applications and some are summarized below:

- <u>Identify a country's position in the value chain of a sector</u>. Determine whether the country is positioned in the upstream or downstream of the value chain. A country in the upstream of the value chain exports intermediate goods to firms operating in the downstream. The authors find that Japan, Western Europe, and the U.S. (among others) operate at the upstream end of the electronics value chain, whereas Singapore, some

EU member countries, Indonesia, and Thailand (among others) operate at the downstream end.

- Determine revealed comparative advantages. Using value added to calculate revealed comparative advantages removes the distortion produced by double counting intermediate goods in gross export data calculations. As such, using value added presents a more accurate identification of comparative advantages. For example, the study finds that when comparative advantages are assessed with value added data, India has a comparative disadvantage in the finished metal products sector whereas it has a comparative advantage when gross export data is used.
- Calculate bilateral trade imbalances. The authors find that Mexico's trade surplus with the U.S. calculated with value added data is 30 percent lower than when it is calculated with gross export data. This is because Mexico is positioned at the downstream end of a large number of global value chains and it uses parts and components from the U.S. and other countries.

Brown, W. M. (2015)

Brown (2015) assesses the impact of additional regulations on the costs of shipping goods across the Canada-U.S. border. Specifically, the study answers three questions:

1. Did costs for moving goods across the border increase with the new regulations implemented in 2004?[6]
2. If costs did increase, what was the magnitude of the increase?
3. Has the cost increase persisted through time?

The study assesses revenues of trucking firms for the period from 1994 to 2009 to measure increases in shipping costs borne by shipping companies transporting goods across the border. It includes a statistical analysis that identifies temporal differences in variable and fixed costs between cross-border shipments and domestic shipments. Since costs for complying with border regulations are included in fixed costs, this disaggregated analysis shows cost increases incurred due to complying with tougher border regulations. The study also determines the premium on cross-border *ad valorem* rates (i.e., the additional cost of moving goods across the Canada-U.S. border over moving goods across the same distance domestically) and assesses how they have changed over time. It uses the Trucking Commodity Origin and Destination Survey which measures output of the trucking sector and the volume of commodities moved by truck.

The study finds that the premium on cross border *ad valorem* rates increased significantly after new regulations were introduced. From 1994 to 2000 it cost 16.2 percent more to ship goods across the border than to ship the same goods over the same distance domestically. However, the premium rose steadily to 25.1 percent from 2000 to 2005. The study also finds that the premium on cross border *ad valorem* rates remained high thereafter. Although the magnitude is

[6] As a result of 9/11, new security regulations were imposed on the movement of goods across the Canada-U.S. border that went into effect in November 2004.

low, higher premiums on cross border *ad valorem* rates can have significant impacts on goods that cross the border at various points during the production process.

Methodological Framework

Our proposed methodological framework to estimate the economic impacts of border delays is split between personal trips and freight movements.

Personal Trips

The economic impact of delays at the border on personal trips can be broken down into three categories: 1) impacts of foregone recreation, shopping, and vacation trips; 2) impacts of foregone work trips; and, 3) productivity losses from impaired cross-border movements. The description of the methodology to estimate each one of these impact categories is presented below.

LOST CROSS-BORDER RECREATION, SHOPPING AND VACATION TRIPS

Traveler behavior differs based on trip purpose (e.g., business vs. leisure), trip time (e.g., peak vs. off-peak), and trip destination (e.g., Mexico vs. U.S.). In particular, the sensitivity to border delay varies under each trip category. Shopping and leisure trips tend to be easier to forego than work trips. For instance, a worker residing in Mexico will be more willing to wait for two hours at the border to commute to his or her job in San Diego. On the other hand, a U.S. resident on a short leisure trip to Baja California will be less willing to cross the border if they know they will have to wait two hours at the border to get back home later in the day.

The methodology therefore takes into account the sensitivity of each type of trip to border delay, thereby allowing us to estimate the number of trips foregone. Based on the trip destination, trip duration, and average spending per trip, we can then derive the direct economic impact. The indirect and induced effects are then estimated by means of input-output analysis. The economic impacts are estimated separately on both sides of the border using economic multipliers specific to the region of interest (for instance, San Diego County, Imperial County, or the State of California on the U.S. side).

The estimation of the economic impact of lost recreation, shopping, and vacation trips consists of seven (7) steps:

1. Obtain recent estimates and projections on border crossings by port of entry, trip purpose (shopping, recreation, and vacation) and destination (U.S. and Mexico);
2. Calculate the annual percentage change in future travel time associated with increased wait times and congestion – with respect to baseline conditions;[7]
3. Apply demand elasticity coefficients to the estimated changes in travel time to derive the annual reduction in recreation, shopping, and vacation trips due to increased wait times and congestion;
4. Estimate the expected revenue loss (spending from vacationers, shoppers, and other travelers) associated with the foregone trips based on the average spending per trip;

[7] Border wait time projections for each POE will be jointly developed by HDR and SANDAG using the Binational Traffic Model (BTM).

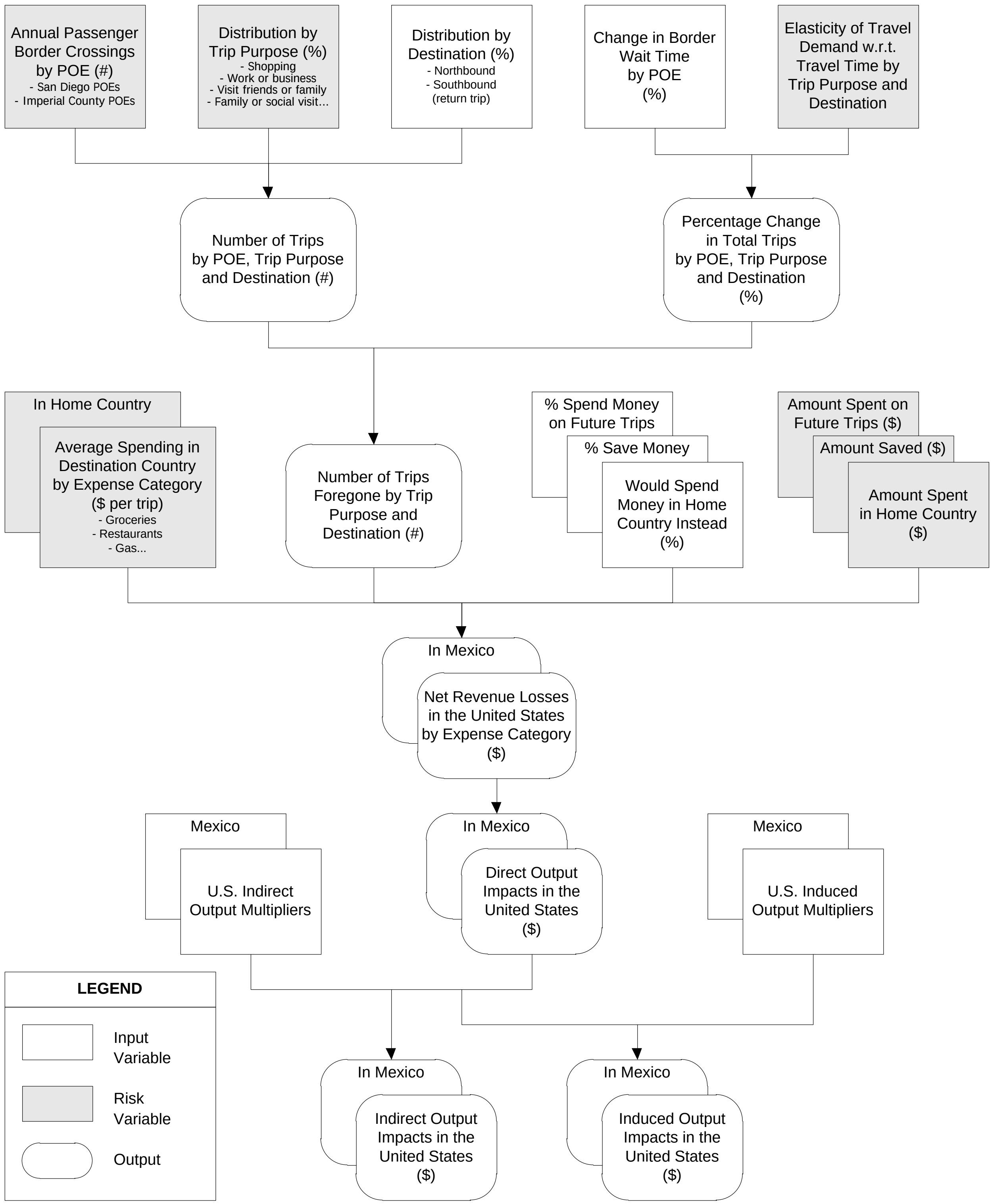
5. Adjust for changes in local demand using the survey data (e.g., vacation money spent in Mexico instead of the U.S. and vice versa);
6. Derive the direct impact of foregone spending on the region's business output, labor income, and employment;
7. Estimate the indirect and induced impacts (on output, income, and jobs) of foregone trips by means of input-output analysis.

Figure 2 on the next page provides an overview of the estimation process. The diagram identifies the different inputs (e.g., annual passenger border crossings), intermediate outputs (e.g., number of trips foregone by trip purpose and destination), and final outputs (e.g., indirect economic impacts in the U.S.) as well as the dependency relationships between them.

Note that the estimation of the economic impacts is conducted within a risk analysis framework to account for uncertainty surrounding some input variables (e.g., percentage of trips for work or business purposes): model inputs are provided as a range of estimates (with lower and upper bounds) instead of single point estimates. These ranges are transformed into probability distributions and combined using a simulation technique (Monte Carlo analysis) that allows each variable to vary simultaneously. Several risk variables will be discussed in detail with a panel of experts during a workshop; these variables are shaded in grey in Figure 2.

An extensive survey of cross-border travelers was conducted for this study at land POEs located along the California – Baja California border in the summer and fall of 2016. The survey responses provide key inputs to the economic impact model, such as trip origin and destination, trip purpose, expected wait time at the border, sensitivity to increased wait times, average spending per trip, and alternative local spending if the trip were not made.

Figure 2: Estimation of the Economic Impacts of Lost Cross-Border Recreation, Shopping, and Vacation Trips



LOST CROSS-BORDER WORK TRIPS

Even though cross-border work trips are anticipated to be harder to forego compared to recreation, shopping or vacation trips, delays at the border can still create a situation where commuters decide not to go to work due to high border-crossing times.

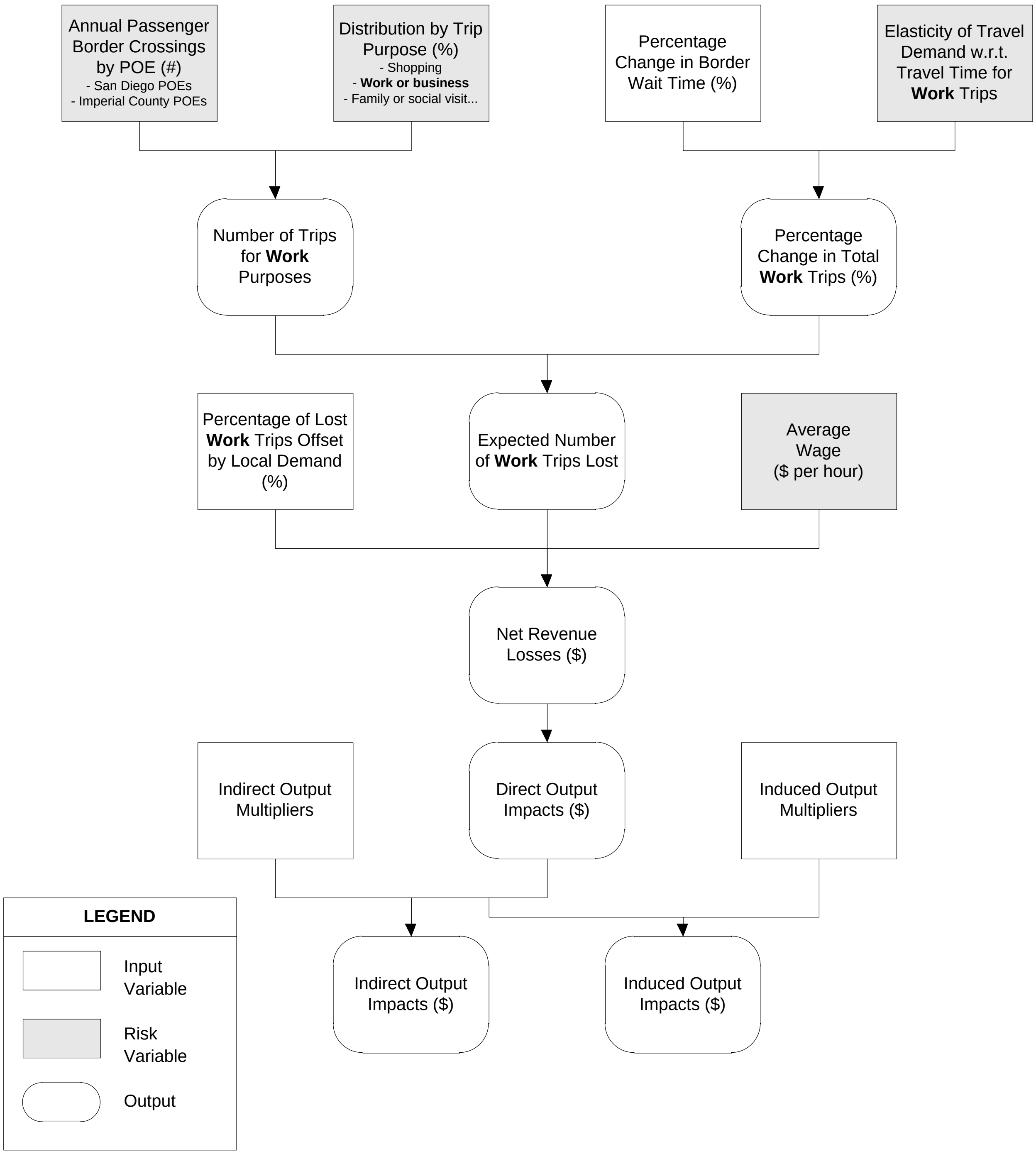
Estimating the economic impact of lost cross-border work trips is similar in concept to the estimation of the economic impact of lost recreation, shopping and vacation trips and follows seven (7) steps:

1. Obtain current data and projections on passenger crossings by port of entry, trip purpose (work) and destination (U.S. and Mexico);
2. Calculate the annual percentage change in future travel time associated with increased wait times and congestion;
3. Apply demand elasticity coefficients to the estimated changes in travel time to derive the annual number of work trips foregone due to increased wait times and congestion;
4. Estimate the expected revenue (productivity) loss associated with the foregone work trips using average wage estimates;
5. Adjust for changes in local demand (i.e., local job gains);
6. Derive the direct impact of foregone work trips on the region’s business output, labor income and employment;
7. Estimate the indirect and induced impacts (on output, income, and jobs) of foregone work trips by means of input-output analysis.

Figure 3 on the next page provides an overview of the estimation process (risk variables to be discussed with the panel are shaded in grey). The figure depicts a method similar to the one used for recreation, shopping, and vacation trips. The number of lost work trips due to border delays is estimated based on the number of crossings for work purposes and the sensitivity of workers to wait times. Lost work trips are then converted to lost earnings. Using multipliers from an input-output model, we can then derive the direct, indirect, and induced economic impacts.

As in the case of foregone recreation, shopping and vacation trips, the survey results are also used to estimate the economic impacts of forgone work trips.

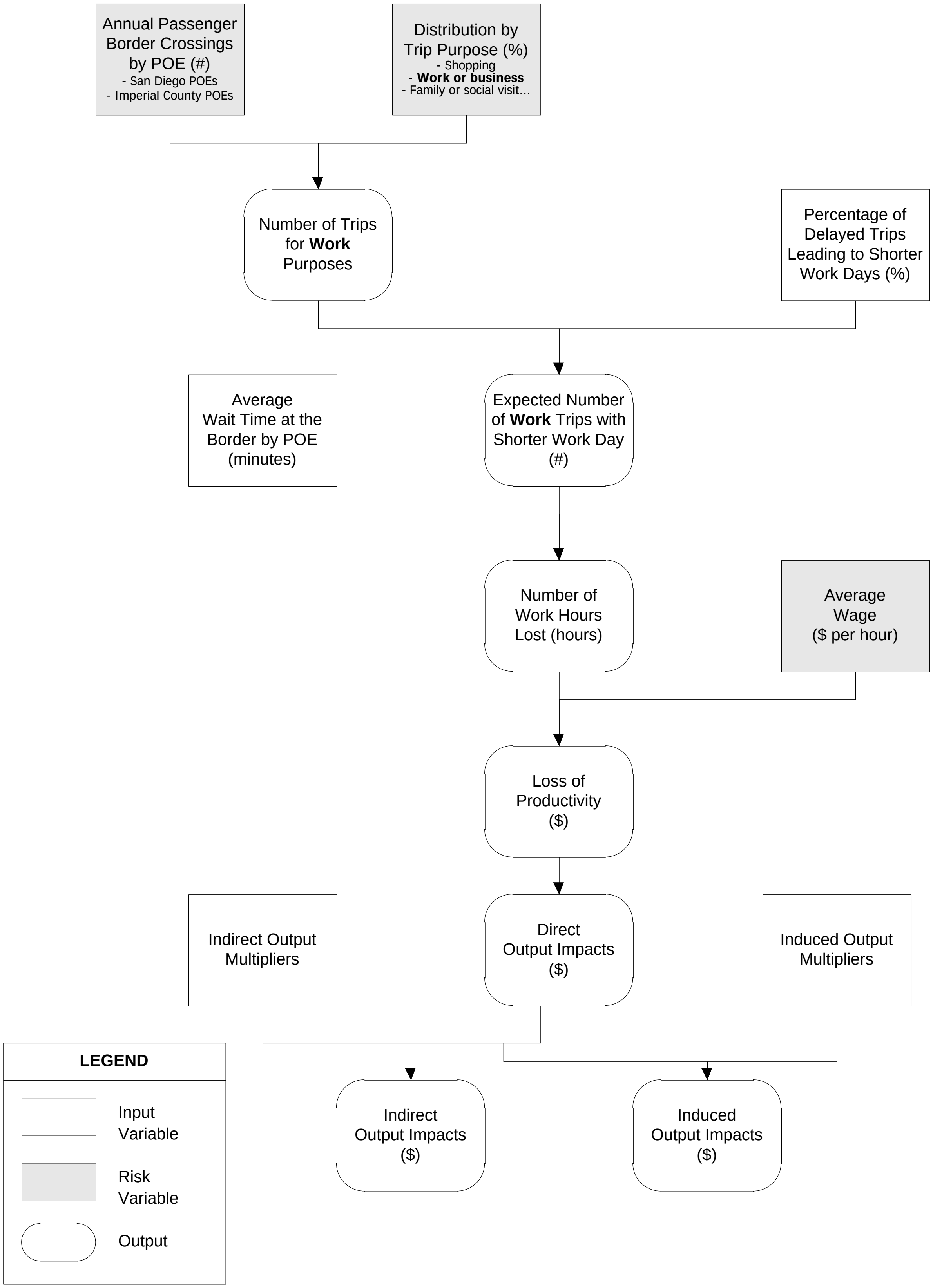
Figure 3: Estimation of the Economic Impacts of Lost Cross-Border Work Trips



PRODUCTIVITY LOSSES DUE TO IMPAIRED CROSS-BORDER WORK TRIPS

In addition to lost work trips, border delays have a significant impact on productivity in the cross-border region. They cause workers to be late at work, spend less time with their family, and make trips at less desirable times. While some of this effect is not directly related to the macro-economic impact, reduced working time has a direct effect on productivity and therefore should be included in the economic impact analysis. If, as a result of a border delay, a person works six hours instead of eight hours, the two hours lost should be accounted for in the economic impact calculation. On the other hand, if that person is delayed at the border but still manages to work eight hours, the delay is part of the user cost and is not estimated at the macro-economic level. Figure 4 on the next page provides an overview of the estimation process (risk variables to be discussed with the panel are shaded in grey).

Figure 4: Estimation of the Economic Impacts of Productivity Losses due to Impaired Cross-Border Work Trips



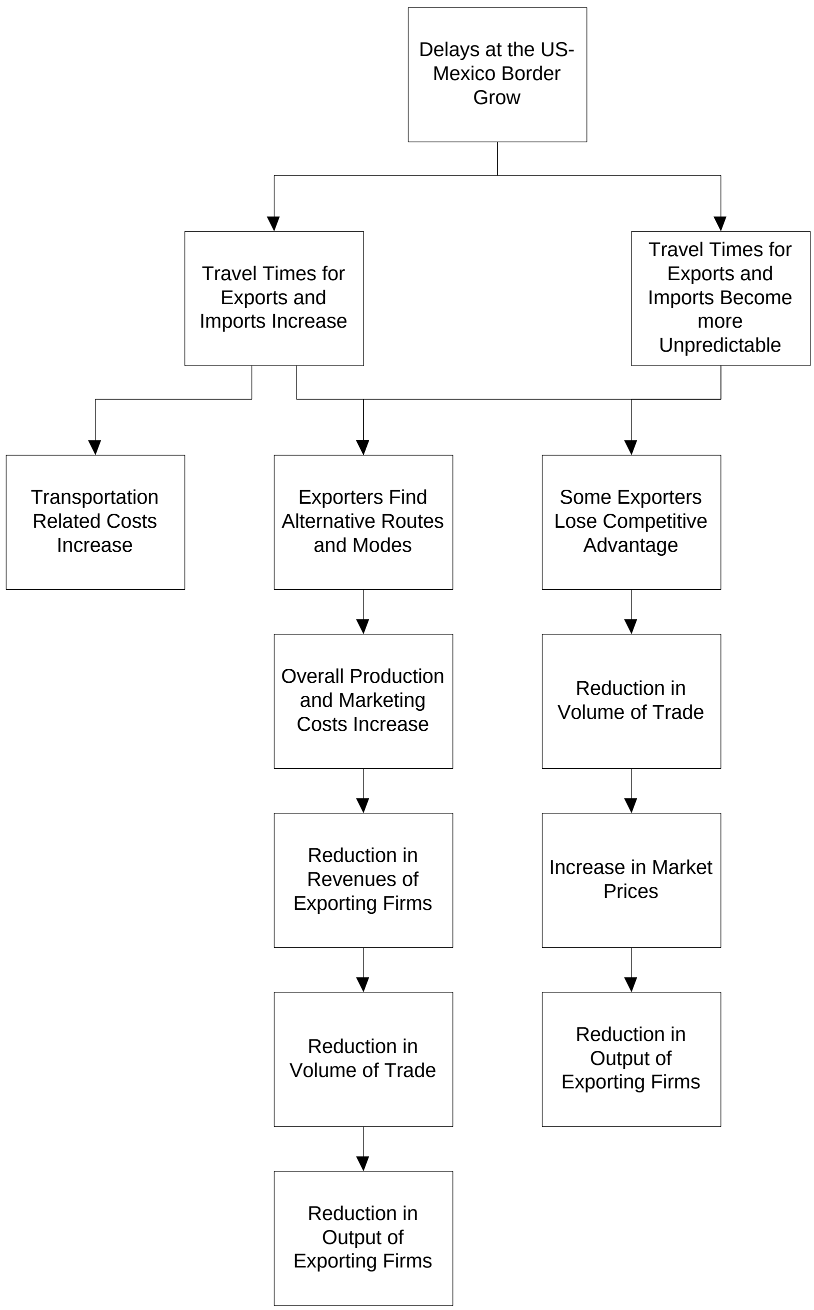
Freight Flows

The methodology to estimate the economic impacts of border delays on freight movements relies on the fundamental principles of the theory of trade between two countries. The following explains how border delays affect prices and production in each trading country and presents the process and key inputs used to estimate the impact on trade and the economy at large.

EFFECTS OF BORDER DELAYS ON PRICES AND PRODUCTION

Figure 5 depicts the general process for production and management decisions in a situation of increasing delays at the U.S.-Mexico border and identifies the main effects of border delays.

Figure 5: Effects of Border Delays on the Production Process of Firms Engaged in Cross-Border Activity



As shown in the diagram, the effects of increasing wait times are estimated separately from the effects of wait time uncertainty. However, in both cases, the final result is an estimation of the change in output of exporting firms. The methodology to estimate the impact on output from increasing wait times is presented below. Multipliers from input-output models are subsequently used to derive the direct, indirect, and induced effects of border delays (see page 21).

ESTIMATION OF OUTPUT IMPACT

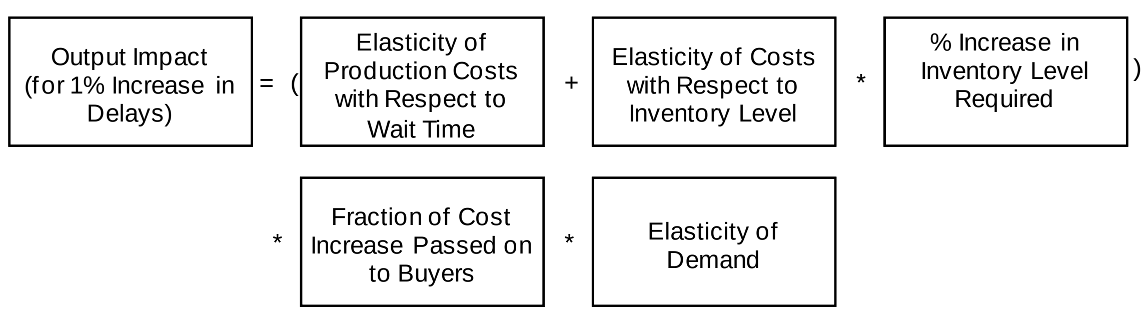
Due to the effects of increasing wait times described in the previous section, the estimation of output impacts is broken down into industries for which timing of their inputs is important for their production processes (i.e., just-in-time industries) and other industries that trade primarily finished goods. Various elasticities, derived from the literature (see Blanchard, 1996), are used to estimate the economic impacts on just-in-time (JIT) industries (e.g., Machinery and Equipment, and Manufactured Goods) and the economic impacts on other industries that trade primarily finished goods (e.g., Agricultural and Food Products, Mining and Mineral Products) separately.

The following data is used to estimate the impact of border delays on the output of just-in-time industries:

- Elasticity of production costs with respect to wait time;
- Elasticity of manufacturing costs with respect to inventory level;
- Percentage increase in inventory level required, for each one percent increase in border delays, to protect the production line against delays;
- Fraction of cost increase passed on to buyers; and
- Elasticity of demand for final product.

The percentage change in total output is calculated as shown in Figure 6 below.

Figure 6: Calculation of Output Impact in Just-in-Time Industries



For other industries, border delays result in a reduction in output through two related effects:

1. Reduction in output due to a loss of competitive advantage in export markets related to transportation times; and
2. Reduction in output due to higher transportation costs.

There is an offsetting effect to the reduction in output mentioned above. The offsetting effect is an increase in output of local or domestic producers competing with imports: since imported goods become more expensive and less attractive, local producers experience a stronger demand.

It should also be pointed out that the reduction in export demand is partially offset by domestic sales, or export substitution. In other words, it is assumed in the methodology that exporters are able to sell some of the lost exports to the domestic market.

The following data is used to estimate the impact of border delays on the output of other industries:

- Elasticity of exports with respect to border wait times;
- Export substitution with domestic sales;
- Elasticity of production costs with respect to border wait times;
- Fraction of cost increase passed on to buyers;
- Elasticity of demand for exports;
- Adjustment factor to avoid double-counting of effects (percentage of export volume that is affected by a loss in competitive advantage and higher transportation costs caused by delays); and
- Elasticity of demand for domestic import competing goods.

Ideally, those estimates are provided by industry or main commodity grouping to account for the fact that not all firms are equally vulnerable to border delays. The (percentage) reduction in output of exporting firms is calculated as shown in Figure 7 below.

Figure 7: Calculation of Output Impact in Other Industries

[Total Output Impact (for 1% Increase in Delays)] = [Reduction in Output due to Loss of Competitive Advantage] + [Reduction in Output due to Higher Transport Costs] - [Increase in Local Output of Import Competing Industries]

= [Elasticity of Exports with Respect to Wait Time] * (1 - [Export Substitution/ Elasticity of Output with Respect to Export Orders]) +

[Elasticity of Production Costs with Respect to Wait Time] * [Fraction of Cost Increase Passed on to Buyers] * [Elasticity of Demand for Exports] * (1 - [Export Substitution/ Elasticity of Output with Respect to Export Orders]) * [Adjustment Factor to Avoid Double-Counting of Effects] -

[Fraction of Cost Increase Passed on to Buyers] * [Elasticity of Demand for Domestic Import Competing Goods]

Once the percentage change in output is known for each type of industries, it is multiplied by the projected freight value at each port of entry to obtain the total output impact.

KEY INPUT VARIABLES

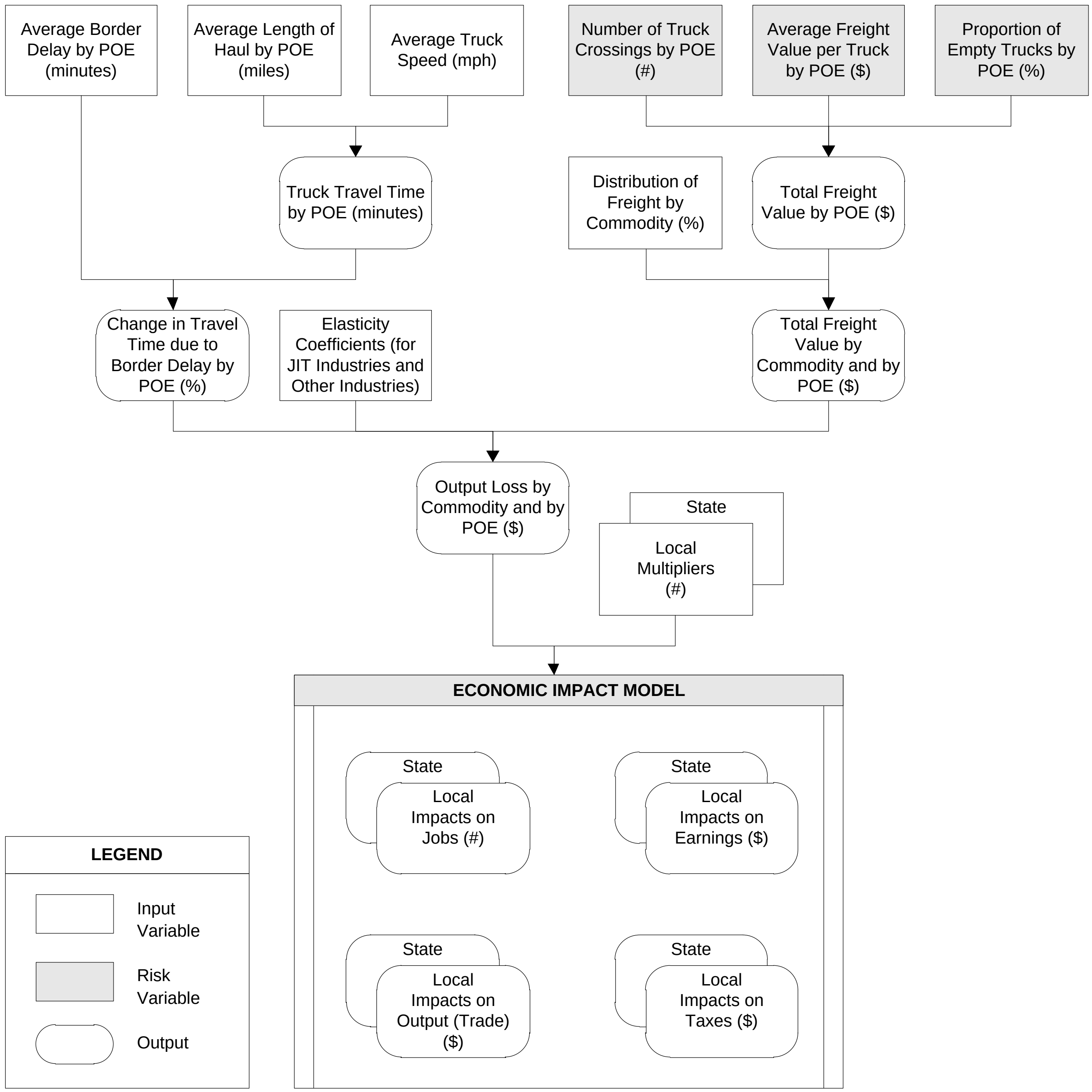
The calculation of the output impact relies on the following key input variables:

- Traffic Volumes – Annual truck traffic volumes at each POE are obtained from the Bureau of Transportation Statistics (Transborder Surface Freight Data); the average annual growth rate for truck traffic over the forecasting period is derived from socio-economic variables and U.S.-Mexico trade forecasts and refined through the use of the Binational Traffic Model (BTM).[8]
- Border Wait Times – Current border wait times are based on data collected for this study for trucks and personal vehicles at each POE. Projections are derived from SANDAG's BTM.
- Average Freight Value – The average freight value per truck is obtained by dividing the total freight value (from the BTS North American Transborder Freight Database) by the number of trucks in both directions at each POE. It is used to estimate the total value of freight at risk.
- Average Length of Haul – The average length of haul (derived from the literature) is used in conjunction with the average truck speed to determine travel time.
- Average Speed – The average truck speed (derived from the BTM) for the entire trip is used in conjunction with the average length of haul to determine travel time. It does not reflect the wait at the border, and is assumed to be the same in both directions.
- Trucks Origin and Destination – Percentage of trucks bound to/from San Diego County, Imperial County, California and Baja California derived from the survey data and the BTM.

Figure 8 on the next page summarizes the methodological framework along with the input variables (described above) to assess the economic impacts of reduced freight movements. Note again that the impacts are separately estimated on both sides of the border.

[8] The BTM is an offshoot of SANDAG's Regional Travel Demand model. It includes the entire San Diego regional highway network plus the network south of the U.S. border covering the roadway system in Tijuana, Playas de Rosarito, and Tecate. The model is designed to assign private auto and commercial vehicle trips originating from Mexico and destined to U.S. (and vice versa) to the roadway system through all the available land POEs. The POEs are coded in the model as a collection of links representing SENTRI, Ready and Regular lanes for auto traffic and Regular and FAST lanes for processing commercial vehicle traffic. For more information, see HDR's memorandum on Border Crossing Wait Time Estimation Methodology.

Figure 8: Estimation of the Economic Impacts of Reduced Freight Movements



Input-Output Analysis

Economic impact analysis helps quantify the effects of a change in the demand for goods and services on the level of economic activity in a given area. The initial change in demand can be the result of decisions made by governments, firms, or households.

The reduction in trade due to border delays affects the export manufacturing industries, thereby reducing the need for inputs (purchases) of labor, materials, equipment, and services, which are supplied by local (and non-local) producers. To the extent that the reduction in these purchases results in reduced productivity and/or reduced levels of labor force utilization (employment), it will cause a decline in the local economy with attendant costs of lower employment, personal income, business profits, and tax revenue.

TYPES OF EFFECT

Traditionally, economic impact analysis involves the estimation of three types of effect, commonly referred to as direct effects, indirect effects, and induced effects. The total economic impact is the sum of these direct, indirect, and induced effects.

- Direct effects – Refer to the economic activity occurring as a result of direct spending by businesses (e.g., import/export companies) or agencies located in the study area. For instance, the direct effect of foregone shopping trips (due to border delays) is the incremental revenue loss to the cross-border retail industry.
- Indirect effects – Refer to the economic activity resulting from purchases by local firms who are the suppliers (e.g., electrical equipment manufacturers) to the directly affected businesses or agencies. The spending by these supplier firms for labor, goods, and services necessary for the production of their own goods or services generates additional economic activity further down the production chain.
- Induced effects – Represent the increase in economic activity – over and above the direct and indirect effects – associated with increased labor income that accrue to workers (of directly and indirectly affected businesses) and is spent on household goods and services purchased from businesses within the study area. As with business purchases, household consumption generates additional economic activity.

The indirect and induced effects are sometimes referred to as “multiplier effects” since they can make the total economic impact substantially larger than the direct effect alone: in theory, the larger the multiplier, the larger the overall response (total economic impact) to the initial shock (direct effect). In reality though, while indirect and induced impacts do always occur, the net impact on the total level of economic activity in an area may or may not be increased by multiplier effects. That outcome depends on the definition of the study area and its ability to provide additional workers and capital resources, or attract them from elsewhere.

An employment multiplier measures the total increase in the number of jobs in the economy per new job created in a specific industry. Consider a drayage company that hires 10 new truck drivers. Let’s assume that the employment multiplier for the trucking industry is 1.5. In this example, 5 additional jobs would be created in the economy as a result of the 10 positions created at the drayage company, for a total of 15 new jobs.

IMPACT METRICS

Typically, economic impacts are measured in terms of business output, value added, employment, and tax revenue.

While business output is the broadest measure of economic activity and refers to the total volume of sales (i.e., intermediate and final demand), value added refers to the value a company adds to a product or service. It is measured by the difference between the amount a company spends to acquire it and its value at the time it is sold to other users. The total value added within a region is equivalent to the gross domestic product (GDP) for that region and consists of employee compensation, taxes on production and imports less subsidies, and gross operating surplus.

Employment impacts measure the number of jobs created for a full year. These impacts should not be interpreted as full-time equivalents (FTEs) as they reflect the mix of full and part-time jobs that is typical for each sector. And, strictly speaking, they should not be interpreted as permanent jobs either, but rather as job-years. A job-year can be defined as one person employed for one year, whether part-time or full-time.

Tax impacts comprise local, state, and federal taxes. They can be broken down by institution (households, corporations, etc.) and by type of tax (personal income tax, corporate profits tax, etc.).

INPUT-OUTPUT MODELS

Input-output (IO) models[9] are often used to simulate the impact of a change in the demand for goods and services. They are used to estimate the direct, indirect, and induced effects of border delays on both personal crossings and freight movements.

To measure the economic impacts in the U.S. we will use IMPLAN Pro, which is an input-output based regional economic assessment modeling system. It consists of a software package and data files that are updated every year. The IMPLAN data files include transaction information (intra-regional and import/export) on 536 industrial sectors (corresponding to four- and five-digit North American Industry Classification System [NAICS] codes) and data on more than 20 different economic variables, including business output and value added. For this study, the IMPLAN system is populated with the most recent data available (2015) for San Diego County, Imperial County, and the rest of California.[10]

In the course of the analysis, several adjustments will be made to help ensure that all impact estimates are truly incremental and specific to the study area:

[9] An input-output approach is followed in this study, drawing on an extensive body of research and experience with successful applications to transportation projects. An IO model calculates impact multipliers, which are then used to compute direct, indirect, and induced effects – output, employment, income, and local tax revenue generated per dollar of direct spending for labor, goods, and services.
[10] The analysis may also be conducted at the city or subregional levels for specific areas within San Diego County and Imperial County.

- Since the original IMPLAN data are for 2015, the analysis results are adjusted for inflation;[11]
- Social Accounting Matrix (SAM)[12] multipliers used for estimating indirect and induced effects are modified with regional purchase coefficients (RPCs)[13] derived from the IMPLAN National Trade Flows Model to ensure that any spending “leaking” out of the study area is not counted; and
- Households are the only institutions considered when building type SAM multipliers. As a result, induced effects are based on the income of residents of the study area solely.[14]

To estimate the economic impacts on the Mexican side of the border we use an input-output model for the State of Baja California developed by the Colegio de la Frontera Norte (COLEF). The model includes 2013 economic data on 261 sectors from Instituto Nacional de Estadística Geografía e Informática (INEGI), Secretaria de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGARPA), and the U.S. Bureau of Transportation Statistics (BTS).

Figure 9 on the next page provides an overview of the economic impact estimation process with an IO model. The key input to the IO model is the incremental change in spending or trade (i.e., direct effect) resulting from border delays. Multipliers are applied to this initial change in demand to calculate the direct, indirect, and induced effects, in terms of output, value added, and employment. Local, state, and federal tax impacts are subsequently estimated.

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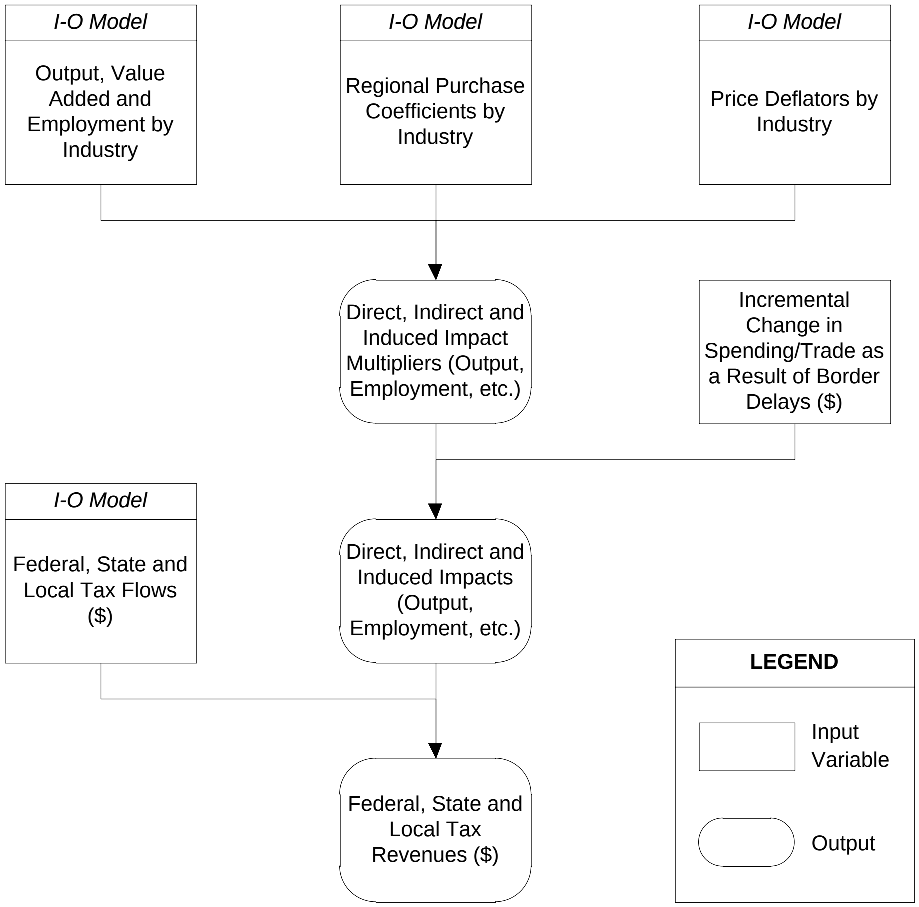
[11] Deflators derived from the most current Bureau of Labor Statistics (BLS) growth model are used in IMPLAN to account for relative price changes over time. These deflators are available through year 2030 and applied at the commodity level.
[12] Type SAM (Social Accounting Matrix) multipliers are the direct, indirect and induced effects where the induced effect is based on information from the social accounting matrix. Type SAM multipliers capture inter-institutional transfers (such as transfers between households and the Federal government) in addition to all commodity flows (purchases of goods).
[13] RPCs are ratios indicating what fraction of total demand for goods and services within a region (both by business and household) is satisfied from within the region; all remaining demand is satisfied by imports, which provide no direct economic benefit to the region. In other words, they filter out economic leakages from the region.
[14] It is commonly accepted that only households should be internalized when building type SAM multipliers. Internalizing households relies on the assumption that local workers will spend a portion of their labor income.

Figure 9: Overview of Input-Output Analysis



Appendix 1: References

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