THE ECONOMIC IMPACTS OF PORTS

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ECONOMIC IMPACTS OF PORTS

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PART 1: DEFINITIONS & MOTIVATION

ECONOMIC IMPACTS OF PORTS

WHAT ARE ECONOMIC IMPACTS?

- In the context of Economic Impact Studies (EIS) the term *Economic Impacts* refers to the effects of an activity on an economic system (eg a regional economy)
- Economic impact is defined as the *output* (sales), *value added*, *income* (wages and salaries) and *employment* generated by a given activity
- Occasionally other impacts are assessed such as, for instance, the amount of *taxes* collected as a result of a given activity, or *pollution effects, public health impacts,* etc;

ECONOMIC IMPACTS OF PORTS

WHY ARE THE ECONOMIC IMPACTS OF PORTS ASSESSED?

- The main reasons for conducting port impact studies are:

  1) To assess the role of ports in regional economic development

  2) To increase the social acceptance of port activity (eg pollution effects)

  3) To decide in capital budgeting and resource allocation

  4) To decide in the granting of regulatory permits allowing the implementation of port projects

- The vast majority of port economic impact studies are commissioned by Port Authorities to demonstrate to their sponsors' (eg the government) the positive contribution of the port to the regional economic prosperity

ECONOMIC IMPACTS OF PORTS

HOW ARE ECONOMIC IMPACTS ASSESSED?

- The approaches most commonly used to assess the economic impact of an activity are:
  - Multiplier analysis (including input-output models)
  - Computable general equilibrium (CGE) models

Input-output models will be the focus of this presentation, CGE models are descendent of input-output models allowing eg for imperfect market clearance

ECONOMIC IMPACTS OF PORTS

HOW ARE ECONOMIC IMPACTS ASSESSED?

- Input-output analysis is the preferred approach for economic impact analysis at the regional level
- Input-output analysis can be used to analyse a variety of regions ranging from a city to a country
- It provides a good combination of relevant activity measures, information on impact components, analytic rigour and cost
- In input-output analysis, a multiplier is obtained which provides a measure of the overall effects on the regional economy of an initial change in the level of activity
- Total impact is the sum of direct effects (the initial round of output, employment and income) and the subsequent flow-on effects to other sectors of the economy

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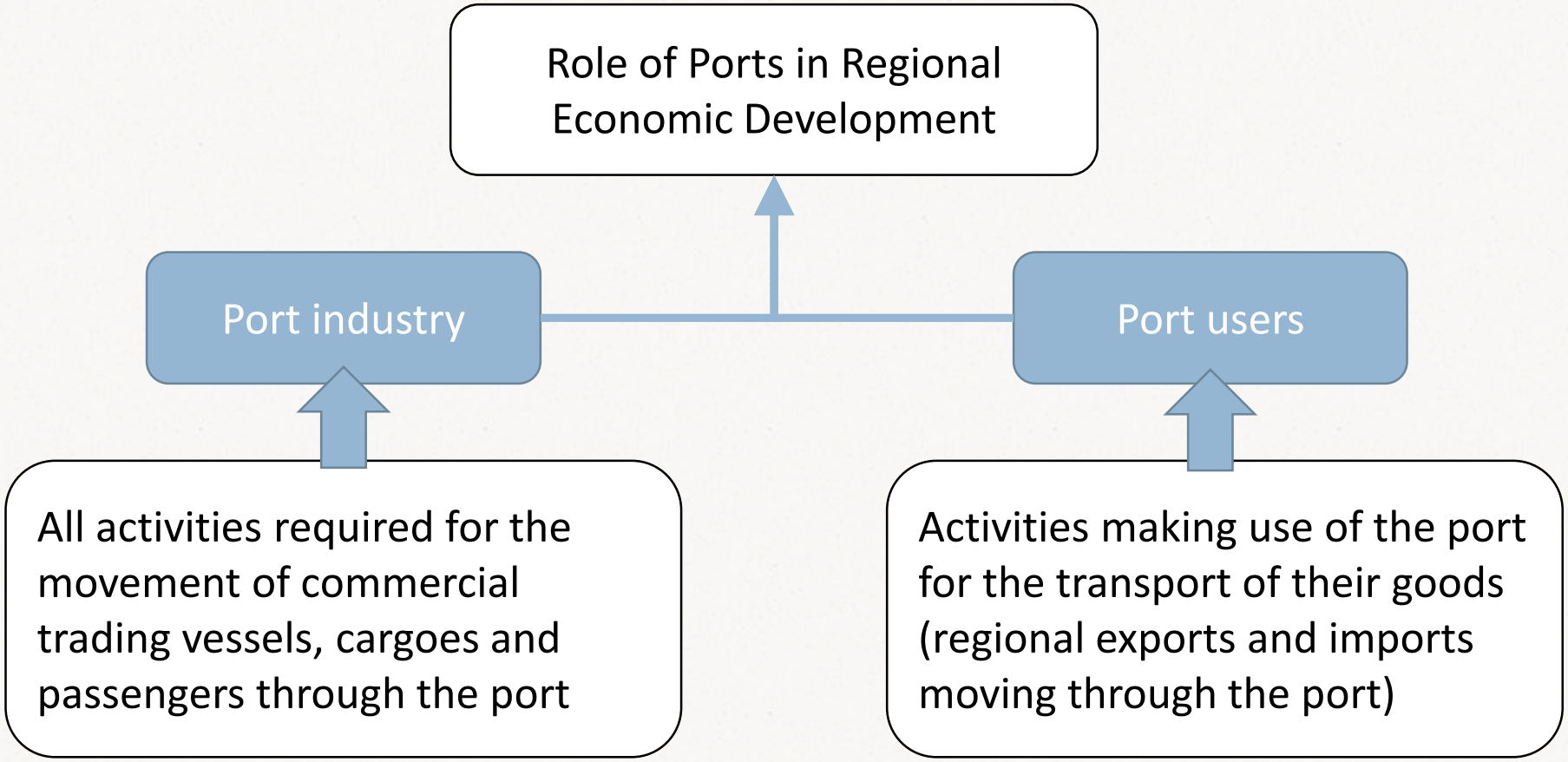
PORT INDUSTRY AND PORT USERS DEFINITION

- Typically, in port impact studies two groups of industries are considered:



ECONOMIC IMPACTS OF PORTS

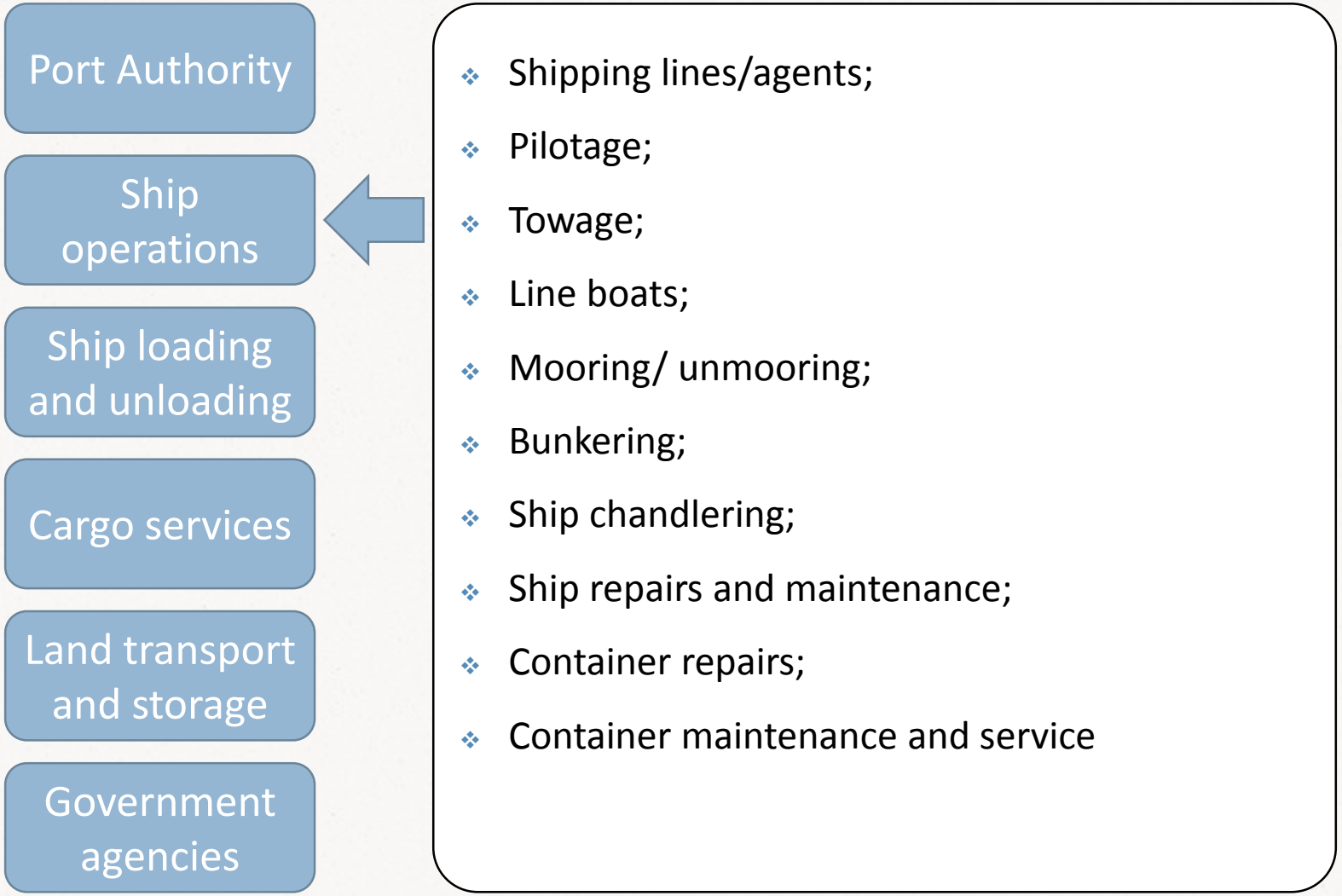
COMPONENTS OF THE PORT INDUSTRY

- Port Authority
- Ship operations
- Ship loading and unloading
- Cargo services
- Land transport and storage
- Government agencies

- Planning, co-ordination and promotion;
- Land and property management
- Safety and emergency response
- Navigation channels and aids
- Port Authority wharves, berths, jetties, etc
- Infrastructure for roads and utilities

ECONOMIC IMPACTS OF PORTS

COMPONENTS OF THE PORT INDUSTRY



ECONOMIC IMPACTS OF PORTS

COMPONENTS OF THE PORT INDUSTRY

- Port Authority
- Ship operations
- Ship loading and unloading
- Cargo services
- Land transport and storage
- Government agencies

- Private wharves, berths, jetties, etc;
- Container and break bulk stevedoring;
- Livestock stevedoring;
- Bulk cargo loading/unloading;
- Passenger terminals;

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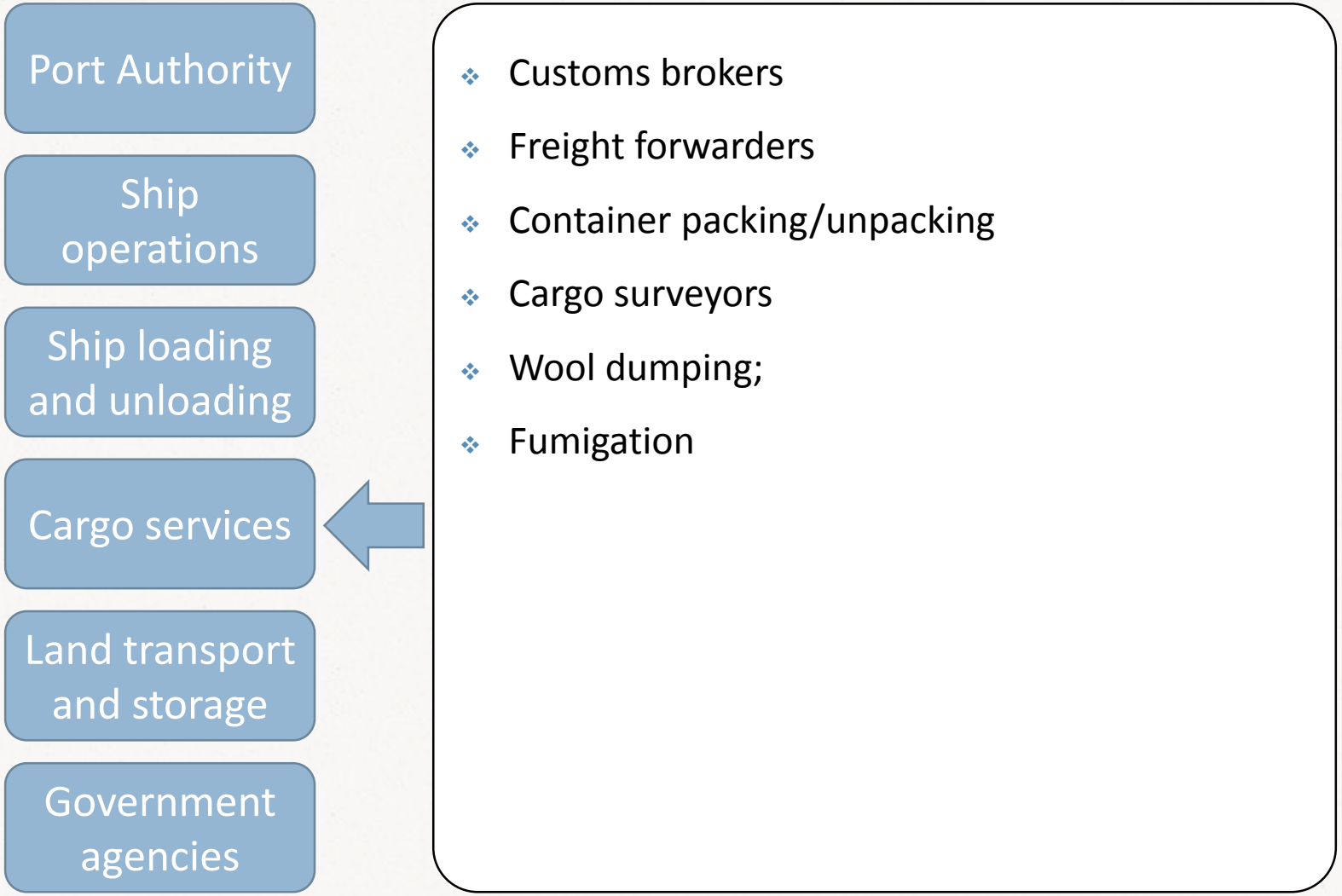
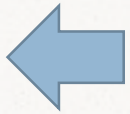
COMPONENTS OF THE PORT INDUSTRY



ECONOMIC IMPACTS OF PORTS

COMPONENTS OF THE PORT INDUSTRY

- Port Authority
- Ship operations
- Ship loading and unloading
- Cargo services
- Land transport and storage
- Government agencies



- Road transport
- Rail transport
- Transfer between road/rail and storage facitilies
- Storage

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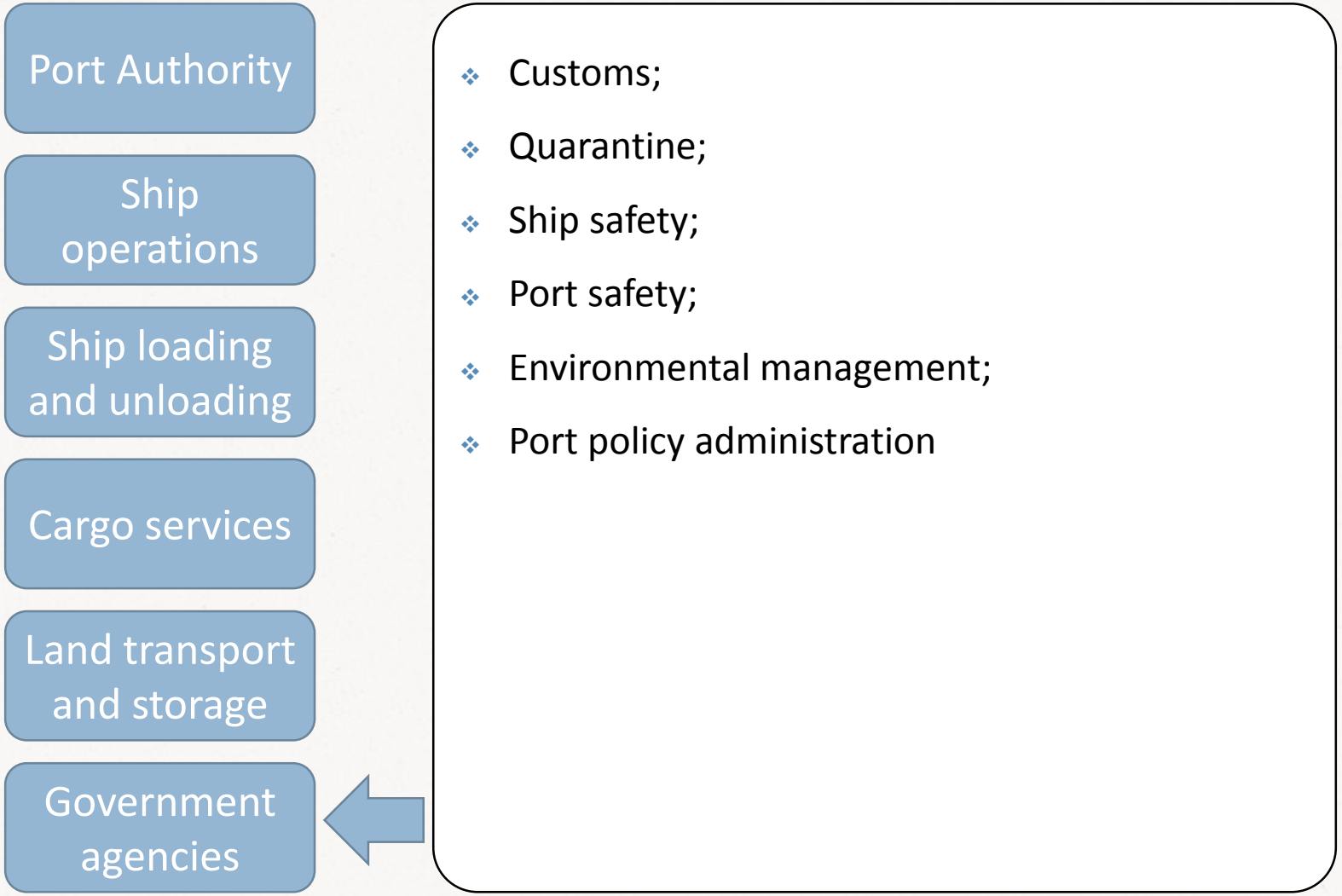
COMPONENTS OF THE PORT INDUSTRY



ECONOMIC IMPACTS OF PORTS

COMPONENTS OF THE PORT INDUSTRY

How to determine if activity x should be considered in the Port Industry:
is activity x necessary for cargo to move through the port?

Note that some port impact studies focus on the activities taking place within the geographical boundary of the port instead of their functional nature.

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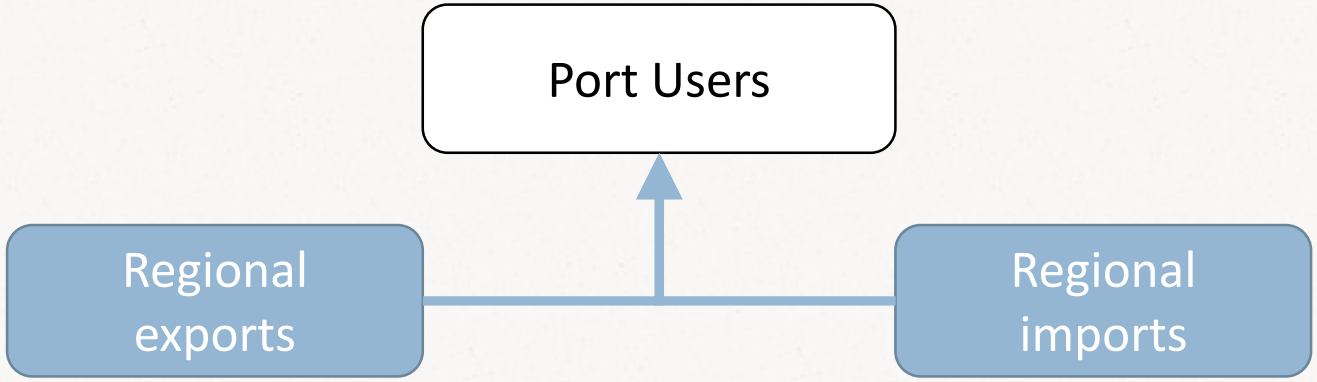
COMPONENTS OF THE PORT USERS

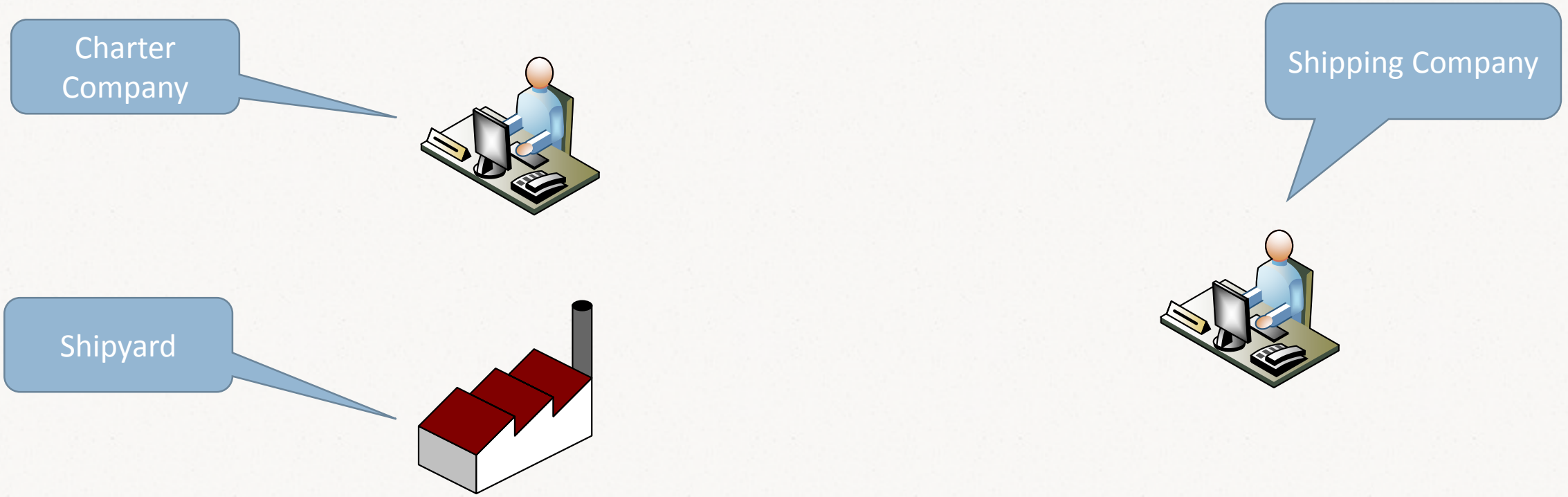


- Transhipment cargo is excluded from port users, its impact being captured in the sales of port industry (transhipment usually has a lower direct impact on regional economic development than exports or imports)
- Care must be taken concerning the treatment of imports (the most common approach is to net competitive imports, ie, $Xnet = X - M$ as in Moon[1995])
- This is why, according to some authors, a port can have a negative impact on regional economic development (“*Subsidizing ports also means subsidizing imports, which may have a negative impact on jobs*” [Meersman et al, 2014, p. 147])

ECONOMIC IMPACTS OF PORTS

INTERSECTORIAL RELATIONSHIPS

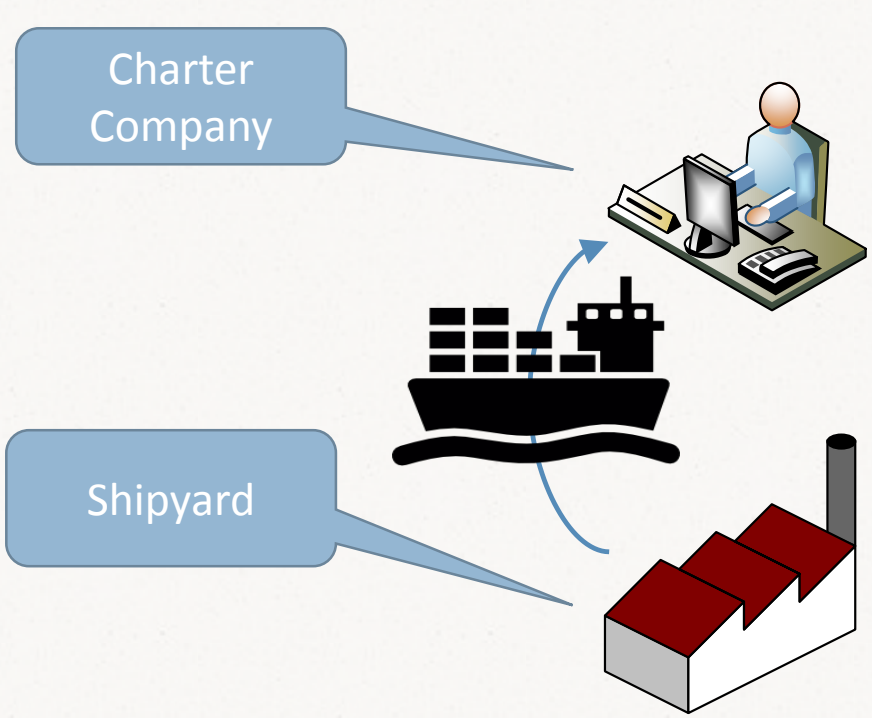
- Consider a simple economy, with only three industries:



ECONOMIC IMPACTS OF PORTS

INTERSECTORIAL RELATIONSHIPS

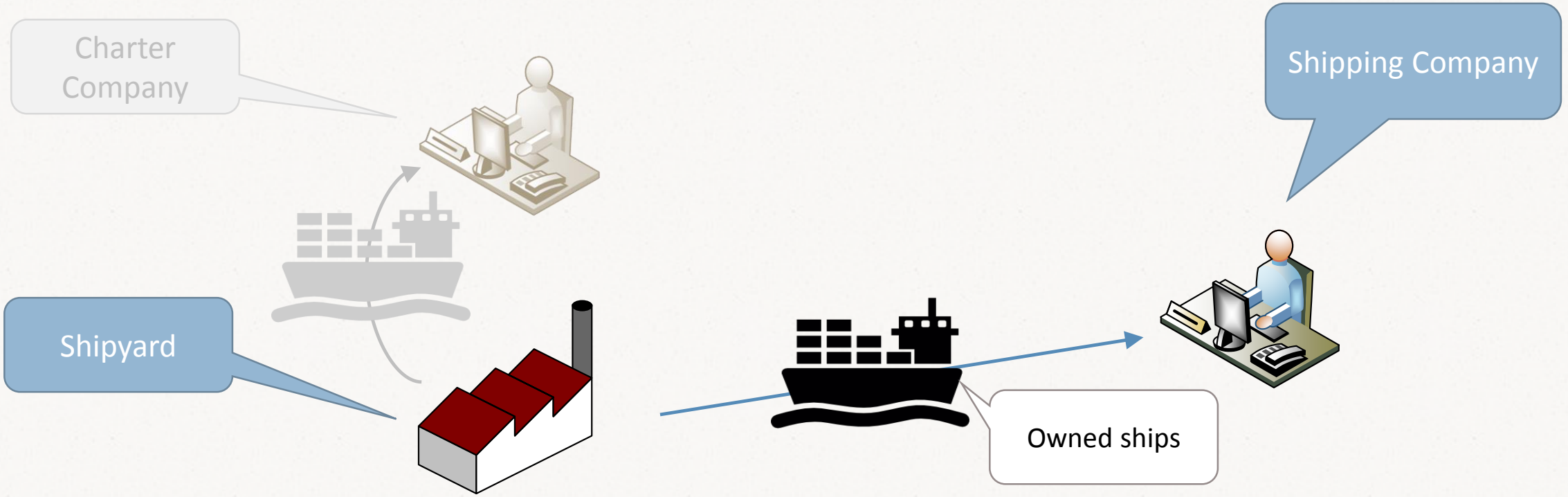
- The *charter company* acquires ships from the *shipyard*, which it then leases to other companies through charter agreements



ECONOMIC IMPACTS OF PORTS

INTERSECTORIAL RELATIONSHIPS

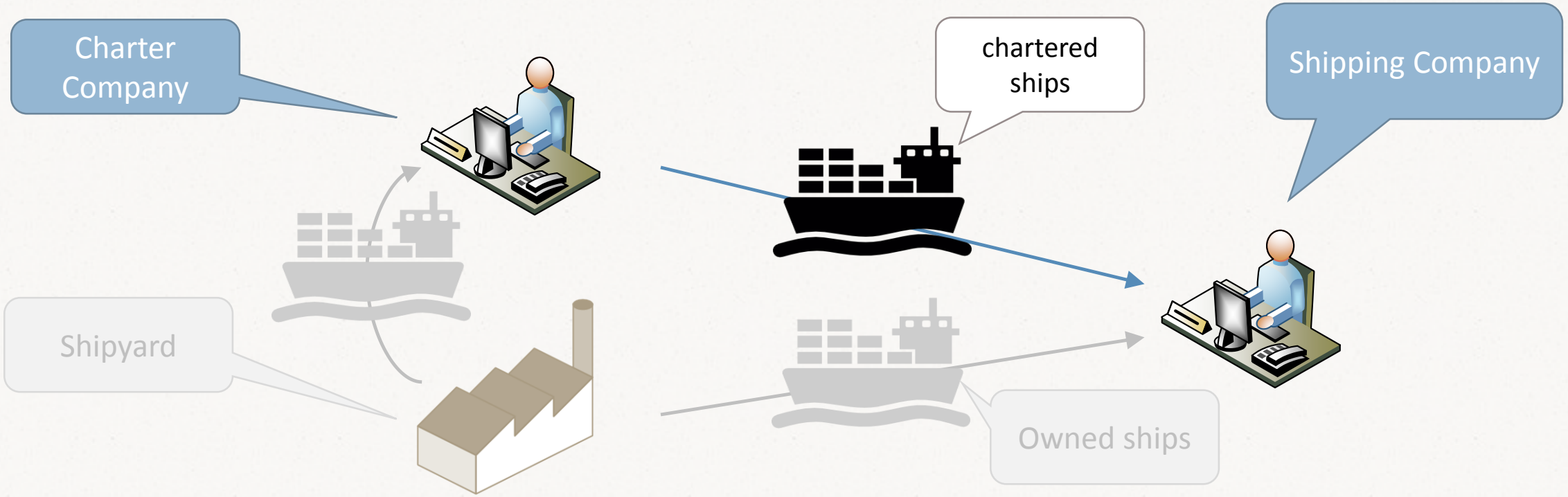
- The *shipping company* acquires ships directly from the *shipyard* to meet its long term transportation needs



ECONOMIC IMPACTS OF PORTS

INTERSECTORIAL RELATIONSHIPS

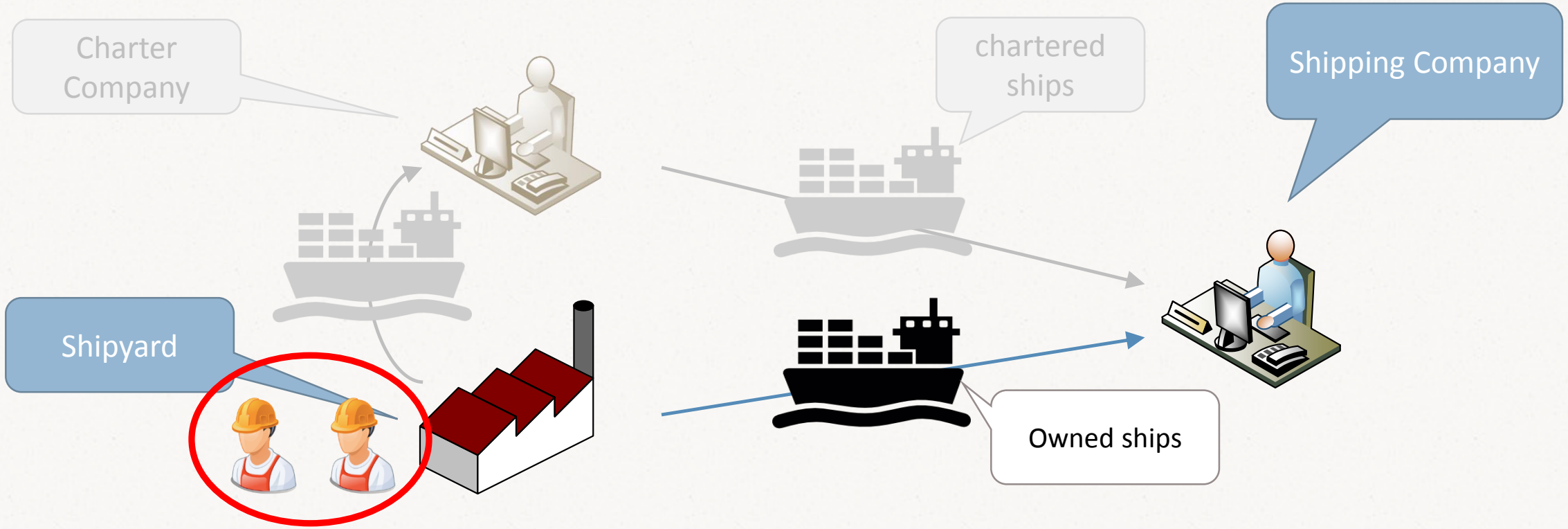
- The *shipping company* charters ships from the *charter company* to meet its short term transportation needs



ECONOMIC IMPACTS OF PORTS

INTERSECTORIAL RELATIONSHIPS

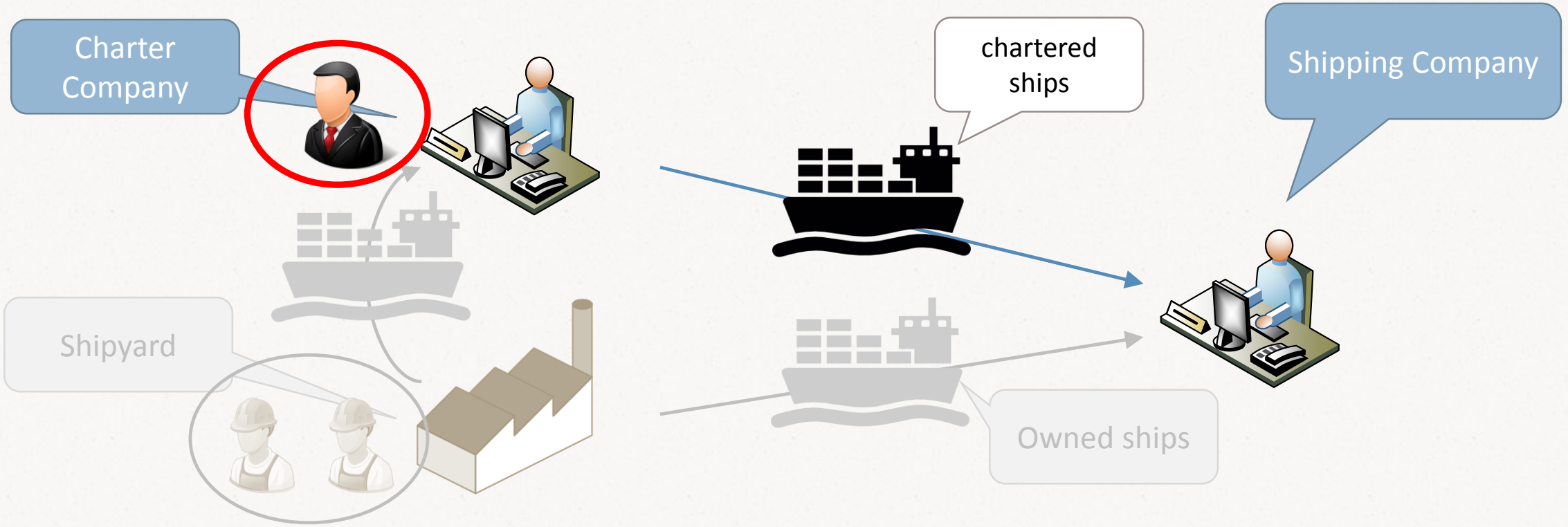
- In order to meet the demand for new ships from the *shipping company*, the *shipyard* must hire some workers to build the ships



ECONOMIC IMPACTS OF PORTS

INTERSECTORIAL RELATIONSHIPS

- In order to meet the demand from the *shipping company* for chartered ships, the charter company must hire some workers



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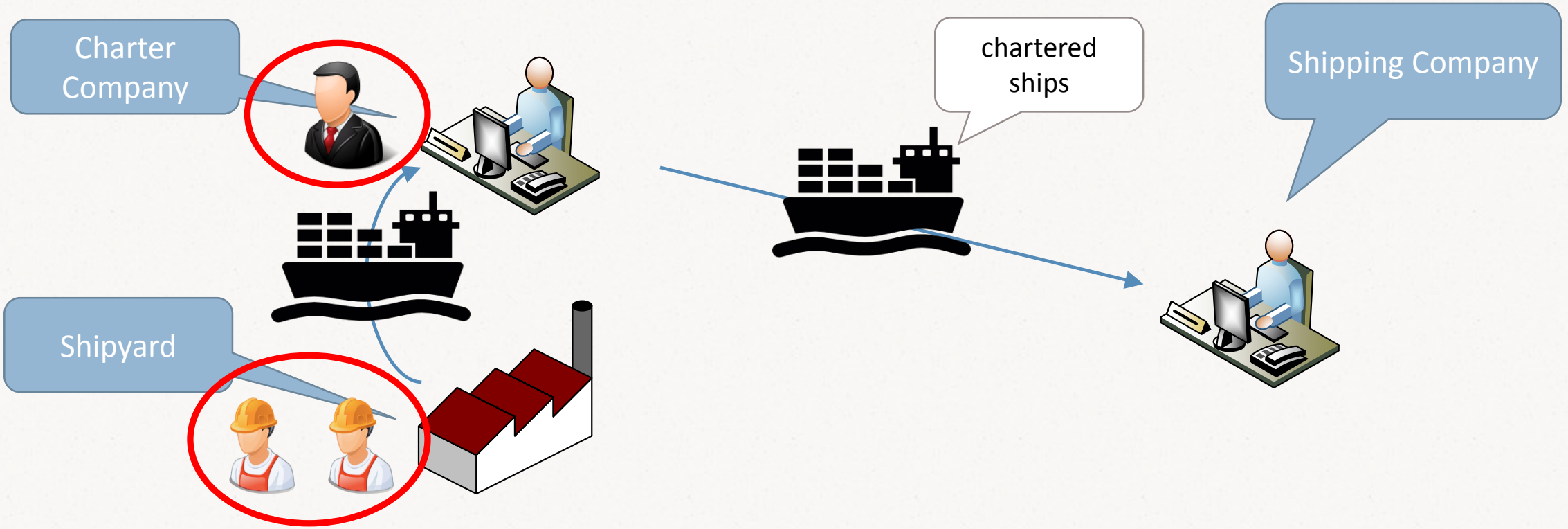
INTERSECTORIAL RELATIONSHIPS

- When the shipping company charters ships from the charter company, the charter company must first acquire the ships from the shipyard, so the chartering of ships has a *direct impact* on the charter company but also an *indirect impact* on the shipyard



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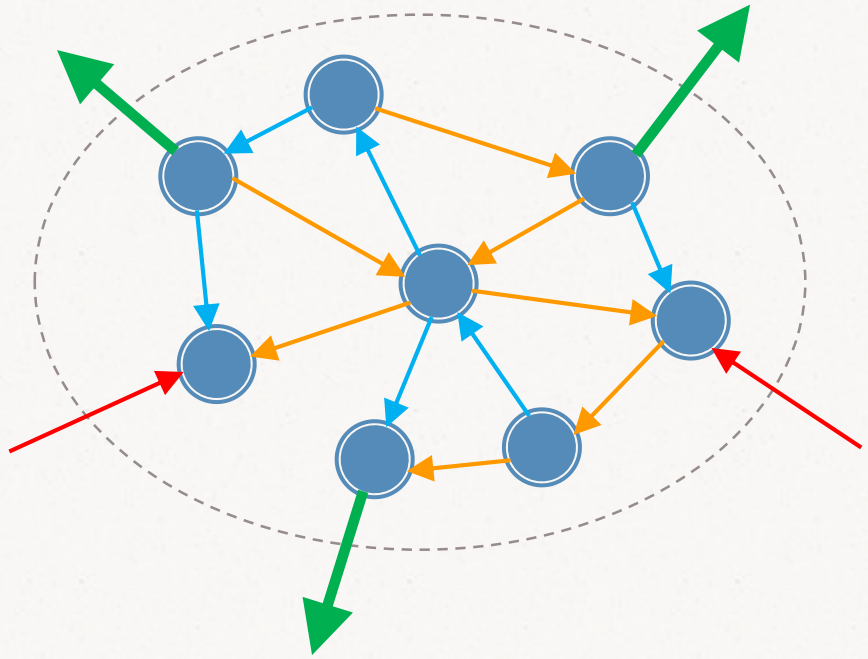
INTERSECTORIAL RELATIONSHIPS

- Therefore, in an economy, companies do not exist in isolation
- They form relationships with other companies, in order to perform their productive function

- Companies *buy inputs* to their production from other companies in the regional economy
- Companies *sell their outputs* to other companies in the regional economy
- Companies *import inputs* to their production from companies located outside the regional economy
- Companies *export their outputs* to their production from companies located outside the regional economy



PART 2: METHODOLOGY

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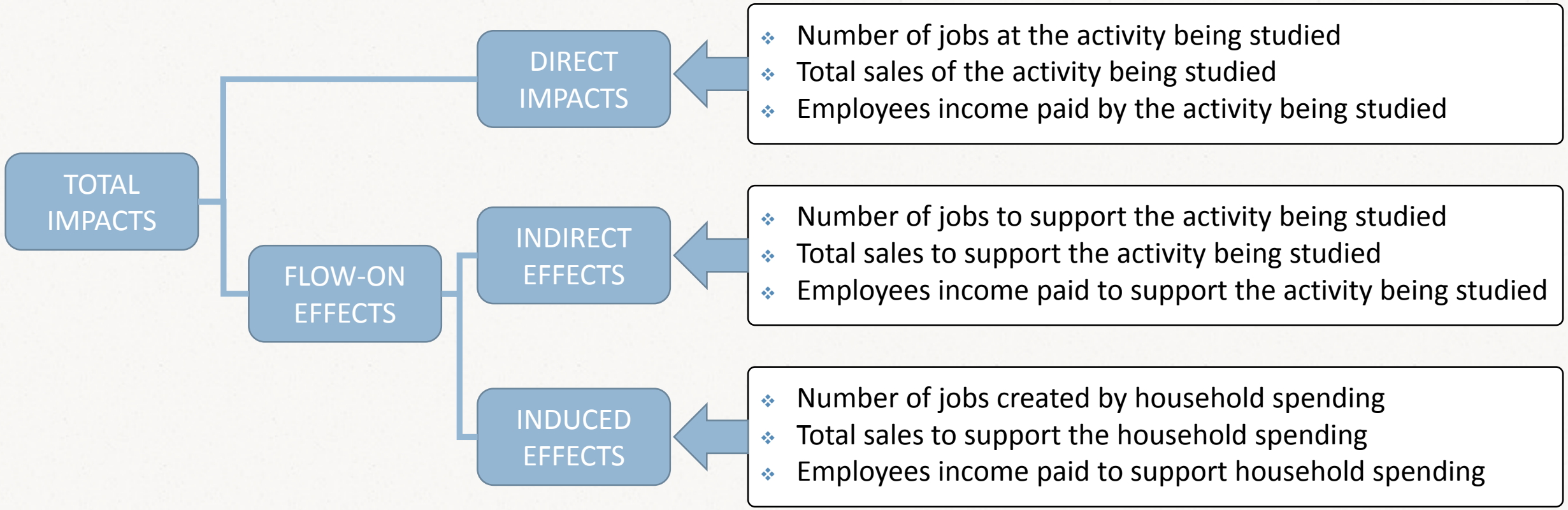
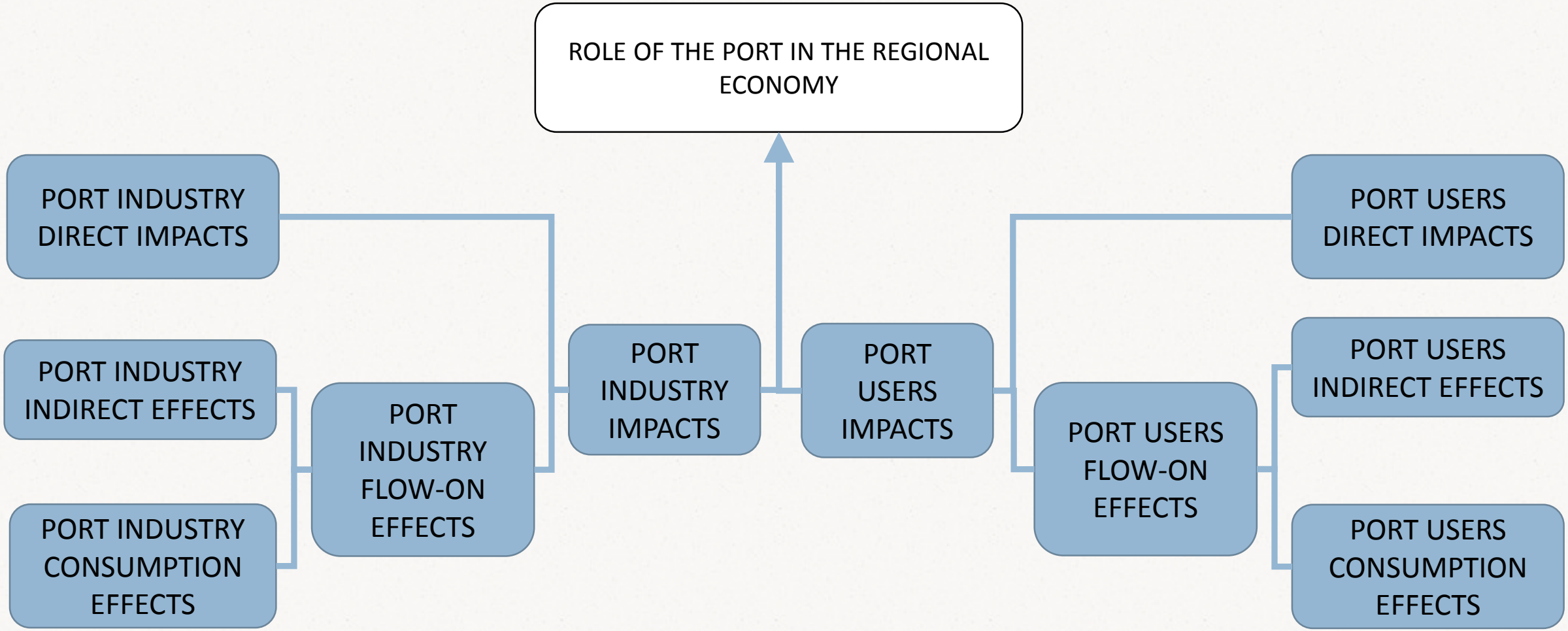
METHODOLOGY



ECONOMIC IMPACTS OF PORTS

GENERAL METHODOLOGY FOR PORT IMPACT STUDIES



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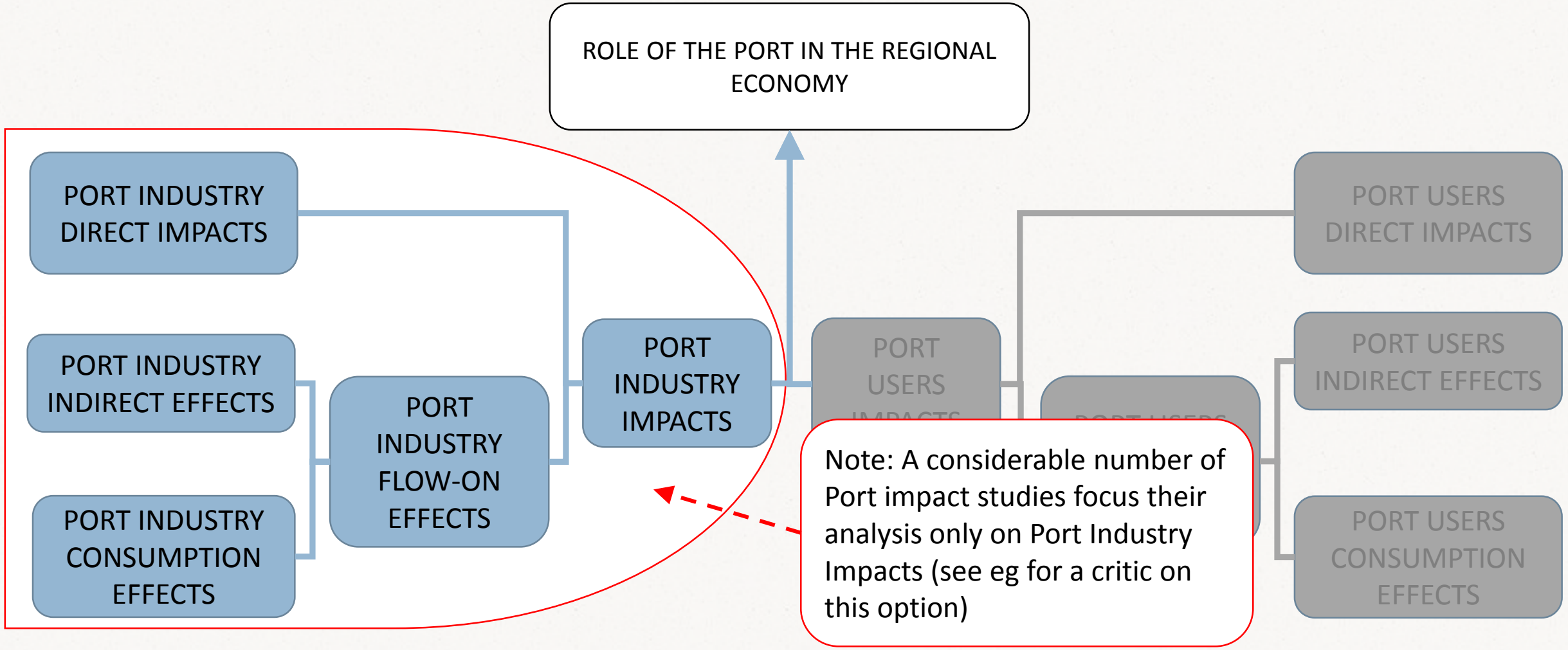
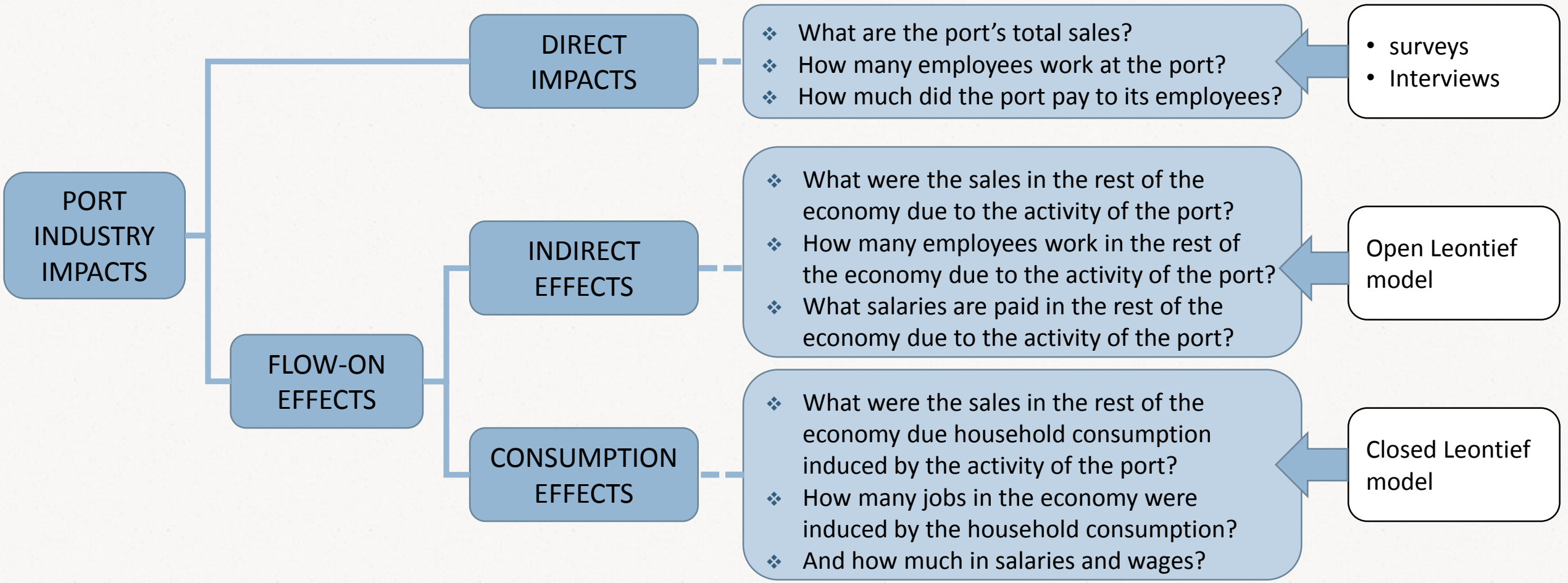


ECONOMIC IMPACTS OF PORTS

METHODOLOGY FOR ASSESSING PORT INDUSTRY IMPACTS



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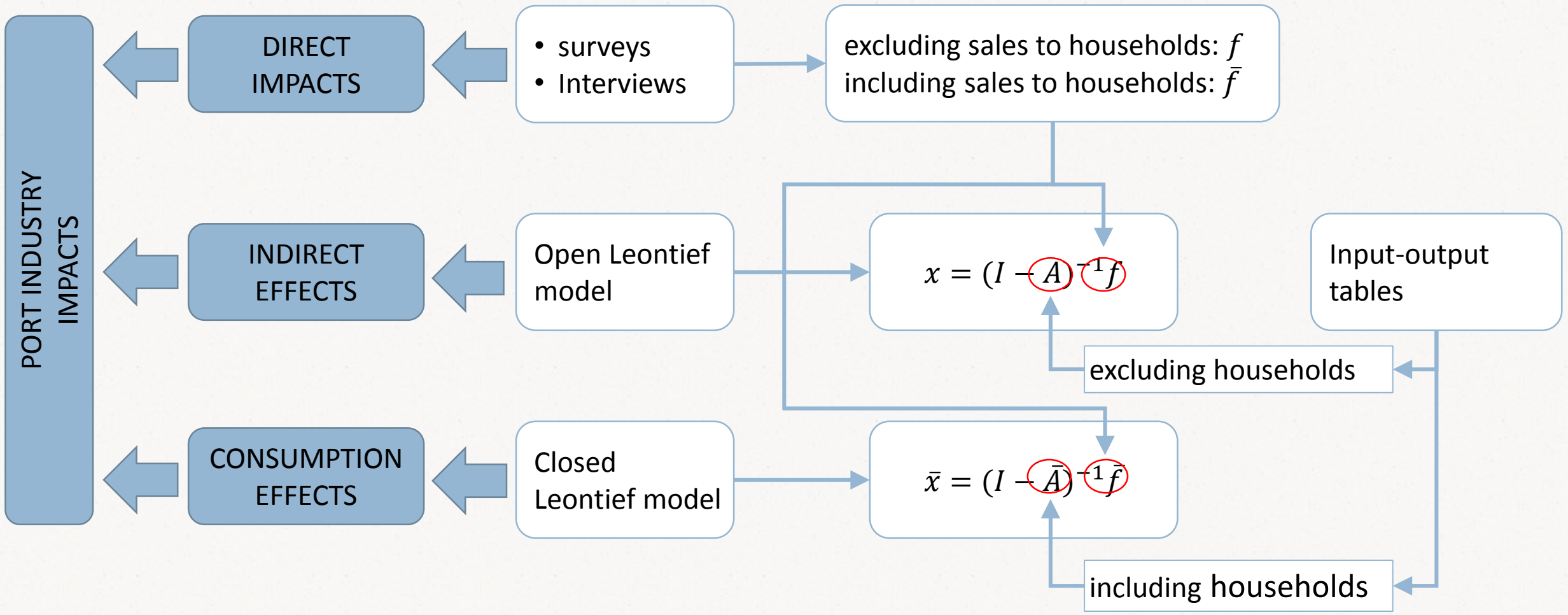

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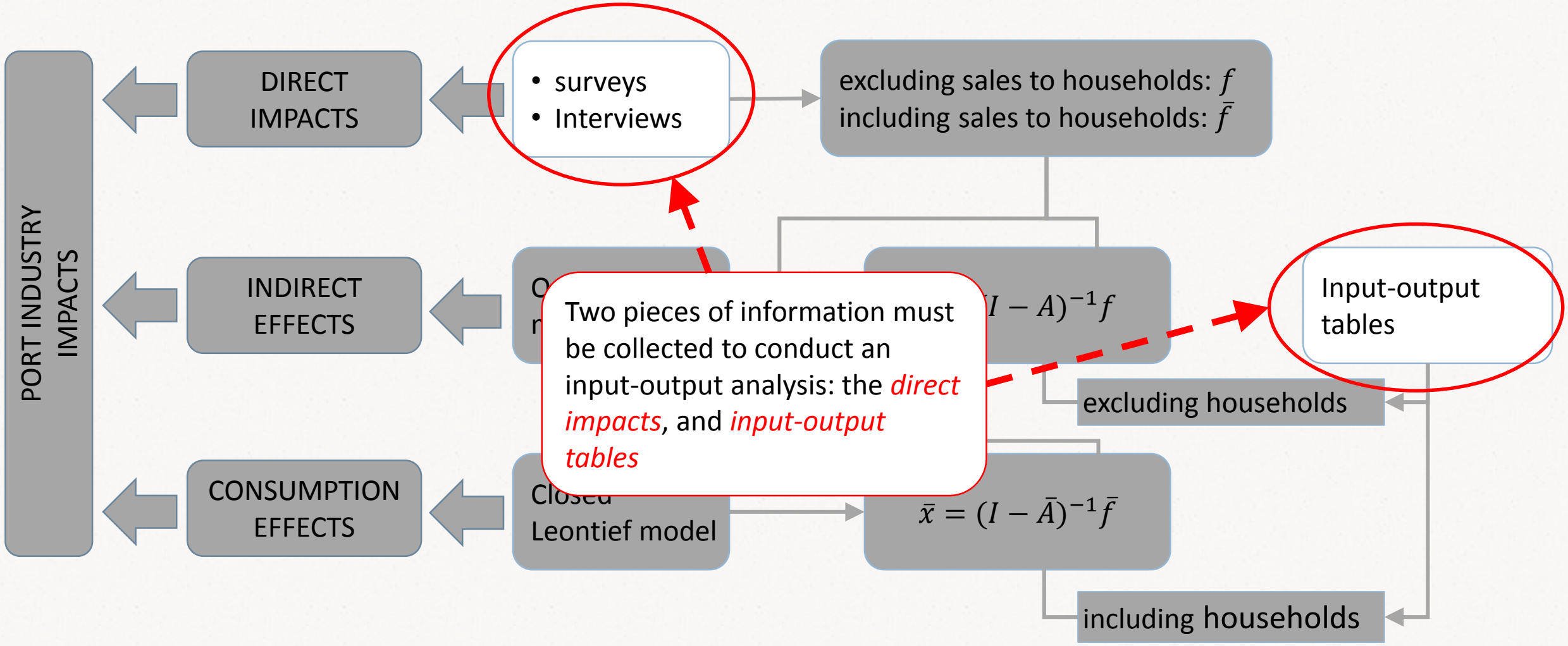

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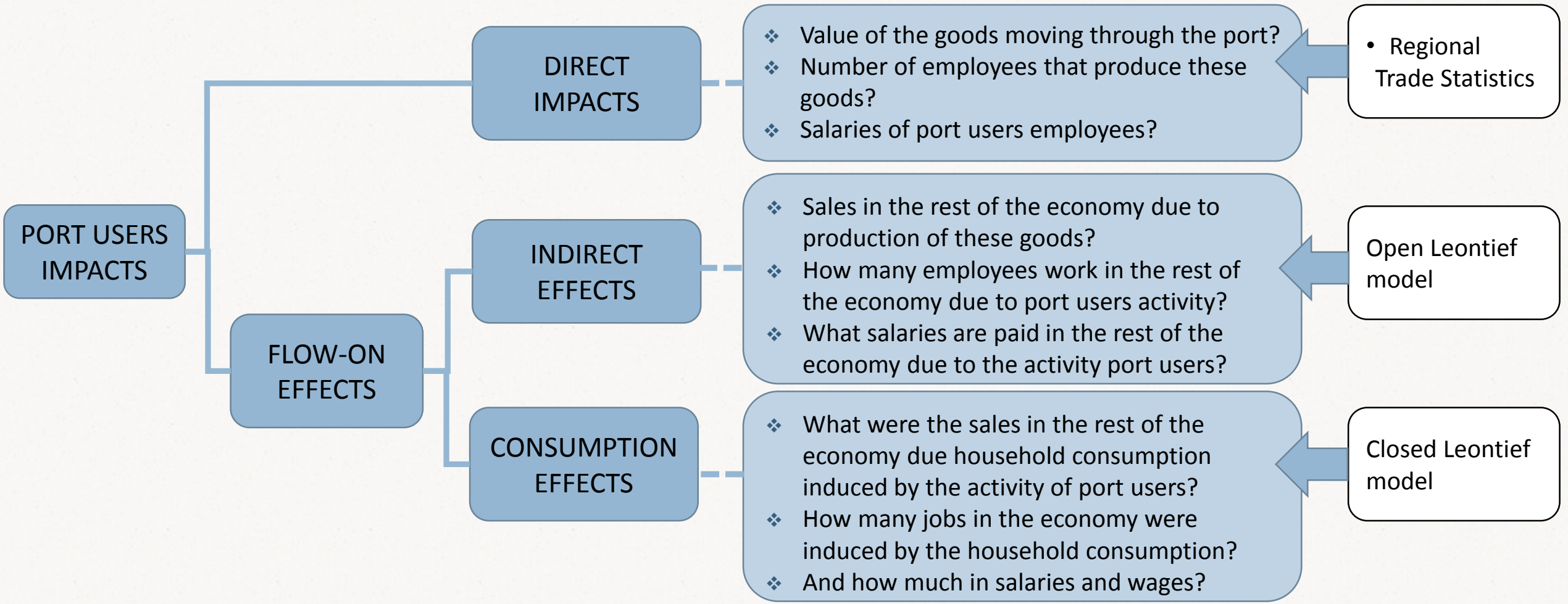
METHODOLOGY FOR ASSESSING PORT USERS IMPACTS



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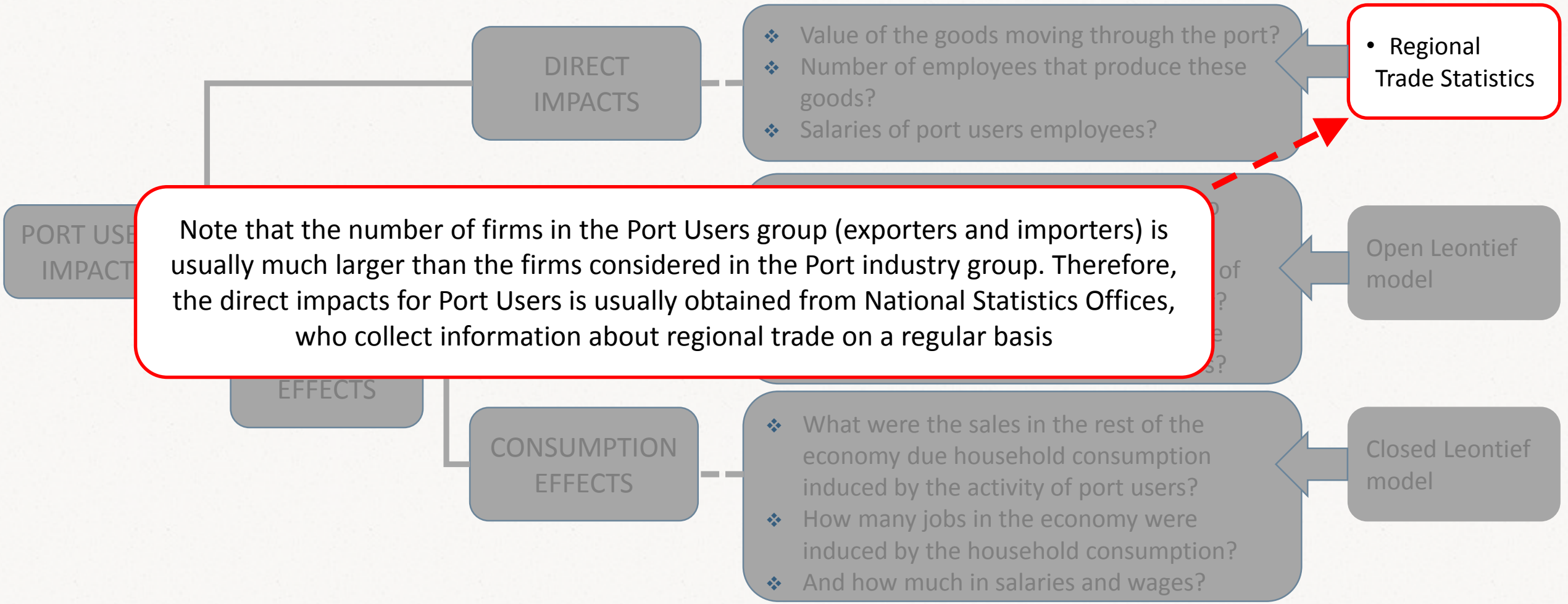

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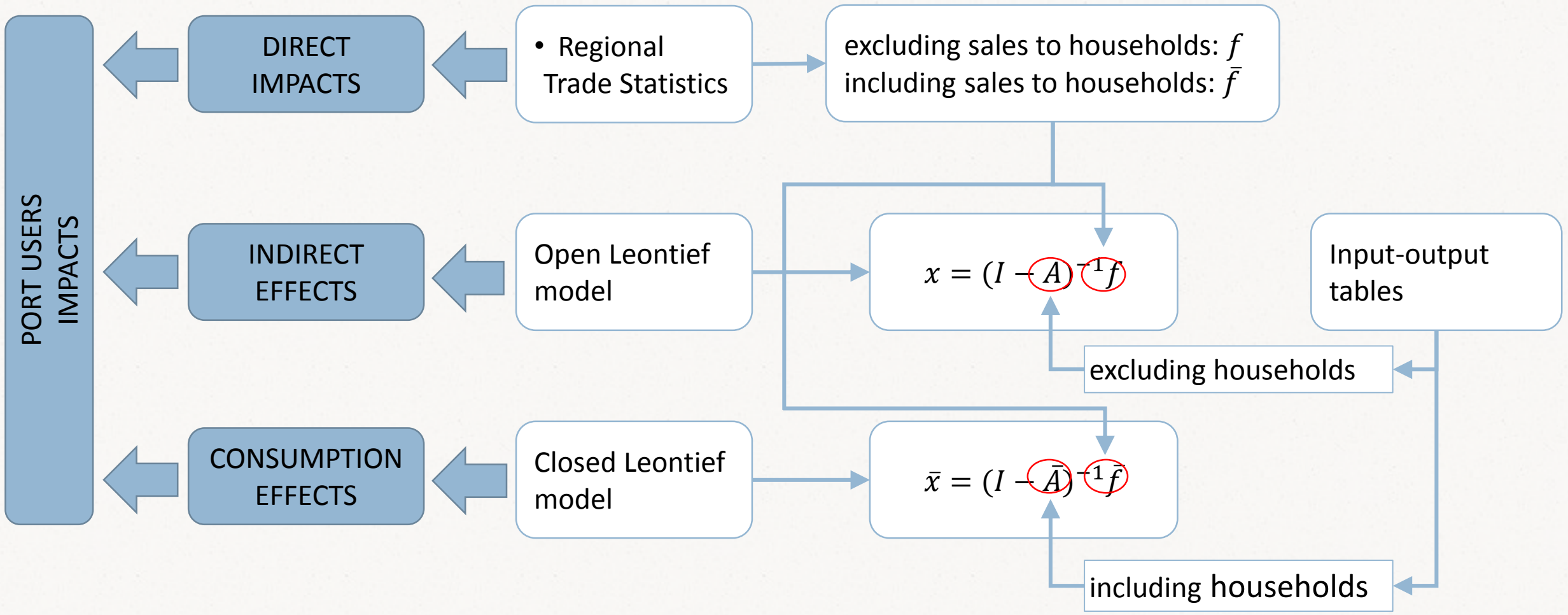

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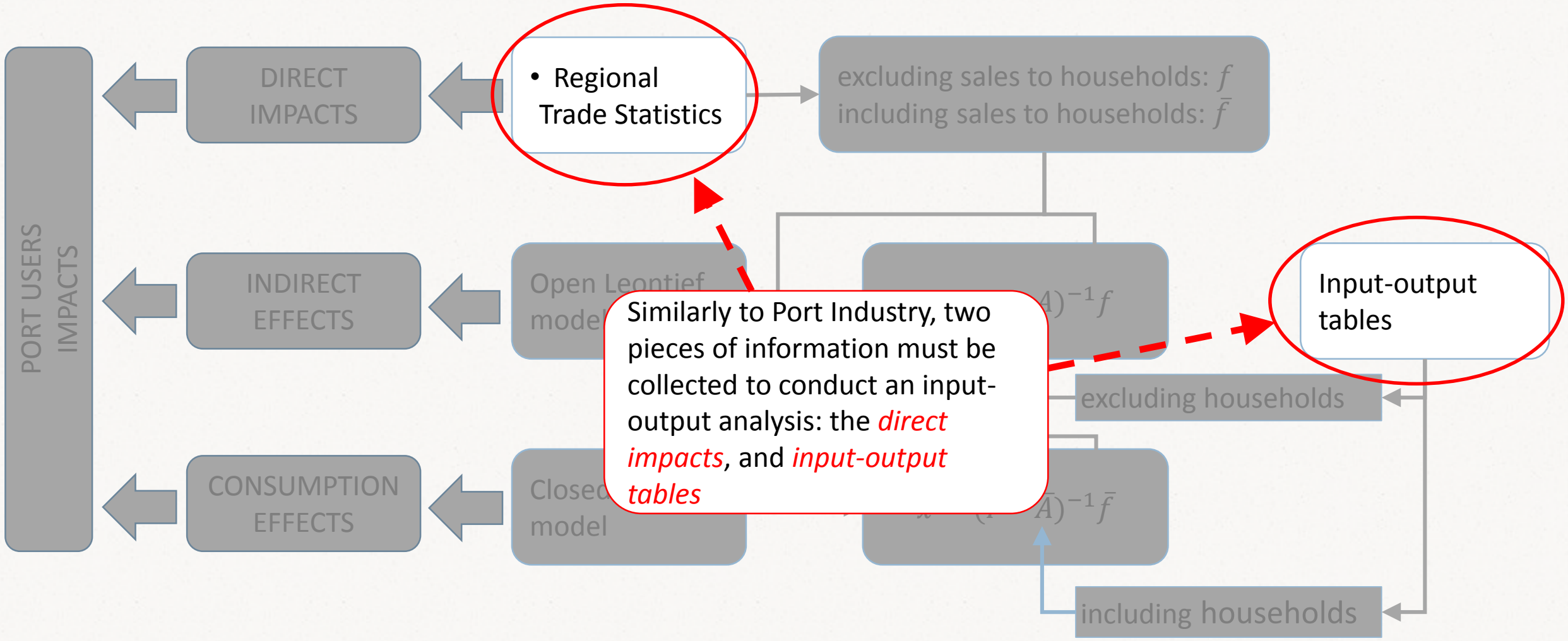


ECONOMIC IMPACTS OF PORTS

SUMMARY OF THE NECESSARY INFORMATION

- Two pieces of information are needed to conduct an input-output analysis of the port industry economic impacts:
  - The direct impacts (collected via surveys and interviews)
  - Input-output tables (obtained from official public officed who publish them regularly)
- Two pieces of information are needed to conduct an input-output analysis of the port users economic impacts:
  - The direct impacts (collected via public statistics offices)
  - Input-output tables (obtained from official public officed who publish them regularly)

Note that this is the same piece of information, therefore, in practice, only three pieces of data are necessary for the whole analysis

PART 3: INPUT-OUTPUT TABLES

ECONOMIC IMPACTS OF PORTS

INPUT-OUTPUT TABLES

- At the heart of multiplier analysis lies the Input-Output table, which depicts the relationships (intersectorial sales and purchases) between activities in a given economy
- Input-output tables allow the representation of the relationships between the companies in a given economy, and allow the calculation of the indirect and induced impacts of a given activity
- An input-output table is constructed from observed data for a *particular economic area* – a nation, a region (however defined), a state, etc, *for a given year* (usually every 5 years)

ECONOMIC IMPACTS OF PORTS

INPUT-OUTPUT TABLES

		BUYING SECTOR					FINAL DEMAND				TOTAL OUTPUT
		1	...	*j*	...	*n*	*c*	*i*	*g*	*e*	
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}	c_1	i_1	g_1	e_1	x_1
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}	c_i	i_i	g_i	e_i	x_i
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	n	z_{n1}	...	z_{nj}	...	z_{nn}	c_n	i_n	g_n	e_n	x_n
PAYMENTS SECTORS	*v*	v_1	...	v_j	...	v_n	v_C	v_I	v_G	v_E	*V*
	m	m_1	...	m_j	...	m_n	m_C	m_I	m_G	m_E	*M*
TOTAL OUTLAYS		x_1	...	x_j	...	x_n	*C*	*I*	*G*	*E*	*X*

ECONOMIC IMPACTS OF PORTS

INPUT-OUTPUT TABLES

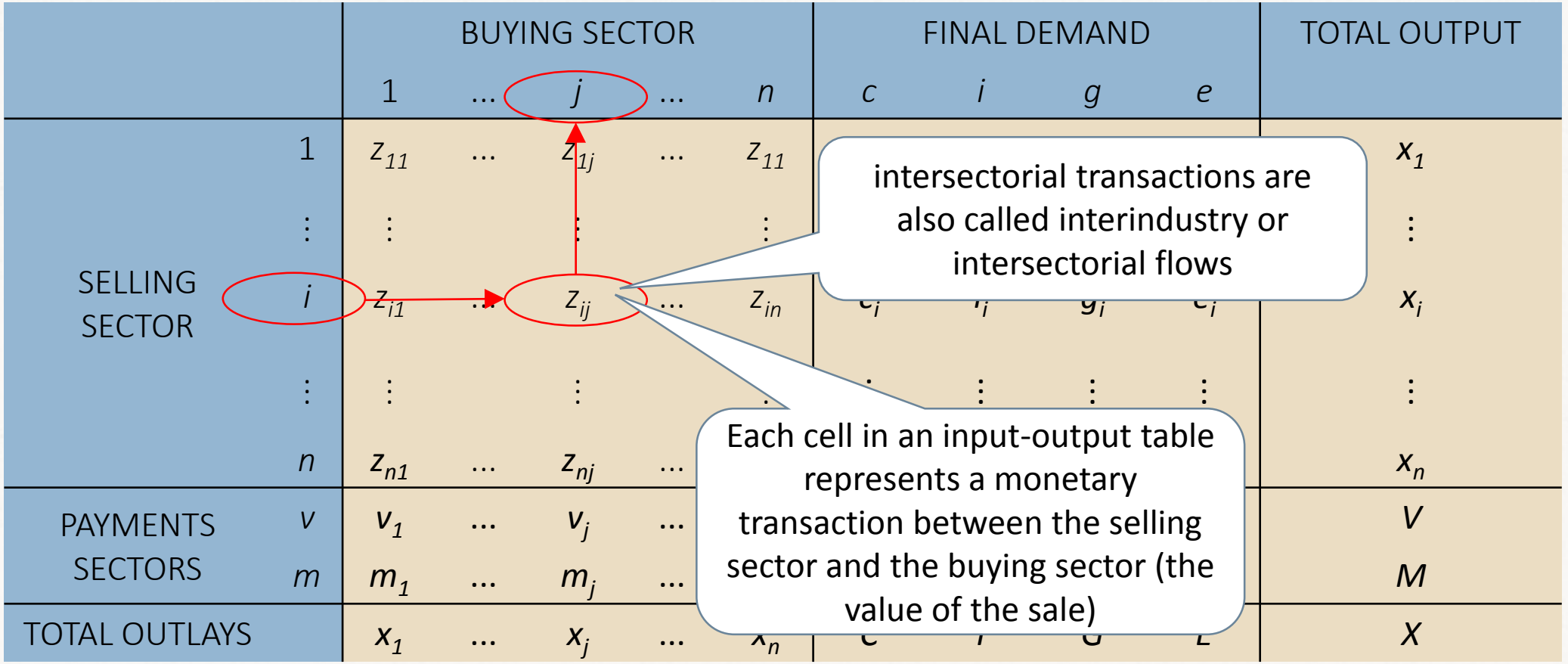
		BUYING SECTOR					FINAL DEMAND				TOTAL OUTPUT
		1	...	*j*	...	*n*	*c*	*i*	*g*	*e*	
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}	c_1	i_1	g_1	e_1	x_1
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	i	z_{i1}	...								x_i
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	n	z_{n1}	...								x_n
PAYMENTS SECTORS	*v*	v_1	...								*V*
	m	m_1	...								*M*
TOTAL OUTLAYS		x_1	...	x_j	...	x_n	*C*	*I*	*G*	*E*	*X*

The economic activity in the area is separated into a number of segments or producing sectors

The producing sectors may be industries in the usual sense (eg, steel) or may be much smaller categories (eg, stell nails) or much larger ones (eg, manufacturing)

ECONOMIC IMPACTS OF PORTS

INPUT-OUTPUT TABLES



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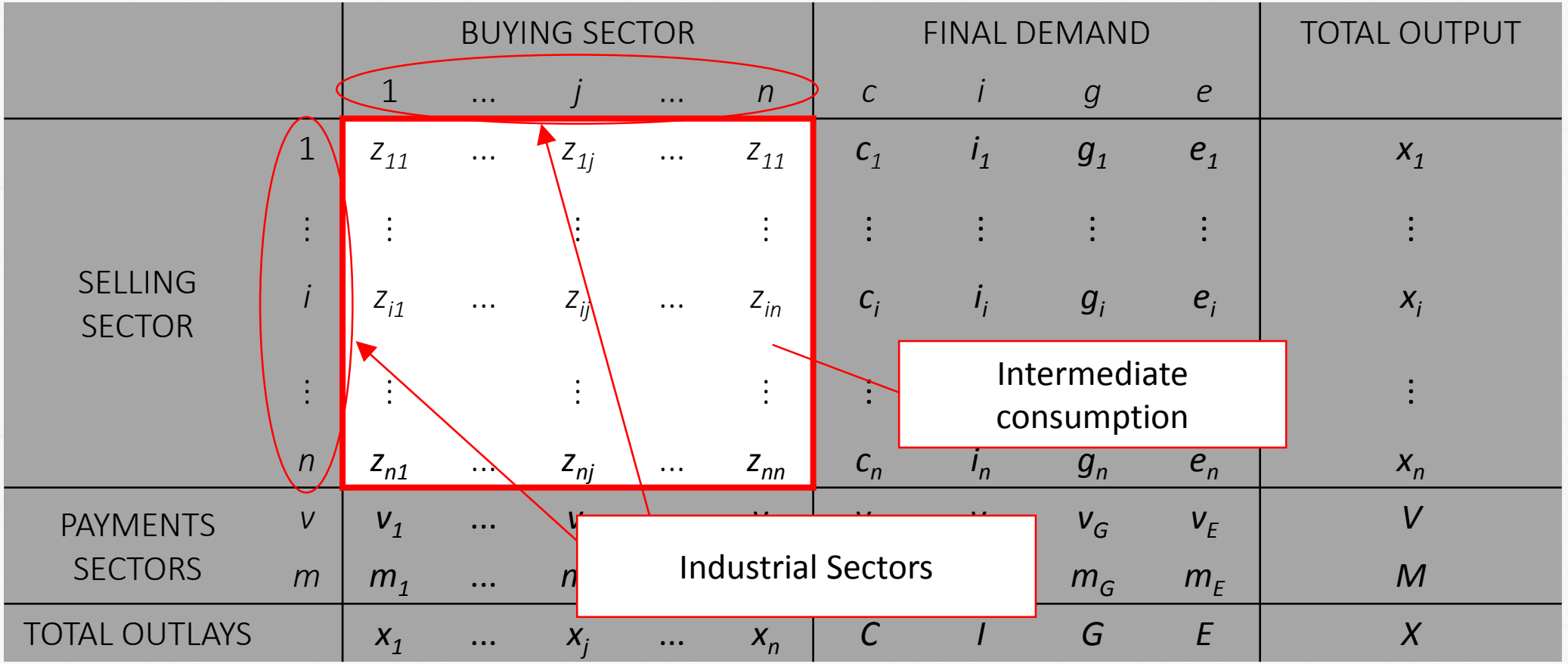

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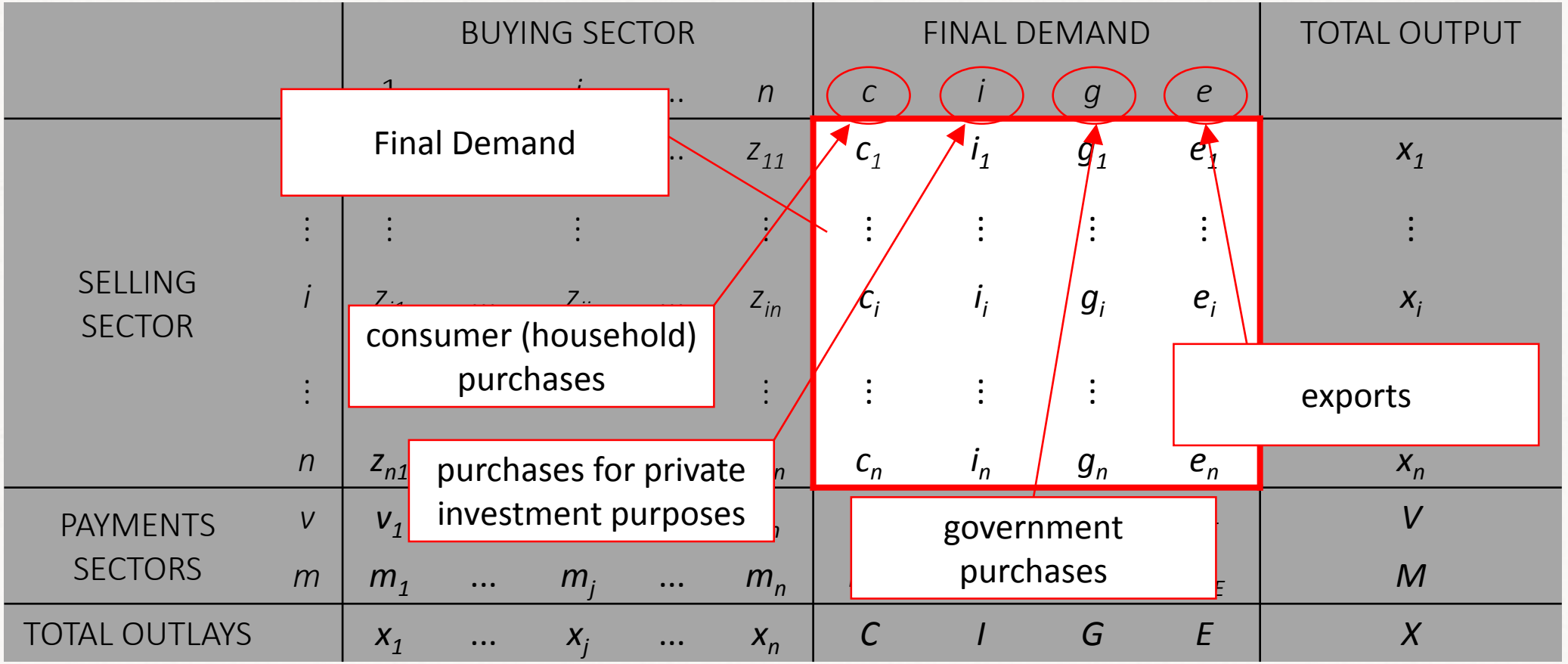

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INPUT-OUTPUT TABLES

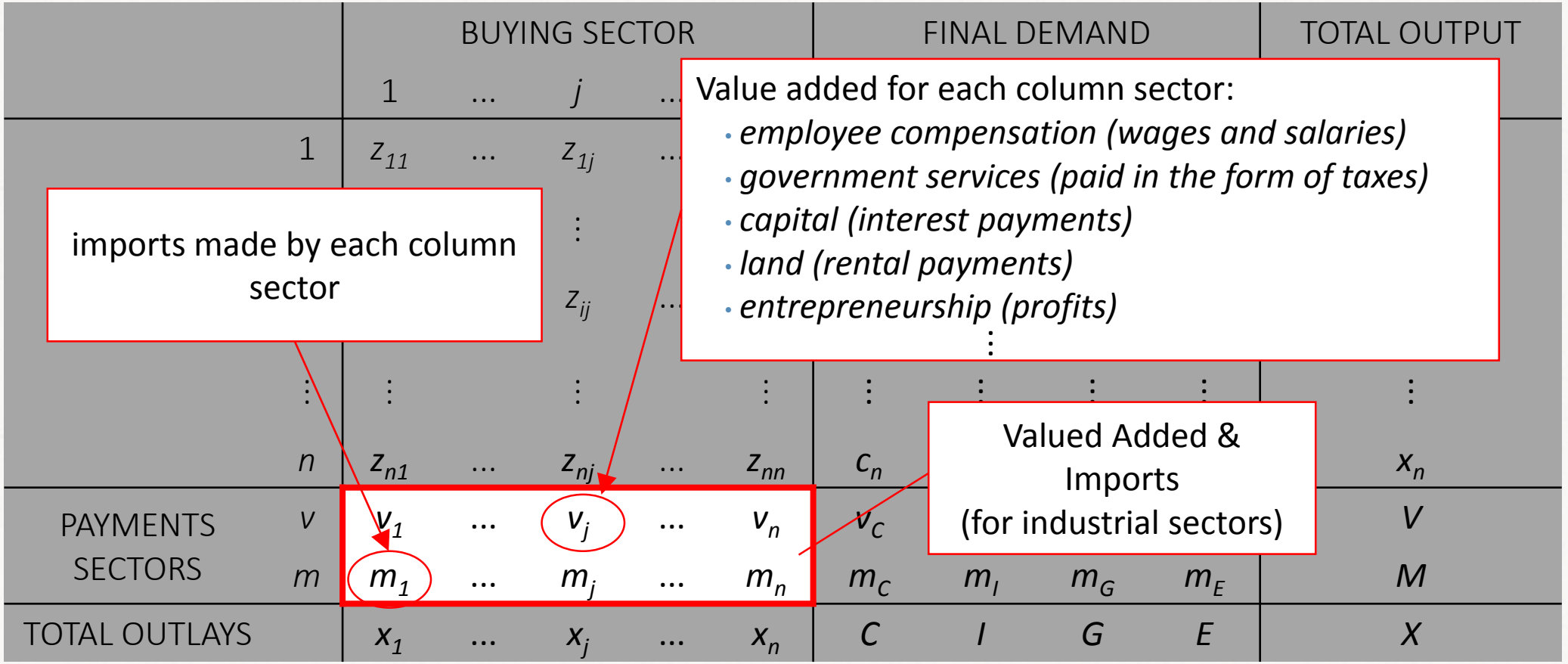
		BUYING SECTOR					FINAL DEMAND				TOTAL OUTPUT
		1	...	*j*	...	*n*	*c*	*i*	*g*	*e*	
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}	c_1	i_1	g_1	e_1	x_1
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	i	z_{i1}	...	z_{ij}	...	z_{i}				e_i	x_i
	⋮	⋮		⋮		⋮				⋮	⋮
	n	z_{n1}	...	z_{nj}	...					$_n$	x_n
PAYMENTS SECTORS	*v*	v_1	...	v_j	...					$_E$	*V*
	m	m_1	...	m_j	...	$_n$	$_C$	$_I$	$_G$	$_E$	*M*
TOTAL OUTLAYS		x_1	...	x_j	...	x_n	*C*	*I*	*G*	*E*	*X*

Total Regional Industrial Output (Production)

each cell contains the total sales made by the corresponding row sector *i*

ECONOMIC IMPACTS OF PORTS

INPUT-OUTPUT TABLES



ECONOMIC IMPACTS OF PORTS

INPUT-OUTPUT TABLES

		BUYING SECTOR					FINAL DEMAND				TOTAL OUTPUT
		1	...	*j*	...	*n*	*c*	*i*	*g*	*e*	
SELLING SECTOR	1	z_{11}	...						g_1	e_1	x_1
	⋮	⋮							⋮	⋮	⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}	c_i	i_i			
	.	.		.		⋮	⋮	⋮	⋮	⋮	⋮
						z_{nn}	c_n	i_n	g_n	e_n	x_n
PAYMENTS SECTORS						v_n	v_C	v_I	v_G	v_E	*V*
	m	m_1	...	m_j	...	m_n	m_C	m_I	m_G	m_E	*M*
TOTAL OUTLAYS		x_1	...	x_j	...	x_n	*C*	*I*	*G*	*E*	*X*

eg, household payments for domestic help, tax payments by households...

eg, government imports, household imports, re-exported imports...

Valued Added & Imports (for final demand sectors)

ECONOMIC IMPACTS OF PORTS

INPUT-OUTPUT TABLES

		BUYING SECTOR					FINAL DEMAND				TOTAL OUTPUT
		1	...	*j*	...	*n*	*c*	*i*	*g*	*e*	
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}	c_1	i_1	g_1	e_1	x_1
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}	c_i	i_i	g_i	e_i	x_i
	⋮	⋮		⋮						⋮	⋮
	n	z_{n1}	...	z_{nj}	...					e_n	x_n
PAYMENTS SECTORS	*v*	v_1	...	v_j	...					v_E	*V*
	m	m_1	...	m_j	...	m_n	m_C	m_I	m_G	m_E	*M*
TOTAL OUTLAYS		x_1	...	x_j	...	x_n	*C*	*I*	*G*	*E*	*X*

Total Regional Valued Added & Imports

ECONOMIC IMPACTS OF PORTS

INPUT-OUTPUT TABLES

		BUYING SECTOR					FINAL DEMAND				TOTAL OUTPUT
		1	...	*j*	...	*n*	*c*	*i*	*g*	*e*	
	1	z_{11}	...	z_{1j}	...	z_{11}	c_1	i_1	g_1	e_1	x_1
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
				z_{ij}	...	z_{in}	c_i	i_i	g_i	e_i	x_i
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	n	z_{n1}	...	z_{nj}	...	z_{nn}	c_n				x_n
PAYMENTS SECTORS	*v*	v_1	...	v_j	...	v_n	v_C				*V*
	m	m_1	...	m_j	...	m_n	m_C	m_I	m_G	m_E	*M*
TOTAL OUTLAYS		x_1	...	x_j	...	x_n	*C*	*I*	*G*	*E*	*X*

each cell contains the total purchases made by the corresponding column sector *j*

Total Regional Industrial Purchases

ECONOMIC IMPACTS OF PORTS

INPUT-OUTPUT TABLES

		BUYING SECTOR					FINAL DEMAND				TOTAL OUTPUT
		1	...	*j*	...	*n*	*c*	*i*	*g*	*e*	
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}	c_1	i_1	g_1	e_1	x_1
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}	c_i	i_i	g_i	e_i	x_i
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	n					z_{nn}	c_n	i_n	g_n	e_n	x_n
PAYMENTS SECTORS	*v*					v_n	v_C	v_I	v_G	v_E	*V*
	m	m_1	...	m_j	...	m_n	m_C	m_I	m_G	m_E	*M*
TOTAL OUTLAYS		x_1	...	x_j	...	x_n	*C*	*I*	*G*	*E*	*X*

Total Regional Final Demand Purchases

ECONOMIC IMPACTS OF PORTS

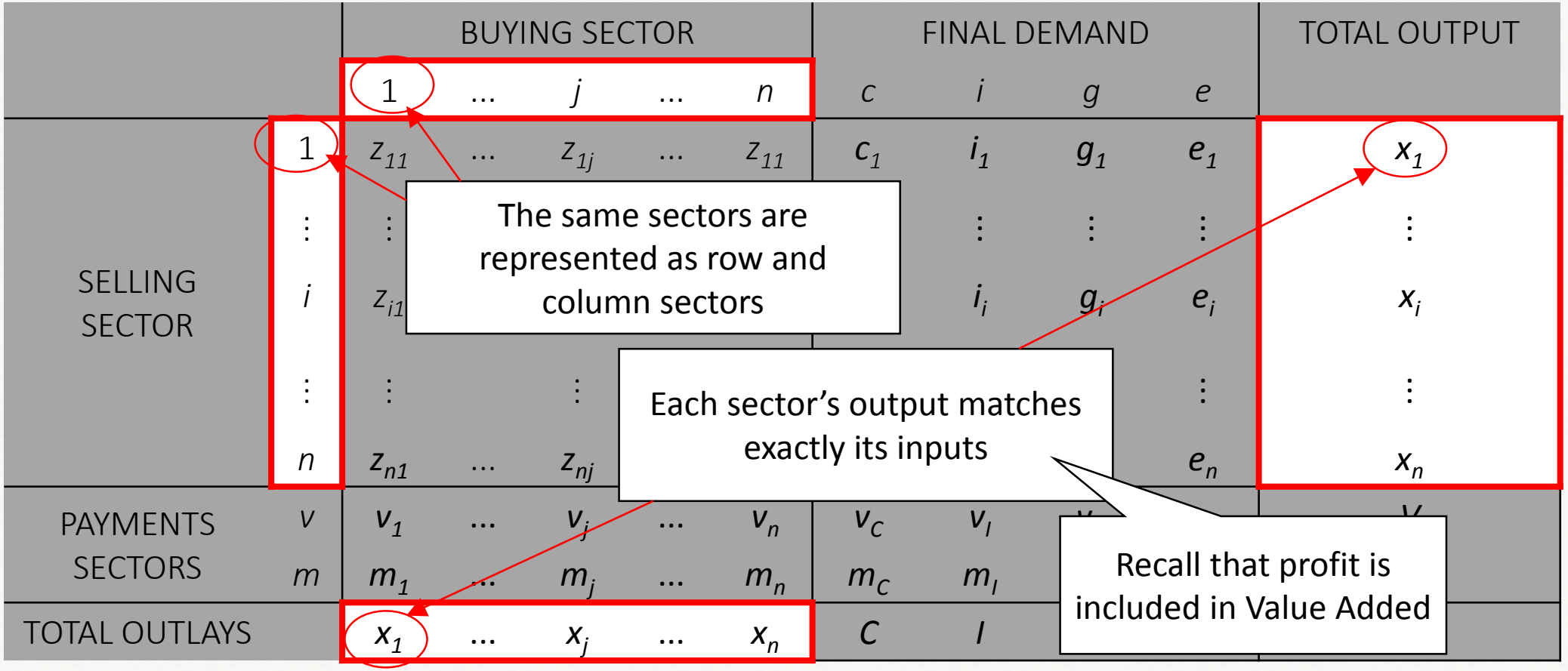
INPUT-OUTPUT TABLES

		BUYING SECTOR					FINAL DEMAND				TOTAL OUTPUT
		1	...	*j*	...	*n*	*c*	*i*	*g*	*e*	
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}	c_1	i_1	g_1	e_1	x_1
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}	c_i	i_i	g_i	e_i	x_i
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	n	z_{n1}	...	z_{nj}	...	z_{nn}					x_n
PAYMENTS SECTORS	*v*	v_1	...	v_j	...	v_n					*V*
	m	m_1	...	m_j	...	m_n	m_C	m_I	m_G	m_E	*M*
TOTAL OUTLAYS		x_1	...	x_j	...	x_n	*C*	*I*	*G*	*E*	*X*

Total Regional Production
(Output=Input)

ECONOMIC IMPACTS OF PORTS

INPUT-OUTPUT TABLES



ECONOMIC IMPACTS OF PORTS

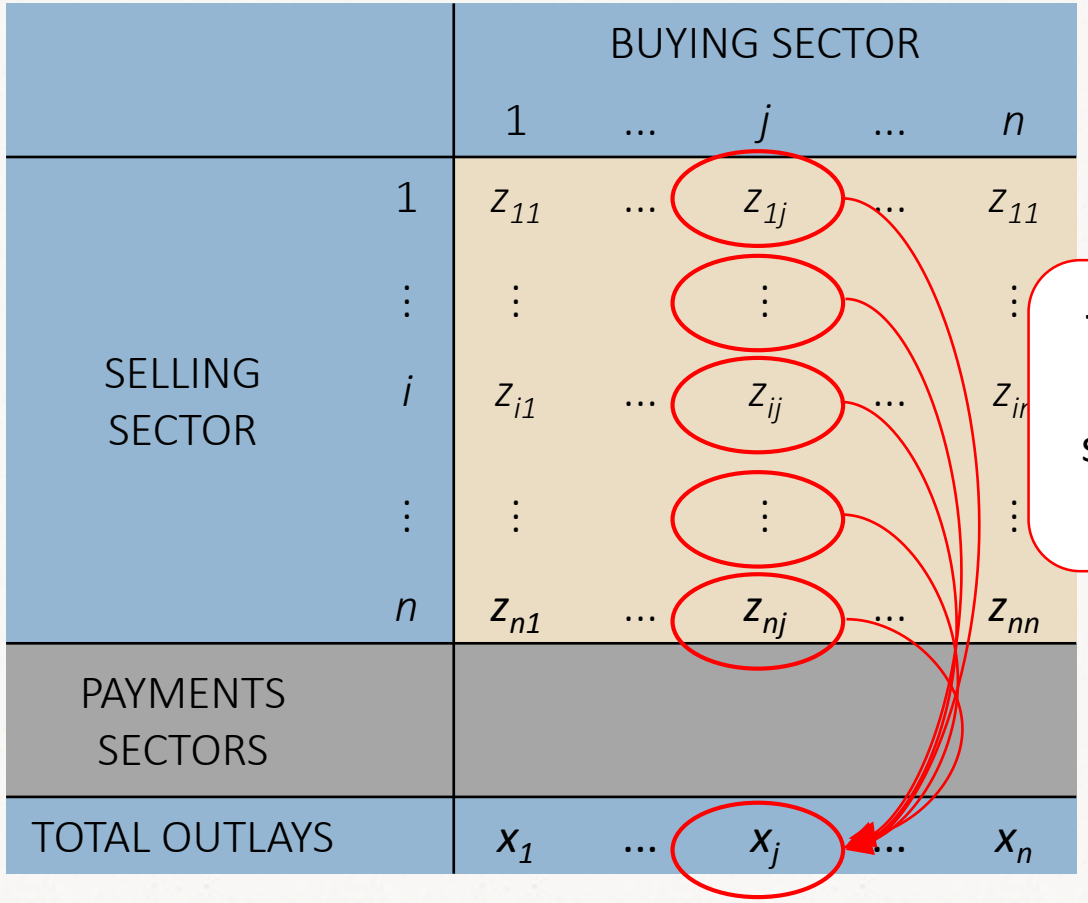
INPUT-OUTPUT TABLES

- In summary, Input-Output tables allow a complete description of all transactions occurring in an economy between industrial sectors, private sectors and the government
- Input-Output tables capture how much input of each sector a given activity needs in order to produce its output
- Next we will focus our attention on a particular part of the input-output table – the intermediate concumption table - and manipulate it to obtain one of the pieces of information that we need to be able to apply the Leontief model: the Technical Coefficients Table

PART 4: THE TECHNICAL COEFFICIENTS TABLE

ECONOMIC IMPACTS OF PORTS

THE TECHNICAL COEFFICIENTS TABLE



To achieve a total production of x_j, sector *j* must acquire a series of inputs to production from other sectors

ECONOMIC IMPACTS OF PORTS

THE TECHNICAL COEFFICIENTS TABLE

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}
	⋮	⋮		⋮		⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}
	⋮	⋮		⋮		⋮
	n	z_{n1}	...	z_{nj}	...	z_{nn}
TOTAL OUTLAYS		x_1	...	x_j	...	x_n

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	$\frac{z_{11}}{x_1} = a_{11}$				
	⋮					
	i					
	⋮					
	n					

This ratio is called a technical coefficient because it expresses the technological interdependency between the two sectors*

* Note that monetary transactions are sensitive to prices, ahtough they are still a strong proxy to expressing the degree of technology interdependency)

ECONOMIC IMPACTS OF PORTS

THE TECHNICAL COEFFICIENTS TABLE

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}
	⋮	⋮		⋮		⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}
	⋮	⋮		⋮		⋮
	n	z_{n1}	...	z_{nj}	...	z_{nn}
TOTAL OUTLAYS		x_1	...	x_j	...	x_n

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	a_{11}				
	⋮	⋮				
	i	$\frac{z_{i1}}{x_1} = a_{i1}$				
	⋮					
	n					

ECONOMIC IMPACTS OF PORTS

THE TECHNICAL COEFFICIENTS TABLE

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}
	⋮	⋮		⋮		⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}
	⋮	⋮		⋮		⋮
	n	z_{n1}	...	z_{nj}	...	z_{nn}
TOTAL OUTLAYS		x_1	...	x_j	...	x_n

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	a_{11}				
	⋮	⋮				
	i	a_{i1}				
	⋮	⋮				
	n	$\frac{z_{n1}}{x_1} = a_{n1}$				

ECONOMIC IMPACTS OF PORTS

THE TECHNICAL COEFFICIENTS TABLE

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}
	⋮	⋮		⋮		⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}
	⋮	⋮		⋮		⋮
	n	z_{n1}	...	z_{nj}	...	z_{nn}
TOTAL OUTLAYS		x_1	...	x_j	...	x_n

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	a_{11}	...	$\frac{z_{1j}}{x_j} = a_{1j}$		
	⋮	⋮				
	i	a_{i1}	...			
	⋮	⋮				
	n	a_{n1}	...			

ECONOMIC IMPACTS OF PORTS

THE TECHNICAL COEFFICIENTS TABLE

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}
	⋮	⋮		⋮		⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}
	⋮	⋮		⋮		⋮
	n	z_{n1}	...	z_{nj}	...	z_{nn}
TOTAL OUTLAYS		x_1	...	x_j	...	x_n

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	a_{11}	...	a_{1j}		
	⋮	⋮		⋮		
	i	a_{i1}	...	$\frac{z_{ij}}{x_j} = a_{ij}$		
	⋮	⋮				
	n	a_{n1}	...			

ECONOMIC IMPACTS OF PORTS

THE TECHNICAL COEFFICIENTS TABLE

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}
	⋮	⋮		⋮		⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}
	⋮	⋮		⋮		⋮
	n	z_{n1}	...	z_{nj}	...	z_{nn}
TOTAL OUTLAYS		x_1	...	x_j	...	x_n

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	a_{11}	...	a_{1j}		
	⋮	⋮		⋮		
	i	a_{i1}	...	a_{ij}		
	⋮	⋮		⋮		
	n	a_{n1}	...	$\frac{z_{nj}}{x_j} = a_{nj}$		

ECONOMIC IMPACTS OF PORTS

THE TECHNICAL COEFFICIENTS TABLE

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}
	⋮	⋮		⋮		⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}
	⋮	⋮		⋮		⋮
	n	z_{n1}	...	z_{nj}	...	z_{nn}
TOTAL OUTLAYS		x_1	...	x_j	...	x_n

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	a_{11}	...	a_{1j}	...	$\frac{z_{1n}}{x_n}=a_{1n}$
	⋮	⋮		⋮		
	i	a_{i1}	...	a_{ij}	...	
	⋮	⋮		⋮		
	n	a_{n1}	...	a_{nj}	...	

ECONOMIC IMPACTS OF PORTS

THE TECHNICAL COEFFICIENTS TABLE

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}
	⋮	⋮		⋮		⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}
	⋮	⋮		⋮		⋮
	n	z_{n1}	...	z_{nj}	...	z_{nn}
TOTAL OUTLAYS		x_1	...	x_j	...	x_n

		BUYING SECTOR				
		1	...	*j*	...	*n*
SELLING SECTOR	1	a_{11}	...	a_{1j}	...	a_{1n}
	⋮	⋮		⋮		⋮
	i	a_{i1}	...	a_{ij}	...	$\frac{z_{in}}{x_n}=a_{in}$
	⋮	⋮		⋮		
	n	a_{n1}	...	a_{nj}	...	

ECONOMIC IMPACTS OF PORTS

THE TECHNICAL COEFFICIENTS TABLE

		BUYING SECTOR				
		1	...	j	...	n
SELLING SECTOR	1	z_{11}	...	z_{1j}	...	z_{11}
	⋮	⋮		⋮		⋮
	i	z_{i1}	...	z_{ij}	...	z_{in}
	⋮	⋮		⋮		⋮
	n	z_{n1}	...	z_{nj}	...	z_{nn}
TOTAL OUTLAYS		x_1	...	x_j	...	x_n

		BUYING SECTOR				
		1	...	j	...	n
SELLING SECTOR	1	a_{11}	...	a_{1j}	...	a_{1n}
	⋮	⋮		⋮		⋮
	i	a_{i1}	...	a_{ij}	...	a_{in}
	⋮	⋮		⋮		⋮
	n	a_{n1}	...	a_{nj}	...	$\frac{z_{nn}}{x_n}=a_{nn}$

ECONOMIC IMPACTS OF PORTS

THE TECHNICAL COEFFICENTS TABLE

- The obtained table is called the technical coefficients table, denoted A (more appropriately, the open technical coefficients table)

		BUYING SECTOR				
		1	…	j	…	n
SELLING SECTOR	1	a_{11}	…	a_{1j}	…	a_{1n}
	⋮	⋮		⋮		⋮
	i	a_{i1}	…	a_{ij}	…	a_{in}
	⋮	⋮		⋮		⋮
	n	a_{n1}	…	a_{nj}	…	a_{nn}

Open Technical Coefficients Matrix, A

ECONOMIC IMPACTS OF PORTS

THE TECHNICAL COEFFICENTS TABLE

- If the household sector is included as an additional production sector (where coefficients for wages & salaries make the extra row, coefficients for private household consumption makes the extra column, and the single coefficient for household payments to domestic help make the crossing cell), then the closed technical coefficients table, $\bar{A}$, is obtained

Closed Technical Coefficients Matrix, $\bar{A}$

		BUYING SECTOR					
		1	...	j	...	n	h
SELLING SECTOR	1	a_{11}	...	a_{1j}	...	a_{1n}	$hc_1/C=a_{1h}$
	⋮	⋮		⋮		⋮	⋮
	i	a_{i1}	...	a_{ij}	...	a_{in}	$hc_i/C=a_{ih}$
	⋮	⋮		⋮		⋮	⋮
	n	a_{n1}	...	a_{nj}	...	a_{nn}	$hc_n/C=a_{nh}$
	h	$hs_1/X_1=a_{h1}$	...	$hs_j/X_j=a_{hj}$	...	$hs_h/X_n=a_{hn}$	$hc_h/C=a_{hh}$

ECONOMIC IMPACTS OF PORTS

THE TECHNICAL COEFFICENTS TABLE

- Having obtained the direct impacts (through surveys and/or interviews for the port industry; through statistics offices for port users) and the regional technical coefficients tables (open and closed with respect to households), the calculation of economic impacts follows directly from the application of Leontief's model:

DIRECT IMPACTS	f
DIRECT+INDIRECT EFFECTS	$x = (I - A)^{-1} f$
DIRECT+INDIRECT+CONSUMPTION EFFECTS	$\bar{x} = (I - \bar{A})^{-1} \bar{f}$

Note that the application of the open Leontief model results in both directs and indirect impacts being calculated; the application of the closed Leontief model results in total impacts being calculated; simple algebra allows the derivation of indirect and consumption or induced effects

PART 5: LEONTIEF'S MODEL

ECONOMIC IMPACTS OF PORTS

LEONTIEF'S MODEL

- Suppose there is some level of private demand (ie household demand) for the output of the automotive sector (sector *i*)
- We write such demand as f_i, to denote such final demand, in monetary units
- We could think that the automobile sector only has to produce enough to satisfy the final demand:

$$x_i = f_i$$

- This is incorrect, because the automotive sector must also sell its output to the other intermediate (industrial) sectors of the economy for them to be able to produce their outputs:

$$x_i = z_{i1} + \cdots + z_{ii} + \cdots + z_{in} + f_i$$

ECONOMIC IMPACTS OF PORTS

LEONTIEF'S MODEL

- Making use of the notion of technical coefficient, we can write for all sectors in the economy:

$$
\begin{aligned}
x_1 &= a_{11}x_1 + \cdots + a_{1i}x_i + \cdots + a_{1n}x_n + f_1 \\
&\vdots \\
x_i &= a_{i1}x_1 + \cdots + a_{ii}x_i + \cdots + a_{in}x_n + f_i \qquad (1.1) \\
&\vdots \\
x_n &= a_{n1}x_1 + \cdots + a_{ni}x_i + \cdots + a_{nn}x_n + f_n
\end{aligned}
$$

We have replaced each z_{ij} by $a_{ij}x_j$ (recall that $a_{ij} = \frac{z_{ij}}{x_j}$)

ECONOMIC IMPACTS OF PORTS

LEONTIEF'S MODEL

- To make the necessary modifications, it is convenient to recall the type of question that is asked in input-output analysis: if the demand of the exogenous sectors for a particular activity i is some specific amount f_i, how much output from each of the sectors in the economy would be necessary to supply these final demands?
- From the viewpoint of our system of equations, $f_1, \dots, f_n$ are known numbers (eg, the sales made by the port industry firms), the a_{ij} are known coefficients (assuming they are directly given or at least that we have access to the Input-Output table from which they can be calculated), the unkowns are $x_1, \dots, x_n$.
- Therefore, we bring all x terms to the left of our system of equations:

$$\begin{aligned} & x_1 - a_{11}x_1 - \cdots - a_{1i}x_i - \cdots - a_{1n}x_n = f_1 \\ & \quad \vdots \\ & x_i - a_{i1}x_1 - \cdots - a_{ii}x_i - \cdots - a_{in}x_n = f_i \\ & \quad \vdots \\ & x_n - a_{n1}x_1 - \cdots - a_{ni}x_i - \cdots - a_{nn}x_n = f_n \end{aligned} \qquad (1.2)$$

ECONOMIC IMPACTS OF PORTS

LEONTIEF'S MODEL

- Grouping all the x_1 together in the first equation, the x_2 in the second equation and so on, and writing in matrix form, we obtain:

$$\begin{bmatrix} (1-a_{11})x_1 - \cdots & -a_{1i}x_i - \cdots & -a_{1n}x_n \\ \vdots & \vdots & \vdots \\ -a_{i1}x_1 - \cdots & (1-a_{ii})x_i - \cdots & -a_{in}x_n \\ \vdots & \vdots & \vdots \\ -a_{n1}x_1 - \cdots & -a_{ni}x_i \ \cdots & (1-a_{nn})x_n \end{bmatrix} = \begin{bmatrix} f_1 \\ \vdots \\ f_i \\ \vdots \\ f_n \end{bmatrix} \qquad (1.3)$$

- Recall from your linear algebra that a product between a matrix and a vector can be interpreted as a linear combination of the columns of that matrix

$$\begin{bmatrix} ax+by+cz \\ dx+ey+fz \\ gx+hy+iz \end{bmatrix} = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

ECONOMIC IMPACTS OF PORTS

LEONTIEF'S MODEL

- Writing in matrix form and grouping all the x_1 together in the first equation, the in the second equation and so on, we obtain:

$$\begin{bmatrix} (1-a_{11})x_1 - \cdots & -a_{1i}x_i - \cdots & -a_{1n}x_n \\ \vdots & \vdots & \vdots \\ -a_{i1}x_1 - \cdots & (1-a_{ii})x_i - \cdots & -a_{in}x_n \\ \vdots & \vdots & \vdots \\ -a_{n1}x_1 - \cdots & -a_{ni}x_i \ \cdots & (1-a_{nn})x_n \end{bmatrix} = \begin{bmatrix} f_1 \\ \vdots \\ f_i \\ \vdots \\ f_n \end{bmatrix} \qquad (1.3)$$

- Recall from your linear algebra that a product between a matrix and a vector can be interpreted as a linear combination of the columns of that matrix

$$\begin{bmatrix} ax+by+cz \\ dx+ey+fz \\ gx+hy+iz \end{bmatrix} = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

ECONOMIC IMPACTS OF PORTS

LEONTIEF'S MODEL

- Therefore our system of equations can be rewriten as:

$$\begin{bmatrix} (1-a_{11}) & \cdots & -a_{1i} & \cdots & -a_{1n} \\ \vdots & & \vdots & & \vdots \\ -a_{i1} & \cdots & (1-a_{ii}) & \cdots & -a_{in} \\ \vdots & & \vdots & & \vdots \\ -a_{n1} & \cdots & -a_{ni} & \cdots & (1-a_{nn}) \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_i \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} f_1 \\ \vdots \\ f_i \\ \vdots \\ f_n \end{bmatrix} \quad (1.4)$$

- Recall from your linear algebra that a product between a matrix and a vector can be interpreted as a linear combination of the columns of that matrix

$$\begin{bmatrix} ax+by+cz \\ dx+ey+fz \\ gx+hy+iz \end{bmatrix} = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

ECONOMIC IMPACTS OF PORTS

LEONTIEF'S MODEL

$$\begin{bmatrix} (1-a_{11}) & \cdots & -a_{1i} & \cdots & -a_{1n} \\ \vdots & & \vdots & & \vdots \\ -a_{i1} & \cdots & (1-a_{ii}) & \cdots & -a_{in} \\ \vdots & & \vdots & & \vdots \\ -a_{n1} & \cdots & -a_{ni} & \cdots & (1-a_{nn}) \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_i \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} f_1 \\ \vdots \\ f_i \\ \vdots \\ f_n \end{bmatrix} \quad (1.4)$$

The elements on the main diagonal are of the form $(1 - a_{ij})$

ECONOMIC IMPACTS OF PORTS

LEONTIEF'S MODEL

- Therefore our system of equations can be rewriten as:

$$\begin{bmatrix} (1-a_{11}) & \cdots & -a_{1i} & \cdots & -a_{1n} \\ \vdots & & \vdots & & \vdots \\ -a_{i1} & \cdots & (1-a_{ii}) & \cdots & -a_{in} \\ \vdots & & \vdots & & \vdots \\ -a_{n1} & \cdots & -a_{ni} & \cdots & (1-a_{nn}) \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_i \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} f_1 \\ \vdots \\ f_i \\ \vdots \\ f_n \end{bmatrix} \quad (1.4)$$

The elements outside of the diagonal are of the form $(-a_{ij})$

ECONOMIC IMPACTS OF PORTS

LEONTIEF'S MODEL

- So we can write in matrix notation:

$$(I - A)x = f \tag{1.5}$$

Where I is the identity matrix, A is the technical coefficients matrix, f is the vector of final demand, and x is the output vector that is needed to satisfy the final demand f.

- Given that x is the unknown, if $(I-A)$ is nonsingular (i.e if $(I - A)^{-1}$ exists)we write:

$$x = (I - A)^{-1} f \tag{1.6}$$

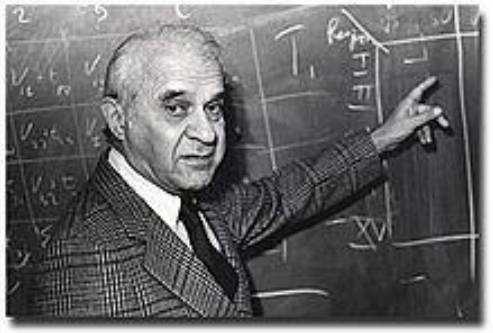
where $(I - A)^{-1} = L$ is known as the *Leontief inverse* or the *total requirements* matrix

ECONOMIC IMPACTS OF PORTS

LEONTIEF'S MODEL

$$x = (I - A)^{-1} f$$

- Leontief's model captures the change in production throughout the economy due to a change in some final demand component
- For the proposal of this model, Wassily Leontief won the Nobel Memorial Prize in Economic Sciences in 1973



PART 6: AN ILLUSTRATION OF INPUT-OUTPUT ANALYSIS CALCULATIONS

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

Question: What is the economic impact of Port x in terms of output, employment, income and value added?

Note: For the sake of clarity, the economy is considered to be composed of only two sectors, with the port being considered to belong to sector 2.

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 1: OBTAIN THE DIRECT IMPACTS

Port Industry Impacts:

- surveys
- Interviews

- The Port's sales total 8.1 million euros
- The employment at the Port totals 174 FTE
- The total income of the Port's employees is 2.4 million euros
- The Port's Added Value totals 4.9 million euros

Port Trade Impacts:

- Regional Trade Statistics

- Sector 1 exports 25 million euros through the Port
- Sector 2 exports 43 million euros through the Port

These are the final demand components, f

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 1: OBTAIN THE DIRECT IMPACTS

Port Industry Impacts:

$$f_{output} = \begin{bmatrix} 0 \\ 8.1 \end{bmatrix}$$

Recall that final demand is represented as a vector and that we admitted that the Port belongs to sector 2

Since we are only interested in knowing the impacts of the Port, all the other components of the final demand vector are set to zero

Port Trade Impacts:

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 1: OBTAIN THE DIRECT IMPACTS

Port Industry Impacts:

$$f_{output} = \begin{bmatrix} 0 \\ 8.1 \end{bmatrix}$$

$$f_{FTE} = \begin{bmatrix} 0 \\ 174 \end{bmatrix}$$

$$f_{salaries} = \begin{bmatrix} 0 \\ 2.4 \end{bmatrix}$$

$$f_{Value\ Added} = \begin{bmatrix} 0 \\ 4.9 \end{bmatrix}$$

Port Trade Impacts:

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- STEP 1: OBTAIN THE DIRECT IMPACTS

Port Industry Impacts:

$$f_{output} = \begin{bmatrix} 0 \\ 8.1 \end{bmatrix}$$

The Direct Impacts of Port Trade other than the sales, are calculated using the appropriate ratios (obtained from statistics offices) for each sector for each variable of interest:

$$f_{FTE(sector\ 1)} = 25(million\ euros\ of\ output) \times 17.08(FTE\ per\ million\ euros\ of\ output) = 427\ FTE$$

Port Trade Impacts:

$$f_{output} = \begin{bmatrix} 25 \\ 43 \end{bmatrix}$$

$$f_{FTE} = \begin{bmatrix} 427 \\ 174 \end{bmatrix}$$

$$f_{salaries} = \begin{bmatrix} 6 \\ 2.4 \end{bmatrix}$$

$$f_{Value\ Added} = \begin{bmatrix} 10 \\ 19.35 \end{bmatrix}$$

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 1: OBTAIN THE DIRECT IMPACTS

Port Industry Impacts:

$$f_{output} = \begin{bmatrix} 0 \\ 8.1 \end{bmatrix}$$

$$f_{FTE} = \begin{bmatrix} 0 \\ 174 \end{bmatrix}$$

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$$f_{Value\ Added} = \begin{bmatrix} 0 \\ 4.9 \end{bmatrix}$$

Port Trade Impacts:

$$f_{output} = \begin{bmatrix} 25 \\ 43 \end{bmatrix}$$

$$= \begin{bmatrix} 427 \\ 174 \end{bmatrix}$$

$$= \begin{bmatrix} 6 \\ 2.4 \end{bmatrix}$$

$$= \begin{bmatrix} 10 \\ 19.35 \end{bmatrix}$$

Given that input-output tables are constructed in terms of output, only the final demand expressed in terms of output can be used in the model. The other types of impacts (employment, income, etc) are obtained by means of ratios.

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 2: OBTAIN THE TECHNICAL COEFFICIENTS TABLE

From \ To	1	2	Household consumption	Other final demand	Total output
1	150	500	50	300	1000
2	200	100	400	1300	2000
Labor Services	300	500	50	150	1000
Other Value Added & imports	350	900	500	400	2150
Total inputs	1000	2000	1000	2150	6150

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AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 2: OBTAIN THE TECHNICAL COEFFICIENTS TABLE

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2	200	100	400	1300	2000
Labor Services	300	500	50	150	1000
Other Value Added &	350	900	500	400	2150
	0	2000	1000	2150	6150

For the open input-output model, only the intersectorial transactions are considered

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 2: OBTAIN THE TECHNICAL COEFFICIENTS TABLE

From \ To	1	2	Household consumption	Other final demand	Total output
1	150	500	50	300	1000
2	200	100	400	1300	2000
Labor Services	300	500	50	150	1000
Other Value Added & imports	350	900	500	400	2150
Total inputs	1000	2000	1000	2150	6150

For the closed input-output model, the household sector is also considered (households endogenous)

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 2: OBTAIN THE TECHNICAL COEFFICIENTS TABLE

Technical coefficients matrix, households exogenous, A:

From \ To	1	2
1	$\frac{150}{1000} = 0.15$	$\frac{500}{2000} = 0.25$
2	$\frac{200}{1000} = 0.20$	$\frac{100}{2000} = 0.05$
Total inputs	1000	2000

Technical coefficients matrix, households endogenous, $\bar{A}$:

From \ To	1	2	Household consumption
1	$\frac{150}{1000} = 0.15$	$\frac{500}{2000} = 0.25$	$\frac{50}{1000} = 0.05$
2	$\frac{200}{1000} = 0.20$	$\frac{100}{2000} = 0.05$	$\frac{400}{1000} = 0.40$
Labor Services	$\frac{300}{1000} = 0.30$	$\frac{500}{2000} = 0.25$	$\frac{50}{1000} = 0.05$
Total inputs	1000	2000	1000

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 3: CONSTRUCT THE LEONTIEF'S MODEL

Open Leontief model:

$$A = \begin{bmatrix} 0.15 & 0.25 \\ 0.20 & 0.05 \end{bmatrix}$$

$$(I - A) = \begin{bmatrix} 0.85 & -0.25 \\ -0.20 & 0.95 \end{bmatrix}$$

$$L = (I - A)^{-1} = \begin{bmatrix} 1.25 & 0.33 \\ 0.26 & 1.12 \end{bmatrix}$$

Closed Leontief model:

$$\bar{A} = \begin{bmatrix} 0.15 & 0.25 & 0.05 \\ 0.20 & 0.05 & 0.40 \\ 0.30 & 0.25 & 0.05 \end{bmatrix}$$

$$(I - \bar{A}) = \begin{bmatrix} 0.85 & -0.25 & -0.05 \\ -0.20 & 0.95 & -0.40 \\ -0.30 & -0.25 & 0.95 \end{bmatrix}$$

$$\bar{L} = (I - \bar{A})^{-1} = \begin{bmatrix} 1.37 & 0.43 & 0.25 \\ 0.53 & 1.35 & 0.60 \\ 0.57 & 0.49 & 1.29 \end{bmatrix}$$

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 4: OBTAIN THE INDIRECT IMPACTS (OPEN LEONTIEF MODEL)

Port Industry Impacts:

$$f_{output} = \begin{bmatrix} 0.00 \\ 8.10 \end{bmatrix}$$

$$x_{dir.+indir.} = (I - A)^{-1} f = \begin{bmatrix} 1.25 & 0.33 \\ 0.26 & 1.12 \end{bmatrix} \begin{bmatrix} 0.00 \\ 8.10 \end{bmatrix} = \begin{bmatrix} 2.67 \\ 9.09 \end{bmatrix}$$

Port Trade Impacts:

$$f_{output} = \begin{bmatrix} 25.00 \\ 43.00 \end{bmatrix}$$

$$x_{dir.+indir.} = (I - A)^{-1} f = \begin{bmatrix} 1.25 & 0.33 \\ 0.26 & 1.12 \end{bmatrix} \begin{bmatrix} 25.00 \\ 43.00 \end{bmatrix} = \begin{bmatrix} 45.54 \\ 54.85 \end{bmatrix}$$

Note that the application of the open Leontief model results in including the direct impacts as well. To obtain only the indirect impacts, the direct impacts must be subtracted

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 4: OBTAIN THE INDIRECT IMPACTS (OPEN LEONTIEF MODEL)

Port Industry Impacts:

$$f_{output} = \begin{bmatrix} 0.00 \\ 8.10 \end{bmatrix}$$

$$x_{dir.+indir.} = (I - A)^{-1} f = \begin{bmatrix} 1.25 & 0.33 \\ 0.26 & 1.12 \end{bmatrix} \begin{bmatrix} 0.00 \\ 8.10 \end{bmatrix} = \begin{bmatrix} 2.67 \\ 9.09 \end{bmatrix}$$

$$x_{indir.} = x_{dir.+indir.} - f = \begin{bmatrix} 2.67 \\ 9.09 \end{bmatrix} - \begin{bmatrix} 0.00 \\ 8.10 \end{bmatrix} = \begin{bmatrix} 2.67 \\ 0.99 \end{bmatrix}$$

$$Indirect\ impacts = 2.67 + 0.99 = 3.66$$
$$[million\ euros]$$

Port Trade Impacts:

$$f_{output} = \begin{bmatrix} 25.00 \\ 43.00 \end{bmatrix}$$

$$x_{dir.+indir.} = (I - A)^{-1} f = \begin{bmatrix} 1.25 & 0.33 \\ 0.26 & 1.12 \end{bmatrix} \begin{bmatrix} 25.00 \\ 43.00 \end{bmatrix} = \begin{bmatrix} 45.54 \\ 54.85 \end{bmatrix}$$

$$x_{indir.} = x_{dir.+indir.} - f = \begin{bmatrix} 45.54 \\ 54.85 \end{bmatrix} - \begin{bmatrix} 25.00 \\ 43.00 \end{bmatrix} = \begin{bmatrix} 20.54 \\ 11.85 \end{bmatrix}$$

$$Indirect\ impacts = 20.54 + 11.85 = 32.40$$
$$[million\ euros]$$

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 5: OBTAIN THE INDUCED/CONSUMPTION IMPACTS (CLOSED LEONTIEF MODEL)

Port Industry Impacts:

$$f_{output} = \begin{bmatrix} 0.00 \\ 8.10 \\ 0.00 \end{bmatrix}$$

$$x_{total} = (I - \bar{A})^{-1}\bar{f} = \begin{bmatrix} 1.37 & 0.43 & 0.25 \\ 0.53 & 1.35 & 0.60 \\ 0.57 & 0.49 & 1.29 \end{bmatrix} \begin{bmatrix} 0.00 \\ 8.10 \\ 0.00 \end{bmatrix} = \begin{bmatrix} 3.44 \\ 10.92 \\ 3.96 \end{bmatrix}$$

$$x_{induced} = x_{total} - x_{dir+indir} = \begin{bmatrix} 3.44 \\ 10.92 \\ 3.96 \end{bmatrix} - \begin{bmatrix} 2.67 \\ 9.09 \\ 0 \end{bmatrix} = \begin{bmatrix} 0.77 \\ 1.83 \\ 3.96 \end{bmatrix}$$

$$Induced\ impacts = 0.77 + 1.83 + 3.96 = \\ = 6.56\ [million\ euros]$$

Port Trade Impacts:

$$f_{output} = \begin{bmatrix} 25 \\ 43 \\ 0 \end{bmatrix}$$

$$x_{total} = (I - \bar{A})^{-1}\bar{f} = \begin{bmatrix} 1.37 & 0.43 & 0.25 \\ 0.53 & 1.35 & 0.60 \\ 0.57 & 0.49 & 1.29 \end{bmatrix} \begin{bmatrix} 25.00 \\ 43.00 \\ 0.00 \end{bmatrix} = \begin{bmatrix} 52.41 \\ 71.15 \\ 35.28 \end{bmatrix}$$

$$x_{induced} = x_{total} - x_{dir+indir} = \begin{bmatrix} 52.41 \\ 71.15 \\ 35.28 \end{bmatrix} - \begin{bmatrix} 45.54 \\ 54.85 \\ 0 \end{bmatrix} = \begin{bmatrix} 6.87 \\ 16.30 \\ 35.28 \end{bmatrix}$$

$$Induced\ impacts = 6.87 + 16.30 + 35.28 = \\ = 58.44\ [million\ euros]$$

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 6: OBTAIN THE MULTIPLIERS

  Often, stakeholders are interested in knowing the multiplicative effect of an activity rather than the impacts per se:

$$\text{Type I multipliers} = \frac{\text{Direct Impacts + Indirect Impacts}}{\text{Direct Impacts}}$$

$$\text{Type II multipliers} = \frac{\text{Direct Impacts + Indirect Impacts + Induced Impacts}}{\text{Direct Impacts}}$$

ECONOMIC IMPACTS OF PORTS

AN ILLUSTRATION OF INPUT-OUTPUT CALCULATIONS

- STEP 6: OBTAIN THE MULTIPLIERS

Port Industry Multipliers:

$$\text{Type I multipliers} = \frac{8.10+3.66}{8.10} = 1.45$$

$$\text{Type II multipliers} = \frac{8.10+3.66+6.56}{8.10} = 2.26$$

For each 1 euro worth of Port sales, an additional 0.45 euros is sold by other sectors in the economy

Port Users Multipliers:

$$\text{Type I multipliers} = \frac{68.00+32.40}{68.00} = 1.48$$

$$\frac{0+58.44}{0} = 2.34$$

PART 7: LIMITATIONS OF THE INPUT-OUTPUT METHODOLOGY

ECONOMIC IMPACTS OF PORTS

LIMITATIONS OF THE INPUT-OUTPUT METHODOLOGY

- The assessment of direct impacts depends heavily on survey and questionnaires, and due to the sensitive nature of the requested information, response rates are typically low, which may render the study infeasible altogether: always engage the Port Authority from the beginning in the survey process
- The analysis assumes that input proportions are fixed; thus the use of input-output analysis is limited to rough approximations rather than prediction
- No economies of scale are accounted for in the model
- The model is sensitive to price changes even in the presence of stable technological relationships

ECONOMIC IMPACTS OF PORTS

LIMITATIONS OF THE INPUT-OUTPUT METHODOLOGY

- Lack of consensus regarding the definition of port activity
- Due to the costs of production, the time between the release of two consecutive input-output tables is typically five years or more, which poses the problem of coeffficient stability (the RAS method may be of usefulness here)
- No causal relationships are depicted in the model (black-box model)
- Leontief's model is incapable of incorporating dynamic effects (dynamic input-output models perform worse than using the last known input-output table!)
- Often the results of input-output analysis are used to justify budget allocation and investment, possibly compromising scientific integrity in the process

PART 8: ECONOMIC IMPACTS OF THE PORT OF LISBON

ECONOMIC IMPACTS OF PORTS

ECONOMIC IMPACTS OF THE PORT OF LISBON

- Port industry impacts [CENTEC,2010]

	Output [million euros]	Income [million euros]	Employment [Full-time equivalent]	Gross added value [million euros]
Direct Impacts	289	70	6,152	143
Indirect Impacts	209	49	4,587	63
Induced Impacts	258	59	3.922	58
Total Impacts	755	178	14,660	264

ECONOMIC IMPACTS OF PORTS

ECONOMIC IMPACTS OF THE PORT OF LISBON

- Port users impacts [CENTEC,2010]

	Output [million euros]	Income [million euros]	Employment [Full-time equivalent]	Gross added value [million euros]
Direct Impacts	5,818	932	57,531	2,063
Indirect Impacts	4,464	914	48,866	1,813
Induced Impacts	1,136	279	13,929	559
Total Impacts	11,418	2,125	120,327	4,433

ECONOMIC IMPACTS OF PORTS

ECONOMIC IMPACTS OF THE PORT OF LISBON

- Port of Lisbon Multipliers [CENTEC,2010]

		Output [million euros]	Income [million euros]	Employment [Full-time equivalent]	Gross added value [million euros]
Port Industry	Type I multipliers	1.723	1.700	1.746	1.441
	Type II multipliers	2.616	2.543	1.746	1.846
Port Users	Type I multipliers	1.767	1.981	1.849	1.879
	Type II multipliers	1.963	2.280	2.091	2.150

ECONOMIC IMPACTS OF PORTS

SUMMARY

Q1) What is the purpose of assessing the socioeconomic impacts of ports?

A1) *To justify or decide in capital budgeting for port projects, decide in the granting of permits for port projects, and increase the societal acceptance of port projects*

Q2) What is the preferred methodology for assessing port economic impact studies?

A2) *Input-output analysis*

Q3) What are the two pieces of information or data that are needed to perform an input-output analysis?

A3) *An input-output table and knowledge of the direct impacts of the activity being analysed*

Q4) How are these two pieces of information usually obtained?

A4) *The input-output table is published regularly by public statistics offices while the direct impacts are obtained through surveys and interviews conducted within companies belonging to the avtivity under analysis*

Q5) What are some of the main shortcomings of input-output analysis?

A5) *Low response rate to surveys and questionnaires*; *Lack of consensus regarding the definition of port activity*; *Absence of nonlinear effects (eg economies of scale); black-box model with no causal relationships*

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