

# NEREUS

Núcleo de Economia Regional e Urbana  
da Universidade de São Paulo  
The University of São Paulo  
Regional and Urban Economics Lab

## Aula 8: Método de Extração Hipotética

Prof. Eduardo A. Haddad

# Atividade

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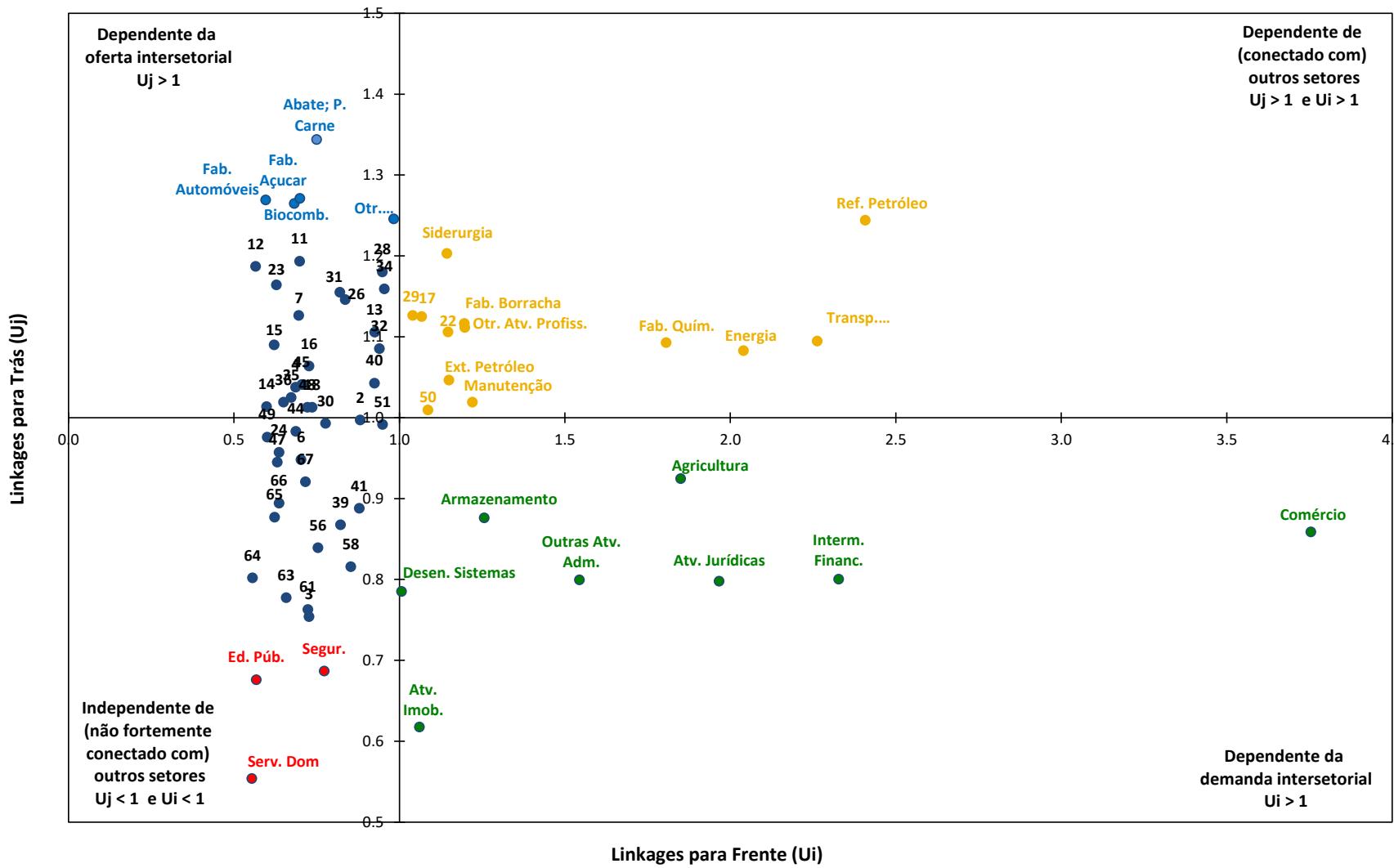
## **Identificação de setores-chave**

Dados: Matriz de Insumo-Produto do Brasil, 2017

Calcule os índices de ligação para o setores econômicos do Brasil e identifique os setores-chave.

Dica: use a matriz do modelo aberto de Leontief.

# Atividade – solução



# Modelos inter-regionais de IP

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## Modelo inter-regional

$$A = \begin{bmatrix} A^{LL} & \vdots & A^{LM} \\ \dots & \dots & \dots \\ A^{ML} & \vdots & A^{MM} \end{bmatrix} \quad y = \begin{bmatrix} y^L \\ \dots \\ y^M \end{bmatrix} \quad x = \begin{bmatrix} x^L \\ \dots \\ x^M \end{bmatrix}$$

$$\left\{ \begin{bmatrix} I & \vdots & 0 \\ \dots & \dots & \dots \\ 0 & \vdots & I \end{bmatrix} - \begin{bmatrix} A^{LL} & \vdots & A^{LM} \\ \dots & \dots & \dots \\ A^{ML} & \vdots & A^{MM} \end{bmatrix} \right\} \begin{bmatrix} x^L \\ \dots \\ x^M \end{bmatrix} = \begin{bmatrix} y^L \\ \dots \\ y^M \end{bmatrix}$$

$$(I - A)x = y \longrightarrow x = (I - A)^{-1}y$$

# Introdução

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Extração hipotética de uma região ou setor na matriz de insumo-produto.

Aplicações adicionais incluem a extração de outros elementos considerados em MIPs mais abrangentes, por exemplo, componentes específicos da demanda final e suas relações (e.g. emissões, trabalhadores em isolamento...)

Esta técnica permite analisar a importância de um setor ou de uma região em uma estrutura econômica, dada sua extração e consequente redução do nível de atividade na economia.

Cabe ressaltar que, quanto maior o nível de interdependência deste setor (ou região) em relação aos demais, maior será o impacto sistêmico na economia.

# Formulação

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O objetivo do método de extração hipotética é o de quantificar o quanto que a produção total de uma economia com  $n$  setores poderia mudar (ou reduzir) se um setor em particular, digamos que o  $j$ -ésimo, fosse removido desta economia.

A formulação a seguir considera que estejamos realizando este tipo de análise, isto é, extraindo um determinado setor  $j$  da economia.

Inicialmente, tem-se que a extração deste setor afeta a matriz  $A$  de coeficientes técnicos, que após a extração terá uma linha e uma coluna a menos.

A extração também afeta a linha do vetor de demanda final,  $f$ , relativa ao setor extraído.

Seja  $\bar{A}_{(j)}$  tal matriz sem o setor  $j$  de dimensão  $(n - 1) \times (n - 1)$  e o novo vetor de demanda definido como  $\bar{f}_{(j)}$ .

# Formulação

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Com isso, a produção na economia sem o setor  $j$  é dada por:

$$\bar{\mathbf{X}}_{(j)} = (\mathbf{I} - \bar{\mathbf{A}}_{(j)})^{-1} \bar{\mathbf{f}}_{(j)}$$

Uma alternativa à extração física da linha e da coluna correspondentes ao setor  $j$  na matriz é **atribuir valores iguais a zero** na matriz  $\mathbf{A}$  e no vetor de demanda final correspondente a tal setor.

No modelo completo, com  $n$  setores, a produção da economia é dada por:

$$\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1} \mathbf{f}$$

Em que  $\mathbf{B} = (\mathbf{I} - \mathbf{A})^{-1}$

# Formulação

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Após realizar a extração, tem-se que:

$$T_j = i'X - i'\bar{X}_{(j)}$$

em que  $T_j$  é a medida agregada de perda na economia – diminuição da produção total se o setor  $j$  “desaparecer”.

Em outras palavras, é uma medida da importância relativa do setor  $j$ , ou dos *linkages* totais do setor  $j$  (grau de interdependência econômica).

A partir da equação acima, pode-se fazer uma análise na qual, no primeiro termo do lado direito da equação, isto é,  $i'X$ , não esteja incluída a produção original  $X_j$ .

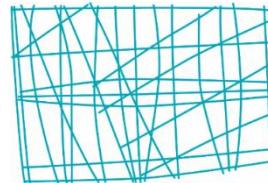
# Formulação

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Se  $X_j$  for omitido, temos que  $(i'X - X_j) - i' \bar{X}$  seria uma medida da importância do setor  $j$  para os demais setores da economia.

Em ambos os casos, a normalização por meio da divisão do resultado pela produção total,  $i'X$ , e a multiplicação por 100 produz uma estimativa de uma diminuição percentual na atividade econômica total da ordem de:

$$\bar{T}_j = 100[i'X - i'\bar{X}_{(j)}]/i'X$$



# Analysis of Economic and Environmental Impacts of Shutting Down the Moroccan Refinery Samir: An Interregional Input-Output Approach

*13<sup>th</sup> World Congress of the RSAI  
Marrakech, June 2-5, 2020*

El-Mansoum, R., Chawki, C. Masnaoui, M. Araujo, I. Haddad, E. A.

# Impacts of Shutting Down the Moroccan Refinery

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The closing of Samir's Mohammedia refinery in August 2015 due to financial constraints has dramatically affected fuel oil market in Morocco.

***What are the economic and environmental impacts of the disruption of activities of Morocco's only refinery?***

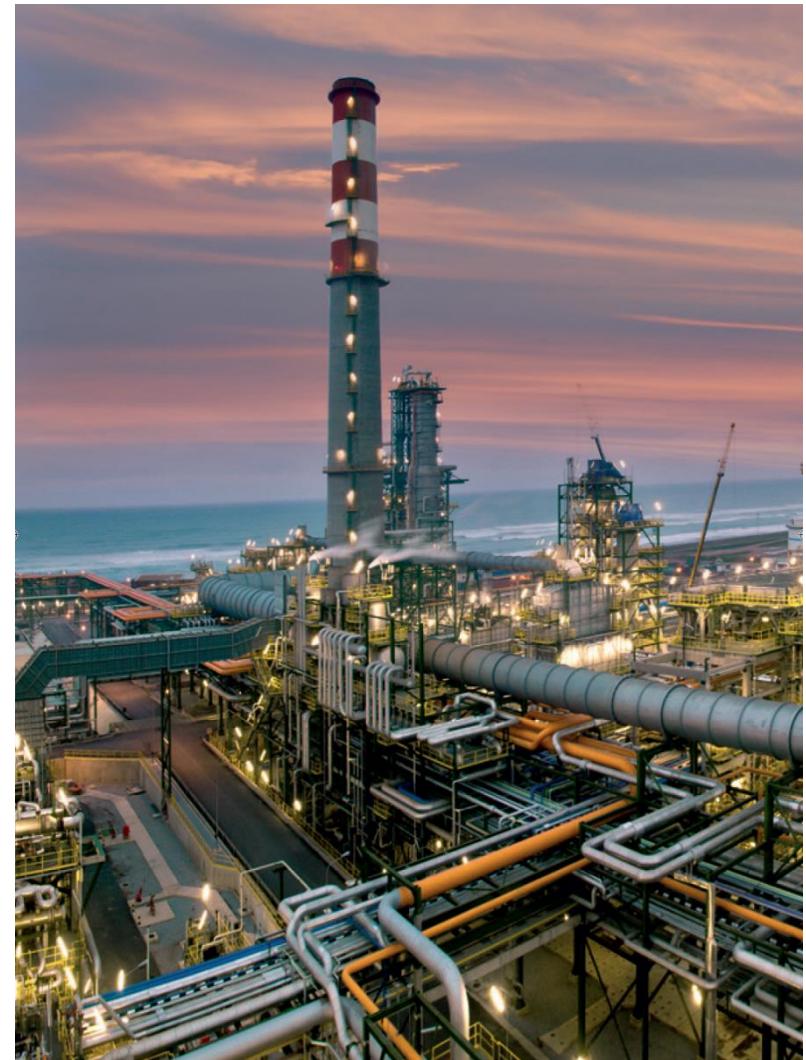
We base our empirical strategy on the “hypothetical extraction” method, which serves as the methodological anchor to isolate the systemic measures of value added and CO<sub>2</sub> emissions related to the refinery activities in a typical year of operation.

# The Samir's Mohammedia refinery

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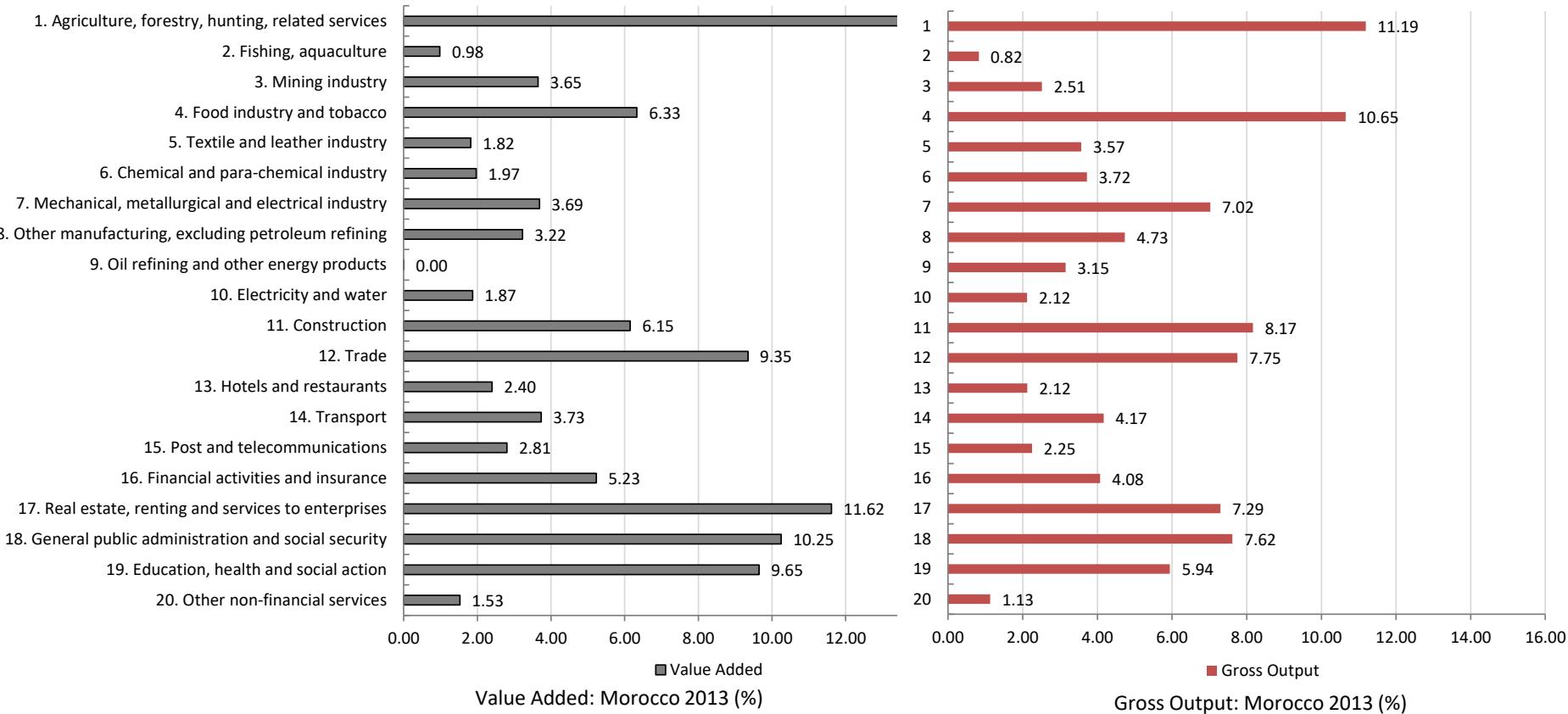


# Location

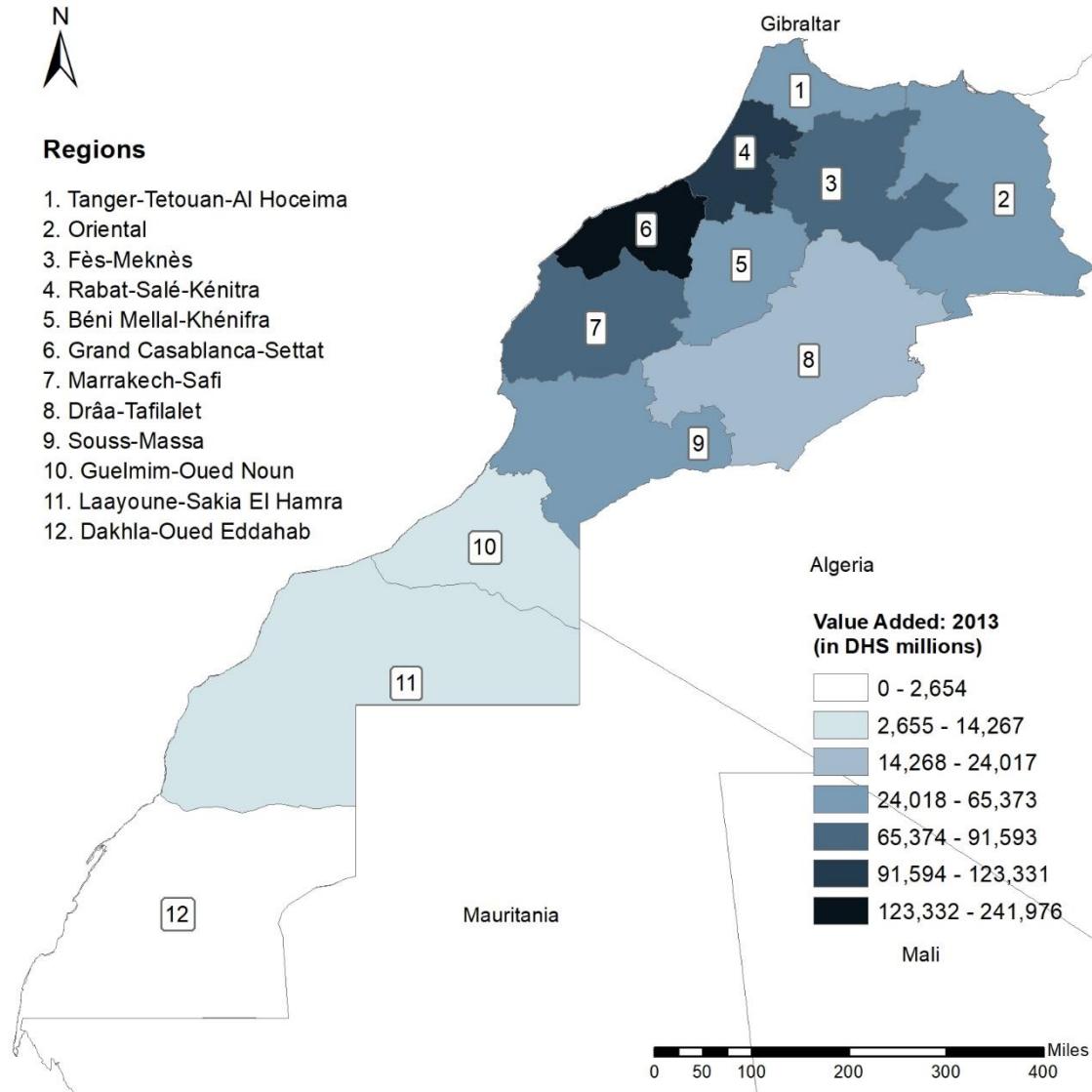


# Structure of the Moroccan economy

Value Added and Gross Output, 2013 (in %)



# Regional distribution of value added

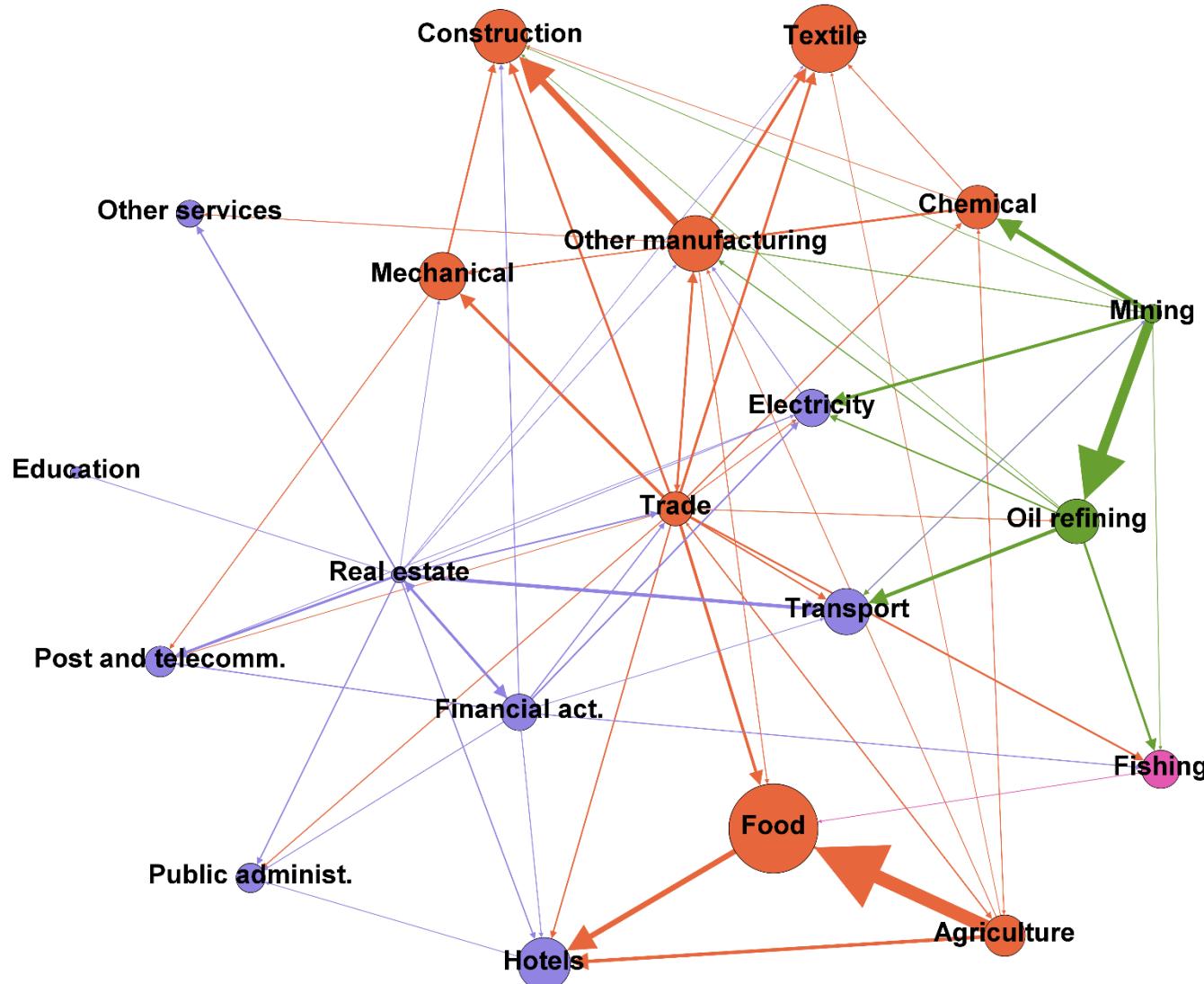


# Oil refining sector in Morocco

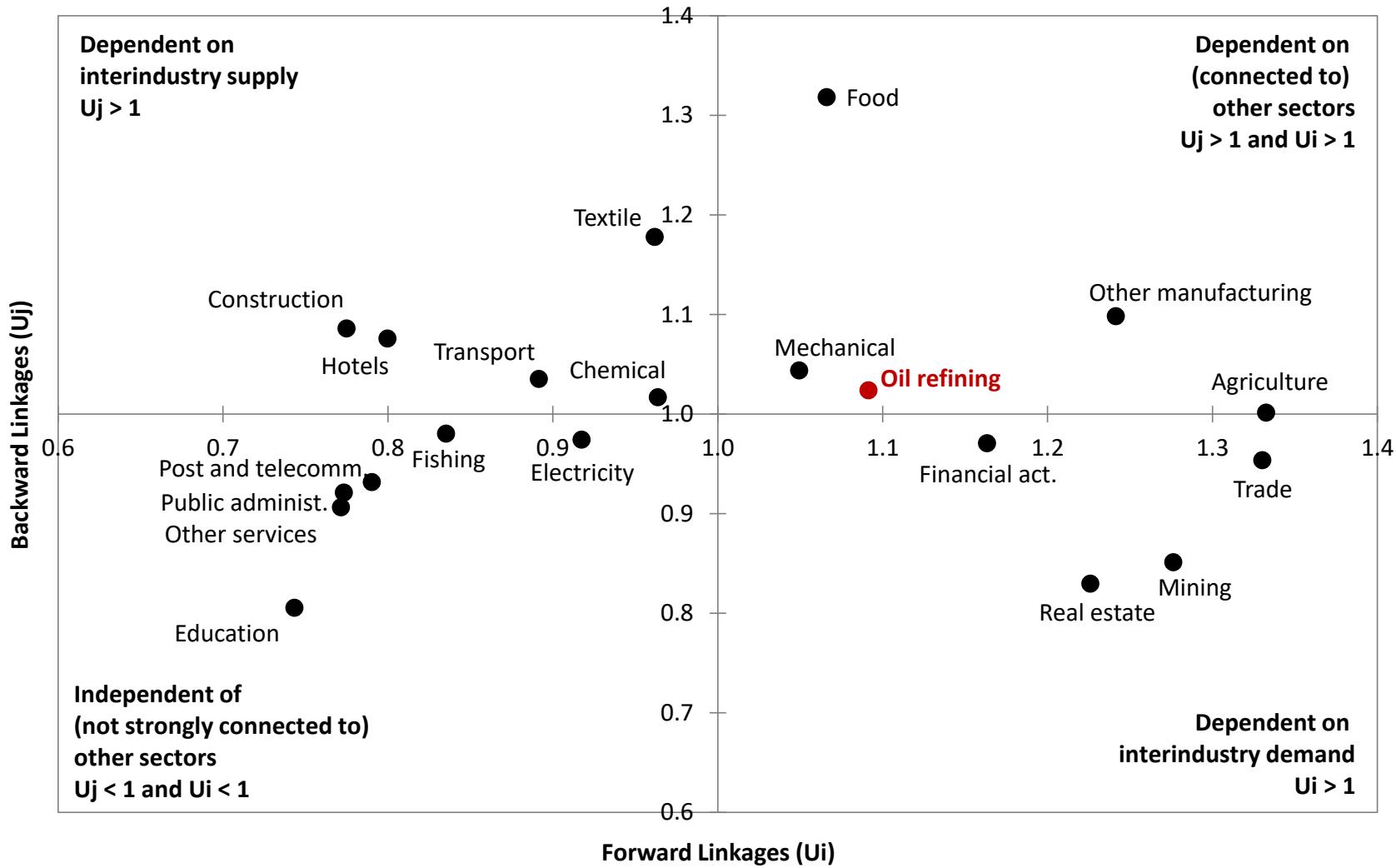
## Descriptive statistics – Summary

	<i>Value (in DHS millions)</i>	<i>Share (in %)</i>
Intermediate Consumption	22,700	47.43
Investment Demand	8	0.02
Household Demand	13,456	28.12
Government Demand	0	0.00
Foreign Exports	10,354	21.63
Statistical Discrepancies	1,342	2.80
<b>Total Demand</b>	<b>47,860</b>	<b>100.00</b>
Intermediate Consumption	16,391	34.25
Imports	31,150	65.09
Taxes and subsidies	287	0.60
Value Added	32	0.07
<b>Gross Output</b>	<b>47,860</b>	<b>100.00</b>

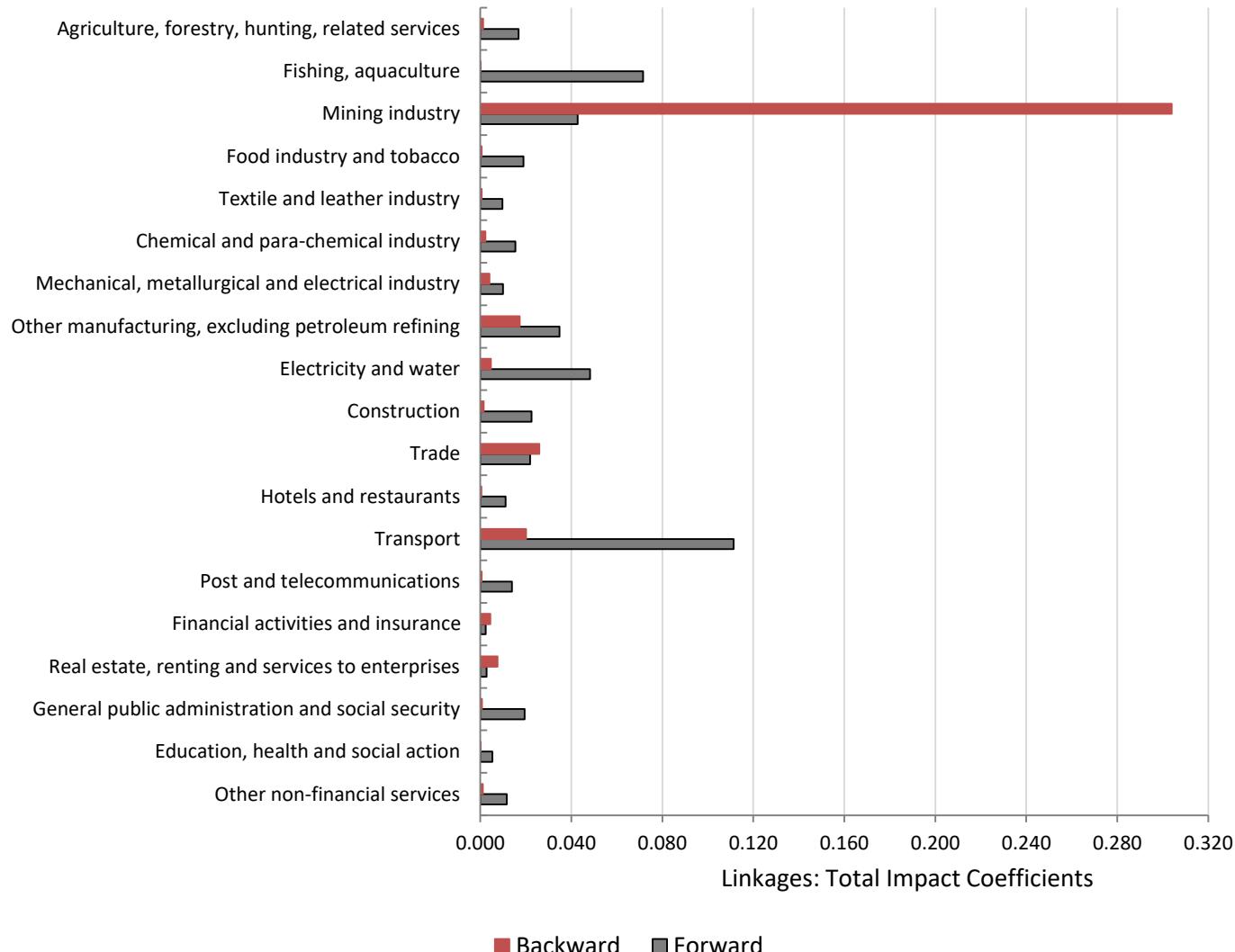
# Production structure: output multipliers



# Rasmussen-Hirschman Index



# Backward and forward linkages for oil refining



# The extraction method: solution guide

See Excel file: ***Exemplo – SAMIR (Marrocos)***"

**1.** Calculate the technical coefficients ( $A_{ij}$ ) - Plan "A"

Obs:  $A_{ij} = Z_{ij} / X_j$

**2** Create an identity matrix ( $I$ ) - Plan "I"

**3** Calculate the  $(I - A_{ij})$  matrix - Plan "(I-A)"

**4** Invert  $(I - A_{ij})$  and find the Leontief inverse ( $B$ ) - Plan "B"

**5** Calculate the vector of gross output by sector ( $X$ ) by premultiplying the total final demand vector by the Leontief inverse - Plan "X"

Obs: Use the solution equation ( $X = B^* Y$ ).

**6** Repeat steps 1-5, this time substituting with "zero" all elements associated with flows to and from the oil refining sector in column (DH) and row (115)- Plans IIOS2; A2; (I-A2); and B2

**7** Calculate the new vector of total output ( $X_2$ ) - Plan X

# Regional and sectorial results

## Hypothetical extraction: change in **gross output** for Morocco, 2013 (in DHS millions)

	R1 Tanger- Tetouan- Al Hoceima	R2 Oriental	R3 Fès- Meknès	R4 Rabat- Salé- Kénitra	R5 Béni Mellal- Khénifra	R6 Grand Casablanca- a-Settat	R7 Marrakech- Safi	R8 Drâa- Taïala	R9 Souss- Massa	R10 Guelmim- Oued Noun	R11 Laayoune- Sakia El Hamra	R12 Dakhla- Oued Eddahab	Morocco	
A00	Agriculture, forestry, hunting, related services	-3.8	-3.9	-8.1	-8.8	-8.4	-9.4	-9.2	-3.1	-3.4	-0.5	0.0	0.0	-58.6
B05	Fishing, aquaculture	-0.1	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	-0.5	-0.2	-0.2	-0.1	-1.3
C00	Mining industry	0.0	-479.7	-74.1	-395.7	-5,441.4	-29.1	-5,248.0	-1,513.9	-9.9	0.0	-1,137.2	0.0	-14,329.0
D01	Food industry and tobacco	-1.0	-0.4	-2.4	-1.7	-1.7	-16.8	-1.8	-0.1	-3.0	-0.1	-0.5	0.0	-29.5
D02	Textile and leather industry	-3.5	-0.2	-2.2	-2.1	0.0	-18.9	-1.0	0.0	0.0	0.0	0.0	0.0	-28.0
D03	Chemical and para-chemical industry	-3.3	-1.5	-5.2	-10.4	-1.1	-70.2	-5.3	-0.1	-2.7	0.0	-5.0	0.0	-104.8
D04	Mechanical, metallurgical and electrical industry	-11.2	-10.3	-11.1	-12.0	-3.5	-132.8	-2.8	-0.2	-3.0	0.0	-0.3	0.0	-187.1
D05	Other manufacturing, excluding petroleum refining	-60.5	-11.1	-39.7	-71.6	-15.4	-524.5	-53.5	-1.1	-27.5	-0.9	-9.9	-0.4	-816.0
D06	Oil refining and other energy products	0.0	0.0	0.0	0.0	0.0	-47,860.0	0.0	0.0	0.0	0.0	0.0	0.0	-47,860.0
E00	Electricity and water	-13.5	-9.0	-14.0	-40.6	-26.3	-50.9	-37.2	-7.5	-9.6	-1.0	-6.8	-0.2	-216.6
F45	Construction	-1.5	-1.4	-1.5	-4.2	-5.5	-47.2	-6.9	-1.7	-0.9	-0.1	-1.1	0.0	-72.0
G00	Trade	-30.1	-52.9	-55.6	-102.6	-109.0	-680.1	-132.2	-19.0	-22.6	-5.1	-13.4	-0.3	-1,222.8
H55	Hotels and restaurants	-0.5	-0.3	-0.6	-0.6	-0.5	-2.4	-10.7	-0.9	-4.4	0.0	-0.1	0.0	-20.9
I01	Transport	-34.6	-14.6	-74.5	-144.5	-132.1	-246.8	-186.2	-42.8	-52.1	-6.0	-12.9	-0.4	-947.5
I02	Post and telecommunications	-0.7	-0.8	-1.4	-3.1	-3.5	-10.0	-4.5	-0.9	-0.8	-0.2	-0.5	0.0	-26.3
J00	Financial activities and insurance	-3.2	-4.8	-5.3	-29.1	-15.3	-112.3	-28.8	-3.8	-3.9	-0.4	-2.4	0.0	-209.3
K00	Real estate, renting and services to enterprises	-7.0	-9.5	-12.9	-57.3	-35.6	-143.5	-65.3	-8.3	-9.7	-0.9	-4.8	-0.1	-354.8
L75	General public administration and social security	-0.6	-1.1	-1.3	-4.3	-7.7	-7.6	-8.2	-2.2	-0.7	-0.3	-1.7	0.0	-35.7
MNO	Education, health and social action	0.0	-0.1	-0.1	-0.2	-0.3	-0.7	-0.5	-0.1	-0.1	0.0	0.0	0.0	-2.1
OP0	Other non-financial services	-1.0	-1.5	-1.3	-6.0	-10.0	-9.2	-16.1	-1.9	-0.8	-0.1	-1.6	0.0	-49.7
Total		-176.2	-603.0	-311.3	-894.9	-5,817.4	-49,972.2	-5,818.3	-1,607.5	-155.6	-15.5	-1,198.4	-1.6	-66,572.0

# Regional and sectorial results

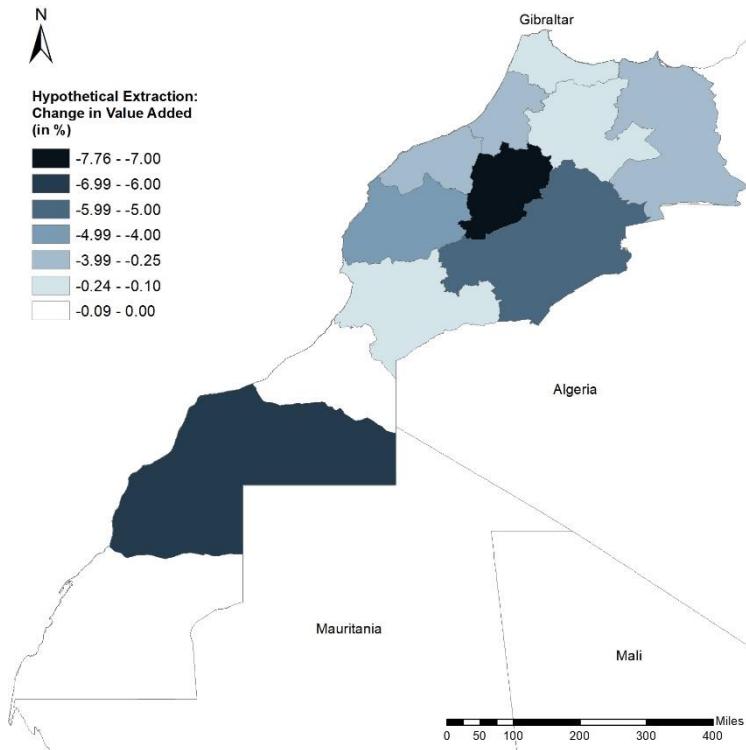
## Hypothetical extraction: change in **value added** and **gross output** for Morocco, 2013 (in %)

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	
	Tanger-Tetouan-Al Hoceima	Oriental	Fès-Meknès	Rabat-Salé-Kénitra	Béni Mellal-Khénifra	Grand Casablanca-Settat	Marrakech-Safi	Drâa-Taïfalet	Souss-Massa	Guelmim-Oued Noun	Laayoune-Sakia El Hamra	Dakhla-Oued Eddahab	Marocco
A00	Agriculture, forestry, hunting, related services	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.02	0.00	0.00
B05	Fishing, aquaculture	-0.01	-0.01	0.00	-0.01	0.00	-0.01	-0.02	0.00	-0.01	-0.01	-0.01	0.00
C00	Mining industry	0.00	-42.12	-37.35	-53.73	-27.98	-42.70	-50.57	-44.49	-33.74	0.00	-39.90	0.00
D01	Food industry and tobacco	-0.01	-0.01	-0.02	-0.02	-0.03	-0.02	-0.02	-0.02	-0.01	-0.01	-0.02	0.00
D02	Textile and leather industry	-0.03	-0.03	-0.04	-0.04	-0.16	-0.06	-0.08	0.00	-0.09	0.00	0.00	-0.05
D03	Chemical and para-chemical industry	-0.21	-0.28	-0.30	-0.36	-0.65	-0.16	-0.10	-0.36	-0.31	-0.23	-0.56	-0.13
D04	Mechanical, metallurgical and electrical industry	-0.04	-0.23	-0.24	-0.13	-0.60	-0.23	-0.41	-0.37	-0.25	0.00	-0.59	-0.12
D05	Other manufacturing, excluding petroleum refining	-0.81	-0.80	-0.94	-1.56	-1.73	-1.17	-1.29	-1.01	-0.88	-0.60	-1.25	-0.37
D06	Oil refining and other energy products	0.00	0.00	0.00	0.00	0.00	-100.00	0.00	0.00	0.00	0.00	0.00	-100.00
E00	Electricity and water	-0.37	-0.41	-0.40	-0.61	-1.55	-0.72	-1.05	-0.99	-0.43	-0.32	-1.60	-0.18
F45	Construction	-0.01	-0.01	-0.01	-0.03	-0.07	-0.19	-0.04	-0.02	-0.01	-0.01	-0.04	0.00
G00	Trade	-0.27	-0.42	-0.40	-0.66	-1.48	-2.30	-0.97	-0.73	-0.27	-0.34	-1.07	-0.08
H55	Hotels and restaurants	-0.02	-0.03	-0.03	-0.05	-0.17	-0.06	-0.09	-0.10	-0.05	-0.03	-0.17	-0.01
I01	Transport	-0.65	-0.27	-1.08	-1.51	-4.31	-1.34	-2.91	-2.52	-1.17	-0.59	-1.60	-0.19
I02	Post and telecommunications	-0.02	-0.03	-0.04	-0.06	-0.21	-0.10	-0.13	-0.09	-0.03	-0.03	-0.12	-0.01
J00	Financial activities and insurance	-0.10	-0.15	-0.14	-0.22	-0.91	-0.42	-0.54	-0.46	-0.13	-0.10	-0.76	-0.04
K00	Real estate, renting and services to enterprises	-0.13	-0.17	-0.18	-0.24	-1.18	-0.30	-0.69	-0.56	-0.18	-0.14	-0.85	-0.05
L75	General public administration and social security	-0.01	-0.01	-0.01	-0.01	-0.13	-0.04	-0.08	-0.06	-0.01	-0.01	-0.03	0.00
MNO	Education, health and social action	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OP0	Other non-financial services	-0.07	-0.14	-0.09	-0.16	-1.25	-0.20	-0.66	-0.61	-0.08	-0.06	-1.38	-0.03
Value Added		-0.13	-0.86	-0.22	-0.48	-7.76	-0.48	-4.85	-5.17	-0.15	-0.08	-6.48	-0.03
Gross Output		-0.13	-0.70	-0.22	-0.45	-6.55	-9.20	-3.88	-4.24	-0.16	-0.09	-5.13	-0.02

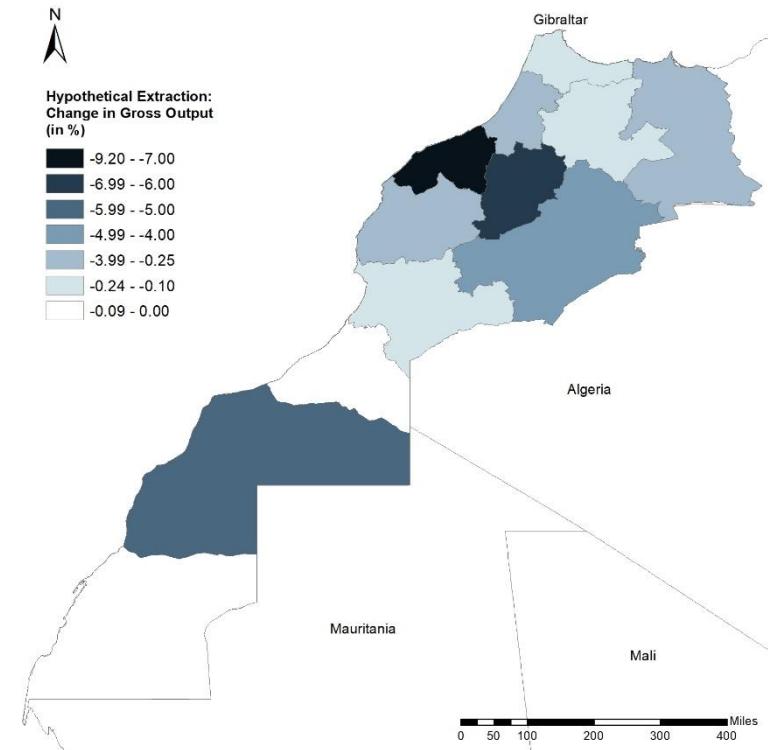
# The geography of the impacts

Hypothetical extraction: change in **value added** and **gross output** for Morocco, 2013 (in %)

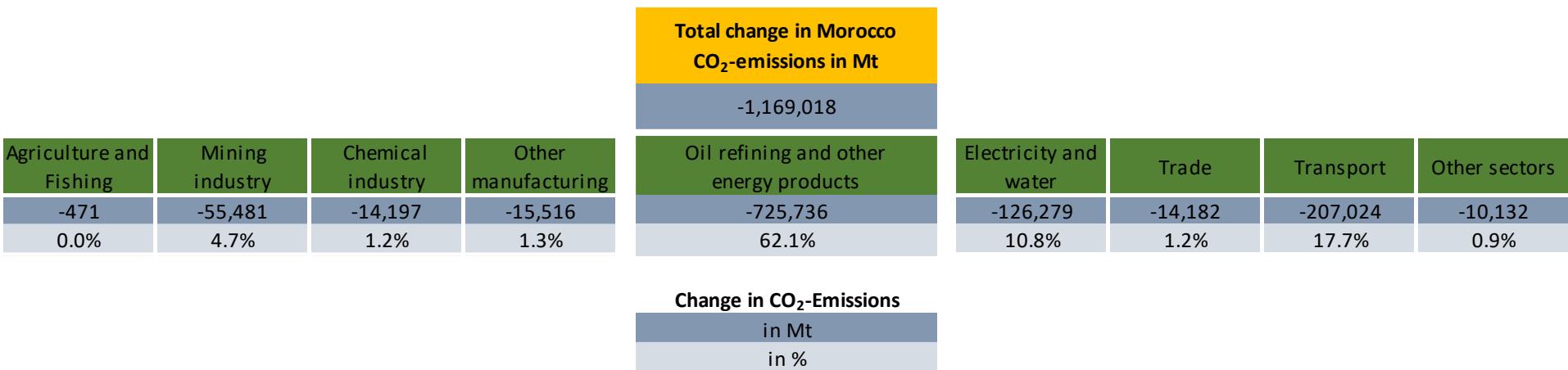
(a) Value Added



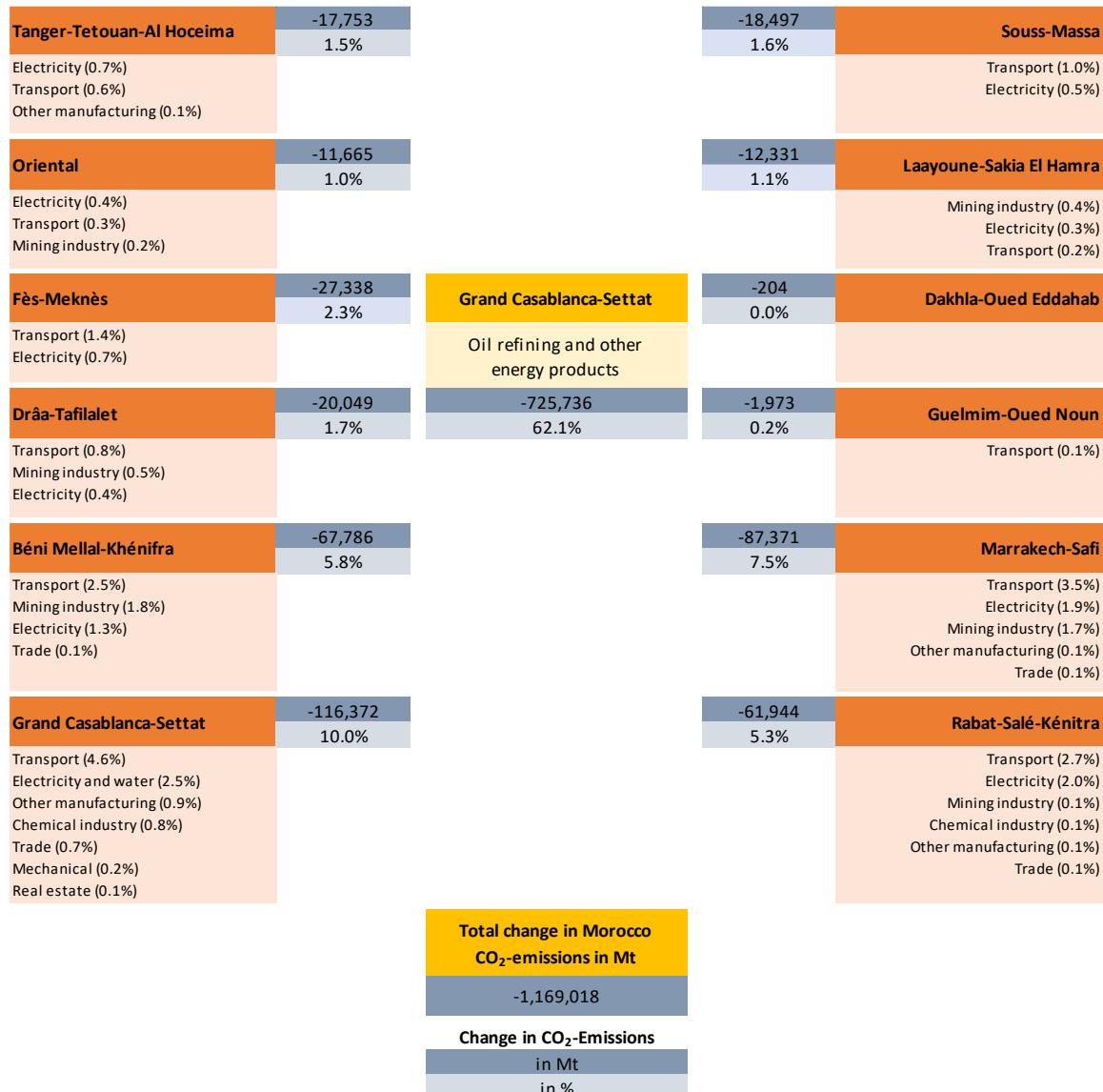
(b) Gross Output



# CO<sub>2</sub> emissions – sectors



# CO<sub>2</sub> emissions – regions



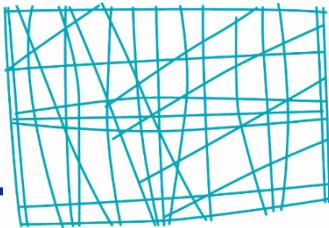
# Atividade: “O Brasil sem Minas Gerais”

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## **Extração hipotética de uma região**

Dados: Matriz Interestadual de Insumo-Produto do Brasil, 2011

1. Se o Estado de Minas Gerais fosse hipoteticamente extraído da economia brasileira (lockdown total), qual seria a variação no produto total da economia mineira?
2. Qual seria a variação no produto dos demais Estados?
3. Quais seriam os Estados que apresentariam maiores perdas?
4. Quais seriam os setores da economia brasileira que apresentariam maiores perdas?



**NEREUS**

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da Universidade de São Paulo  
The University of São Paulo  
Regional and Urban Economics Lab



# Water Content in Trade: A Regional Analysis for Morocco

*Secrétariat d'Etat Chargé de l'Eau  
Rabat, April 27, 2018*

Prof. Eduardo A. Haddad

*Professor of Economics, University of São Paulo, Brazil  
Senior Fellow at OCP Policy Center, Morocco*

<http://www.ocppc.ma/sites/default/files/OCPPC-RP1803.pdf>

The image shows the front cover of a research paper. The background features a light blue grid pattern. At the top right, a dark blue header bar contains the text "Research Paper" in white, bold letters, followed by "April 2018" in a smaller white font. To the left of the header is the logo for "OCP POLICY CENTER" with the tagline "THINK • STIMULATE • BRIDGE". The main title "Water Content in Trade: A Regional Analysis for Morocco" is centered in large, bold, dark blue capital letters. Below the title, the authors' names are listed in a smaller dark blue font: "EDUARDO A. HADDAD", "FATIMA EZZAHRA MENGOUB", and "VINÍCIUS A. VALE".

**Research Paper**  
April 2018

OCP  
POLICY  
CENTER  
THINK • STIMULATE • BRIDGE

**Water Content in  
Trade: A Regional  
Analysis for  
Morocco**

EDUARDO A. HADDAD  
FATIMA EZZAHRA MENGOUB  
VINÍCIUS A. VALE

# IPCC lessons from Berlin

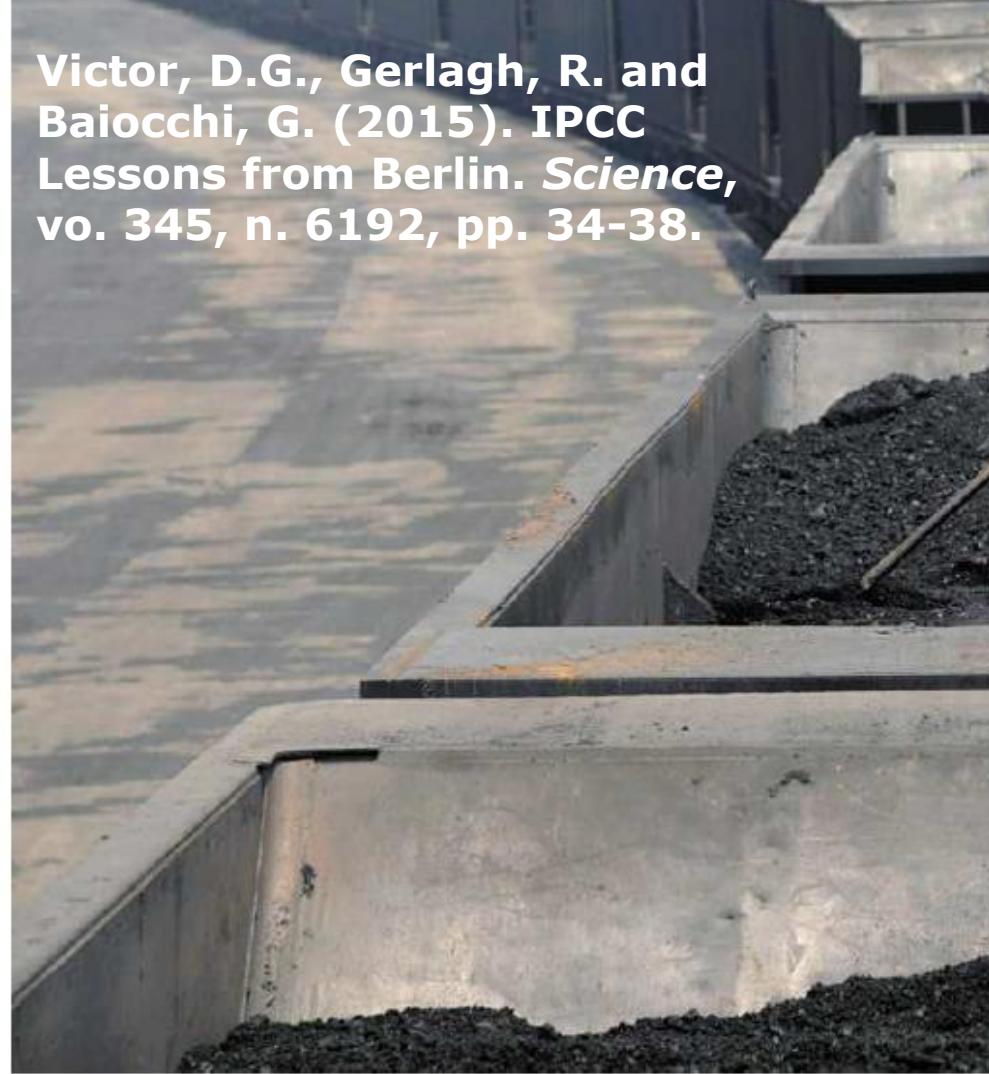
Did the “Summary for Policymakers” become a summary by policy-makers?

In April in Berlin, governments approved the third of three reports comprising the fifth assessment report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). The report from Working Group 1 (WGI) made clear that human impact on climate change is almost certain. WGI showed that impacts of climate change are evident and poised to worsen. WGIII focused on how to mitigate the emissions that cause global warming (1).

Although the underlying technical report from WGIII was accepted by the IPCC, final, heated negotiations among scientific authors and diplomats led to substantial deletion of figures and text from the influential “Summary for Policy-makers” (SPM). The deleted content focused largely on historic emissions trends analyzed by

**POLICY** country income groups and international cooperation. IPCC authors are instructed to be policy-relevant without being

**Victor, D.G., Gerlagh, R. and Baiocchi, G. (2015). IPCC Lessons from Berlin. *Science*, vo. 345, n. 6192, pp. 34-38.**



## Getting serious about categorizing countries

By David G. Victor,<sup>1,9</sup> Reyer Gerlagh,<sup>2,9</sup> Giovanni Baiocchi<sup>3,10</sup>

A central finding of WGIII is that growth of income has been the largest single driver of emissions. Governments accepted that finding at the global level, where it is safe to discuss generalities because no country is in the spotlight. But WGIII

# Introduction

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Research on **water accounting** related to international trade flows has boosted in the last few years with the development of worldwide input-output systems and the stronger concern with the future of resources availability in the context of global climate change.

**Accountability** of the pressure on the use of the world's natural resources has reached the political debate, as attempts to characterize countries according to their historical, current and expected role played in this process has reopened political fissures (Victor et al., 2014).

# Introduction

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Similarly to nations, **regions within countries** can also be characterized by their pressure on the demand for natural resources.

As shown by Hoekstra and Chapagain (2008), **local water depletion is often closely tied to the structure of the global economy.**

For regions within a country, the national economy adds another layer to the relevant structural hierarchy to **understand resources uses.**

# Introduction

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This paper reports on the results of an **application with an interregional input-output matrix for Morocco**, developed as part of an ongoing project at the OCP Policy Center, in Rabat (Haddad et al., 2017).

We estimate, for each flow **originated in one of the Moroccan regions**, measures of trade in value added and trade in water that are further used to calculate our index.

The parsimonious approach proposed in Los et al. (2016), based on “**hypothetical extraction**”, serves as the methodological anchor.

## Polarization by Casablanca

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Casablanca region – ~30% of national GDP.

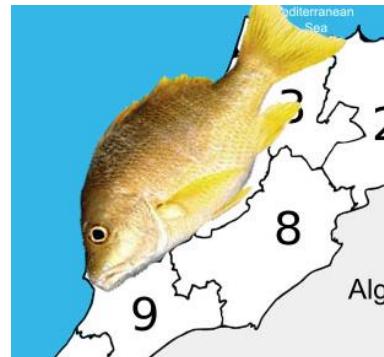
Asymmetries in the distribution of productive activity, with the primacy of Casablanca, serve to strengthen existing competitive advantages.

Presence of other relevant industrial areas outside Casablanca (the “fish”)

# The “fish”



~ 80% of national GDP



# Aggregate trade flows in Morocco

Table 2. Interregional Trade in Morocco, 2013 (in DHS millions)

	DESTINATION												TOTAL		
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	EXP		
ORIGIN	R1	69,980	2,187	3,537	3,911	1,218	12,832	2,171	1,224	1,479	282	565	414	20,098	119,898
	R2	2,681	54,731	3,813	2,401	995	7,686	1,414	1,335	1,068	225	583	409	8,447	85,785
	R3	5,956	5,656	81,361	6,755	2,346	18,203	2,860	2,768	1,956	408	904	636	9,157	138,967
	R4	7,778	3,291	6,460	111,369	2,753	37,929	4,284	2,065	2,505	625	1,117	686	17,403	198,266
	R5	2,018	1,189	2,394	2,673	39,855	18,271	4,089	997	2,038	270	537	359	15,242	89,932
	R6	34,753	18,362	27,080	52,858	19,104	215,240	35,012	10,375	16,944	3,220	4,212	2,862	120,080	560,102
	R7	3,899	2,319	3,308	5,759	4,330	25,670	85,581	1,774	4,588	832	1,360	839	10,513	150,771
	R8	1,056	810	1,655	1,131	693	4,768	1,080	23,678	835	113	287	198	1,466	37,769
	R9	2,974	2,088	2,540	3,767	2,187	12,059	5,128	1,421	55,014	1,923	1,732	983	5,838	97,655
	R10	295	175	257	376	188	1,094	430	131	943	10,547	342	152	1,742	16,670
	R11	438	269	365	437	209	2,729	497	179	540	201	14,457	314	2,847	23,483
	R12	80	63	89	79	43	236	80	38	96	23	90	3,730	2,609	7,257
	IMP	48,842	26,748	37,534	47,529	21,206	160,187	41,340	12,627	23,625	3,651	5,759	2,579	0	431,626
	TOTAL	180,749	117,887	170,393	239,045	95,127	516,904	183,965	58,612	111,628	22,321	31,946	14,161	215,444	1,958,182

Source: Calculations by the authors.

81.6% of total domestic flows

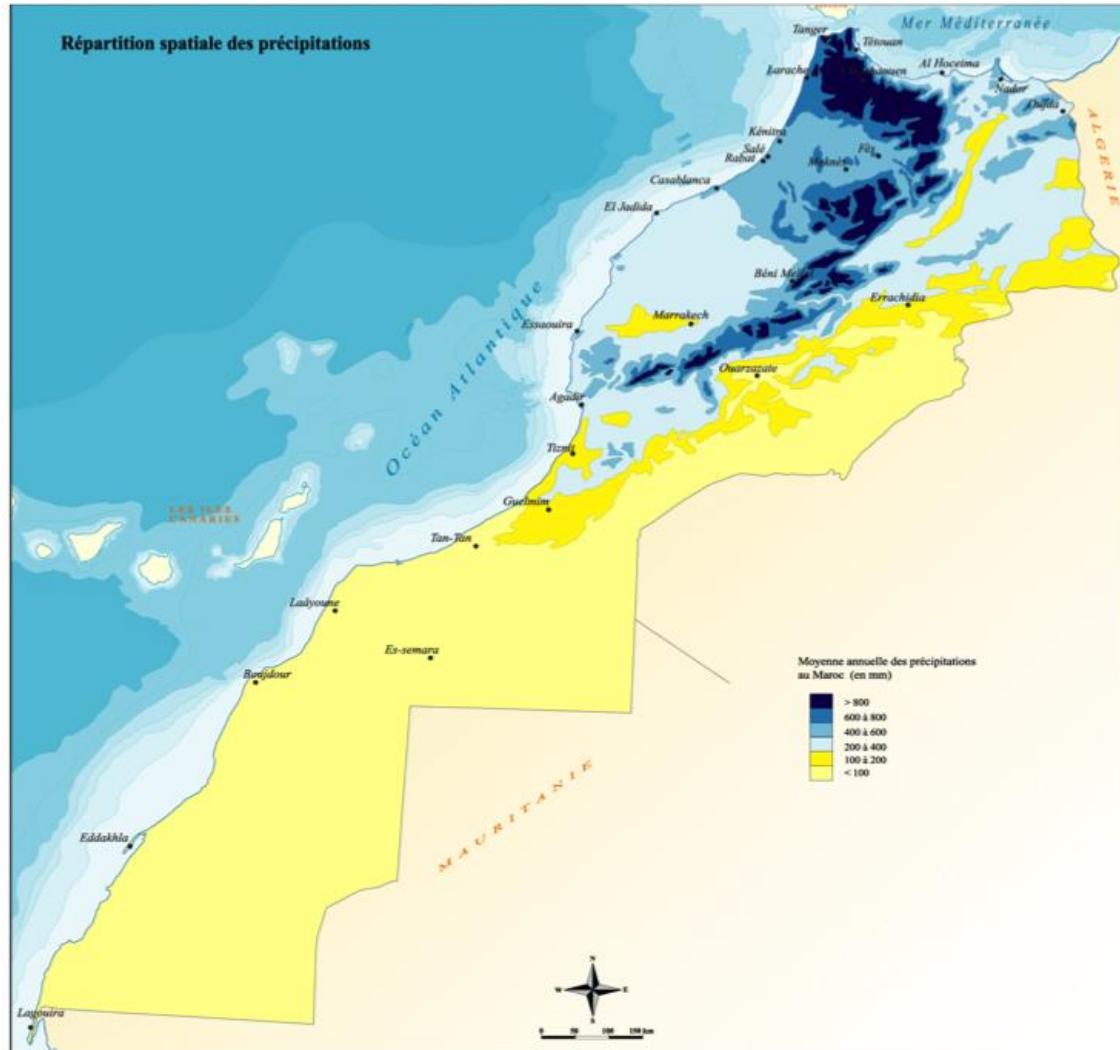
# Morocco: geography

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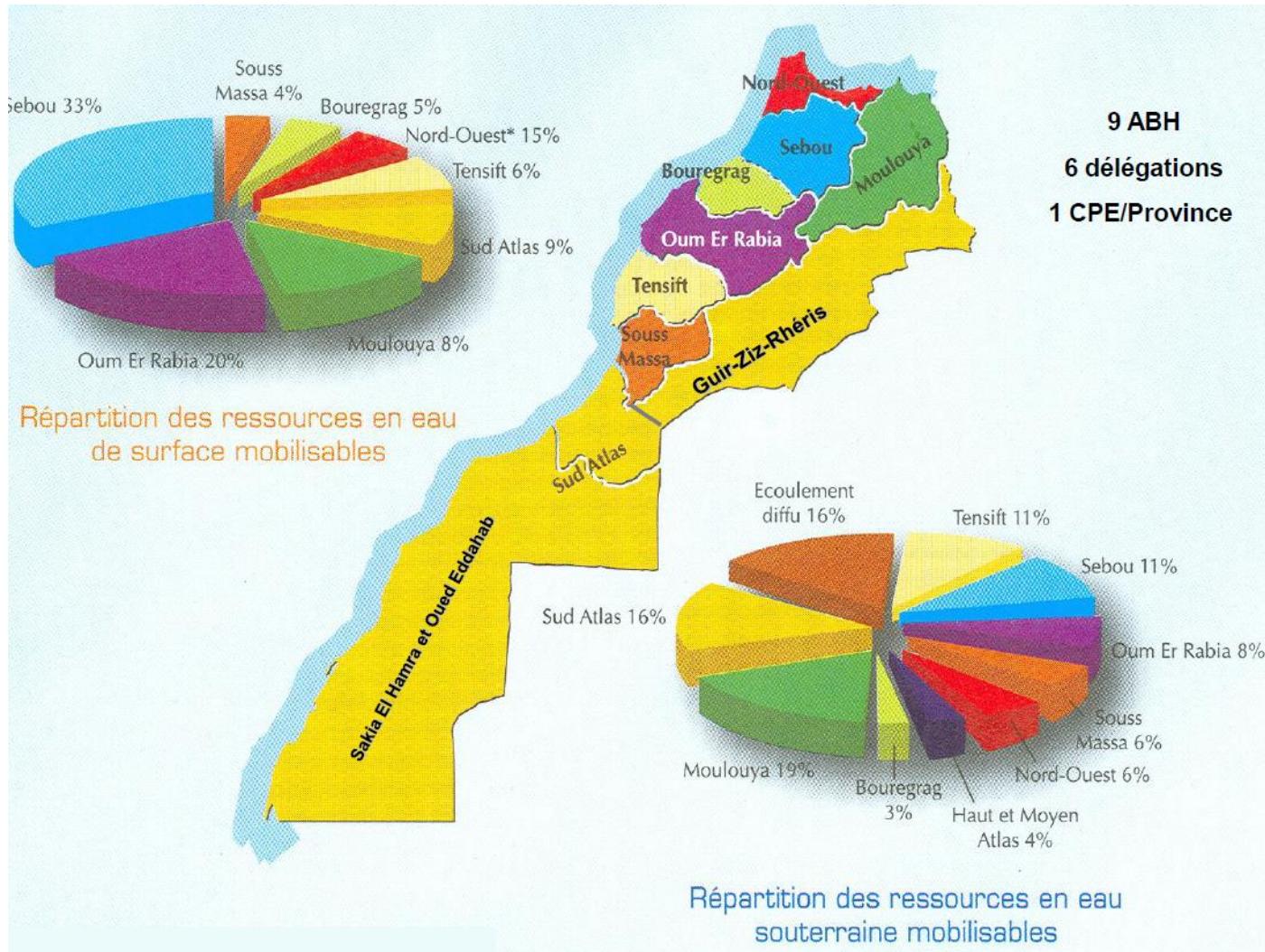


*Source:* <http://www.lahistoriaconmapas.com/atlas/map-satellite/Morocco-satellite-map.htm>

# “Climate divide”



# Water basins (ABH)



# Virtual water

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Allan (2003) – volume of “embodied water”.

Hoekstra and Chapagain (2008) – the “virtual-water content” of a product is the volume of water used to produce it, measured at the place(s) where it was actually produced.

Empirical issue: hypothetical *need* x actual volume.

- Coefficient intensity.

# Measurement of Domestic Value Added in Exports

The input-output model can be expressed by

$$\mathbf{x} = \mathbf{Ax} + \mathbf{f} \quad (1)$$

and

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1} \mathbf{f} = \mathbf{Lf} \quad (2)$$

where  $\mathbf{x}$  and  $\mathbf{f}$  are the vectors of gross output and final demand;  $\mathbf{A}$  is a matrix with the input coefficients ( $a_{ij}$ );  $\mathbf{I}$  is the identity matrix; and  $\mathbf{L}$  is the Leontief inverse.<sup>1</sup>

# Measurement of Domestic Value Added in Exports (cont.)

Considering a national interregional input-output model with  $n$  different regions and the RoW as a column vector in the final demand, (1) and (2) can be represented as

$$\begin{bmatrix} \mathbf{x}^1 \\ \vdots \\ \mathbf{x}^n \end{bmatrix} = \begin{bmatrix} \mathbf{A}^{11} & \cdots & \mathbf{A}^{1n} \\ \vdots & \ddots & \vdots \\ \mathbf{A}^{n1} & \cdots & \mathbf{A}^{nn} \end{bmatrix} \begin{bmatrix} \mathbf{x}^1 \\ \vdots \\ \mathbf{x}^n \end{bmatrix} + \begin{bmatrix} \mathbf{f}^{11} & \cdots & \mathbf{f}^{1n} & \mathbf{f}^{1\text{row}} \\ \vdots & \ddots & \vdots & \vdots \\ \mathbf{f}^{n1} & \cdots & \mathbf{f}^{nn} & \mathbf{f}^{n\text{row}} \end{bmatrix} \mathbf{i} \quad (3)$$

and

$$\begin{bmatrix} \mathbf{x}^1 \\ \vdots \\ \mathbf{x}^n \end{bmatrix} = \left\{ \begin{bmatrix} \mathbf{I} & \cdots & \mathbf{0} \\ \vdots & \ddots & \vdots \\ \mathbf{0} & \cdots & \mathbf{I} \end{bmatrix} - \begin{bmatrix} \mathbf{A}^{11} & \cdots & \mathbf{A}^{1n} \\ \vdots & \ddots & \vdots \\ \mathbf{A}^{n1} & \cdots & \mathbf{A}^{nn} \end{bmatrix} \right\}^{-1} \begin{bmatrix} \mathbf{f}^{11} & \cdots & \mathbf{f}^{1n} & \mathbf{f}^{1\text{row}} \\ \vdots & \ddots & \vdots & \vdots \\ \mathbf{f}^{n1} & \cdots & \mathbf{f}^{nn} & \mathbf{f}^{n\text{row}} \end{bmatrix} \mathbf{i}$$
$$= \begin{bmatrix} \mathbf{L}^{11} & \cdots & \mathbf{L}^{1n} \\ \vdots & \ddots & \vdots \\ \mathbf{L}^{n1} & \cdots & \mathbf{L}^{nn} \end{bmatrix} \begin{bmatrix} \mathbf{f}^{11} & \cdots & \mathbf{f}^{1n} & \mathbf{f}^{1\text{row}} \\ \vdots & \ddots & \vdots & \vdots \\ \mathbf{f}^{n1} & \cdots & \mathbf{f}^{nn} & \mathbf{f}^{n\text{row}} \end{bmatrix} \mathbf{i} \quad (4)$$

where  $\mathbf{i}$  is a column vector with all elements equal unity which sums all elements in each of the  $n+1$  rows of the matrix  $\mathbf{f}$ .

# Measurement of Domestic Value Added in Exports (cont.)

Following Los et al. (2016), the value added in region 1 ( $GDP_1$ ) can be expressed as

$$GDP_1 = \mathbf{v}_1(\mathbf{I} - \mathbf{A})^{-1}\mathbf{f}\mathbf{i} \quad (5)$$

where  $\mathbf{v}_1$  is a row vector with ratios of value added to gross output in industries in region 1 as first elements ( $\tilde{\mathbf{v}}_1$ ) and zeros elsewhere ( $\mathbf{v}_1 = [\tilde{\mathbf{v}}_1 \quad \mathbf{0}]$ ); and  $\mathbf{i}$  is a column vector which all elements are unity.

In order to attribute the amount of domestic value added in exports from region 1 to region  $n$ , as proposed by Los et al. (2016), we consider a hypothetical world where region 1 does not export anything to region  $n$ . In this case, the new GDP or hypothetical GDP can be represented by

$$GDP_{1,n}^* = \mathbf{v}_1(\mathbf{I} - \mathbf{A}_{1,n}^*)^{-1}\mathbf{f}_{1,n}^*\mathbf{i} \quad (6)$$

# Measurement of Domestic Value Added in Exports (cont.)

where  $\mathbf{A}_{1,n}^*$  and  $\mathbf{f}_{1,n}^*$  are the hypothetical matrix of input coefficients and final demand, respectively, expressed as

$$\mathbf{A}_{1,n}^* = \begin{bmatrix} \mathbf{A}^{11} & \cdots & \mathbf{0} \\ \vdots & \ddots & \vdots \\ \mathbf{A}^{n1} & \cdots & \mathbf{A}^{nn} \end{bmatrix} \quad (7)$$

$$\mathbf{f}_{1,n}^* = \begin{bmatrix} \mathbf{f}^{11} & \cdots & \mathbf{0} & \mathbf{f}^{1\text{row}} \\ \vdots & \ddots & \vdots & \vdots \\ \mathbf{f}^{n1} & \cdots & \mathbf{f}^{nn} & \mathbf{f}^{n\text{row}} \end{bmatrix} \quad (8)$$

In addition, in order to attribute the amount of domestic value added in exports from region 1 to the RoW, we consider a hypothetical world where region 1 does not export to the RoW. In this case, the hypothetical GDP can be represented as

$$GDP_{1,\text{row}}^* = \mathbf{v}_1(\mathbf{I} - \mathbf{A})^{-1}\mathbf{f}_{1,\text{row}}^*\mathbf{i} \quad (9)$$

# Measurement of Domestic Value Added in Exports (cont.)

where  $\mathbf{A}$  is the original matrix with the input coefficients as in (5); and  $\mathbf{f}_{1, \text{row}}^*$  is the hypothetical matrix of final demand, expressed as

$$\mathbf{f}_{1, \text{row}}^* = \begin{bmatrix} \mathbf{f}^{11} & \dots & \mathbf{f}^{1n} & \mathbf{0} \\ \vdots & \ddots & \vdots & \vdots \\ \mathbf{f}^{n1} & \dots & \mathbf{f}^{nn} & \mathbf{f}^{nrow} \end{bmatrix} \quad (10)$$

From (5) and (6), we can define the domestic value added in exports (DVA) from region 1 to region  $n$  as follows:

$$DVA_{1,n} = GDP_1 - GDP_{1,n}^* \quad (11)$$

# Measurement of Domestic Value Added in Exports (cont.)

and, from (5) and (9), we can define DVA in exports from region 1 to the RoW as

$$DVA_{1, \text{row}} = GDP_1 - GDP_{1, \text{row}}^* \quad (12)$$

Similarly, we can attribute the amount of domestic value added in exports from region 1 to all regions ( $2, 3, \dots, n$ ), and from each region to the  $n$ -regions ( $1, 2, \dots, n$ ), excluding itself. We can also attribute the DVA from each region to the RoW. In this sense, in an interregional system with  $n$  regions and the RoW exogenous, we have  $n$  DVA in exports for each region, as illustrated in Table 5.

# Methodology

**Table 1.** Domestic value added in exports (DVA)

Hypothetical no export	to					
from	R <sub>1</sub>	R <sub>2</sub>	...	R <sub>n-1</sub>	R <sub>n</sub>	RoW
R <sub>1</sub>		DVA <sub>1,2</sub>	...	DVA <sub>1,n-1</sub>	DVA <sub>1,n</sub>	DVA <sub>1,row</sub>
R <sub>2</sub>	DVA <sub>2,1</sub>		...	DVA <sub>2,n-1</sub>	DVA <sub>2,n</sub>	DVA <sub>2,row</sub>
:	:	:		:	:	:
R <sub>n-1</sub>	DVA <sub>n-1,1</sub>	DVA <sub>n-1,2</sub>	...		DVA <sub>n-1,n</sub>	DVA <sub>n-1,row</sub>
R <sub>n</sub>	DVA <sub>n,1</sub>	DVA <sub>n,2</sub>	...	DVA <sub>n,n-1</sub>		DVA <sub>n,row</sub>

Total value added content in  
exports from R1 to R2

# Methodology

**Table 2.** Domestic total traded water in exports (DTW)

Hypothetical no export	to					
from	R <sub>1</sub>	R <sub>2</sub>	...	R <sub>n-1</sub>	R <sub>n</sub>	RoW
R <sub>1</sub>		DTW <sub>1,2</sub>	...	DTW <sub>1,n-1</sub>	DTW <sub>1,n</sub>	DTW <sub>1,row</sub>
R <sub>2</sub>	DTW <sub>2,1</sub>		...	DTW <sub>2,n-1</sub>	DTW <sub>2,n</sub>	DTW <sub>2,row</sub>
:	:	:		:	:	:
R <sub>n-1</sub>	DTW <sub>n-1,1</sub>	DTW <sub>n-1,2</sub>	...		DTW <sub>n-1,n</sub>	DTW <sub>n-1,row</sub>
R <sub>n</sub>	DTW <sub>n,1</sub>	DTW <sub>n,2</sub>	...	DTW <sub>n,n-1</sub>		DTW <sub>n,row</sub>

Total water content in  
exports from R1 to R2

# Methodology

**Table 3.** Relative importance of each DVA in the whole economy

Hypothetical no export		to					
From		R <sub>1</sub>	R <sub>2</sub>	...	R <sub>n-1</sub>	R <sub>n</sub>	RoW
R <sub>1</sub>			I <sub>1,2</sub> <sup>DVA</sup>	...	I <sub>1,n-1</sub> <sup>DVA</sup>	I <sub>1,n</sub> <sup>DVA</sup>	I <sub>1,row</sub> <sup>DVA</sup>
R <sub>2</sub>		I <sub>2,1</sub> <sup>DVA</sup>		...	I <sub>2,n-1</sub> <sup>DVA</sup>	I <sub>2,n</sub> <sup>DVA</sup>	I <sub>2,row</sub> <sup>DVA</sup>
:		:	:		:	:	:
R <sub>n-1</sub>		I <sub>n-1,1</sub> <sup>DVA</sup>	I <sub>n-1,2</sub> <sup>DVA</sup>	...		I <sub>n-1,n</sub> <sup>DVA</sup>	I <sub>n-1,row</sub> <sup>DVA</sup>
R <sub>n</sub>		I <sub>n,1</sub> <sup>DVA</sup>	I <sub>n,2</sub> <sup>DVA</sup>	...	I <sub>n,n-1</sub> <sup>DVA</sup>		I <sub>n,row</sub> <sup>DVA</sup>

Share of value added content  
in exports from R1 to R2 in  
total value added traded

# Methodology

**Table 4.** Relative importance of each DTW in the whole economy

Hypothetical no export		To					
from		R <sub>1</sub>	R <sub>2</sub>	...	R <sub>n-1</sub>	R <sub>n</sub>	RoW
R <sub>1</sub>			$I_{1,2}^{DTW}$	...	$I_{1,n-1}^{DTW}$	$I_{1,n}^{DTW}$	$I_{1,roW}^{DTW}$
R <sub>2</sub>		$I_{2,1}^{DTW}$		...	$I_{2,n-1}^{DTW}$	$I_{2,n}^{DTW}$	$I_{2,roW}^{DTW}$
:		:	:		:	:	:
R <sub>n-1</sub>		$I_{n-1,1}^{DTW}$	$I_{n-1,2}^{DTW}$	...		$I_{n-1,n}^{DTW}$	$I_{n-1,roW}^{DTW}$
R <sub>n</sub>		$I_{n,1}^{DTW}$	$I_{n,2}^{DTW}$	...	$I_{n,n-1}^{DTW}$		$I_{n,roW}^{DTW}$

Share of water content in  
exports from R1 to R2 in  
total water traded

# Methodology

**Table 5.** Trade-Based Index of Water Intensity

Hypothetical no export		To					
from		R <sub>1</sub>	R <sub>2</sub>	...	R <sub>n-1</sub>	R <sub>n</sub>	RoW
R <sub>1</sub>			TWI <sub>1,2</sub>	...	TWI <sub>1,n-1</sub>	TWI <sub>1,n</sub>	TWI <sub>1,row</sub>
R <sub>2</sub>		TWI <sub>2,1</sub>		...	TWI <sub>2,n-1</sub>	TWI <sub>2,n</sub>	TWI <sub>2,row</sub>
:		:	:		:	:	:
R <sub>n-1</sub>		TWI <sub>n-1,1</sub>	TWI <sub>n-1,2</sub>	...		TWI <sub>n-1,n</sub>	TWI <sub>n-1,row</sub>
R <sub>n</sub>		TWI <sub>n,1</sub>	TWI <sub>n,2</sub>	...	TWI <sub>n,n-1</sub>		TWI <sub>n,row</sub>

Location quotient of traded  
water to value added

# Methodology

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The *TWI* can be interpreted as

- (a) if **greater** than 1, exports from the region use more intensively water resources compared to its contribution to value added creation; and
- (b) if **lower** than 1, the opposite.

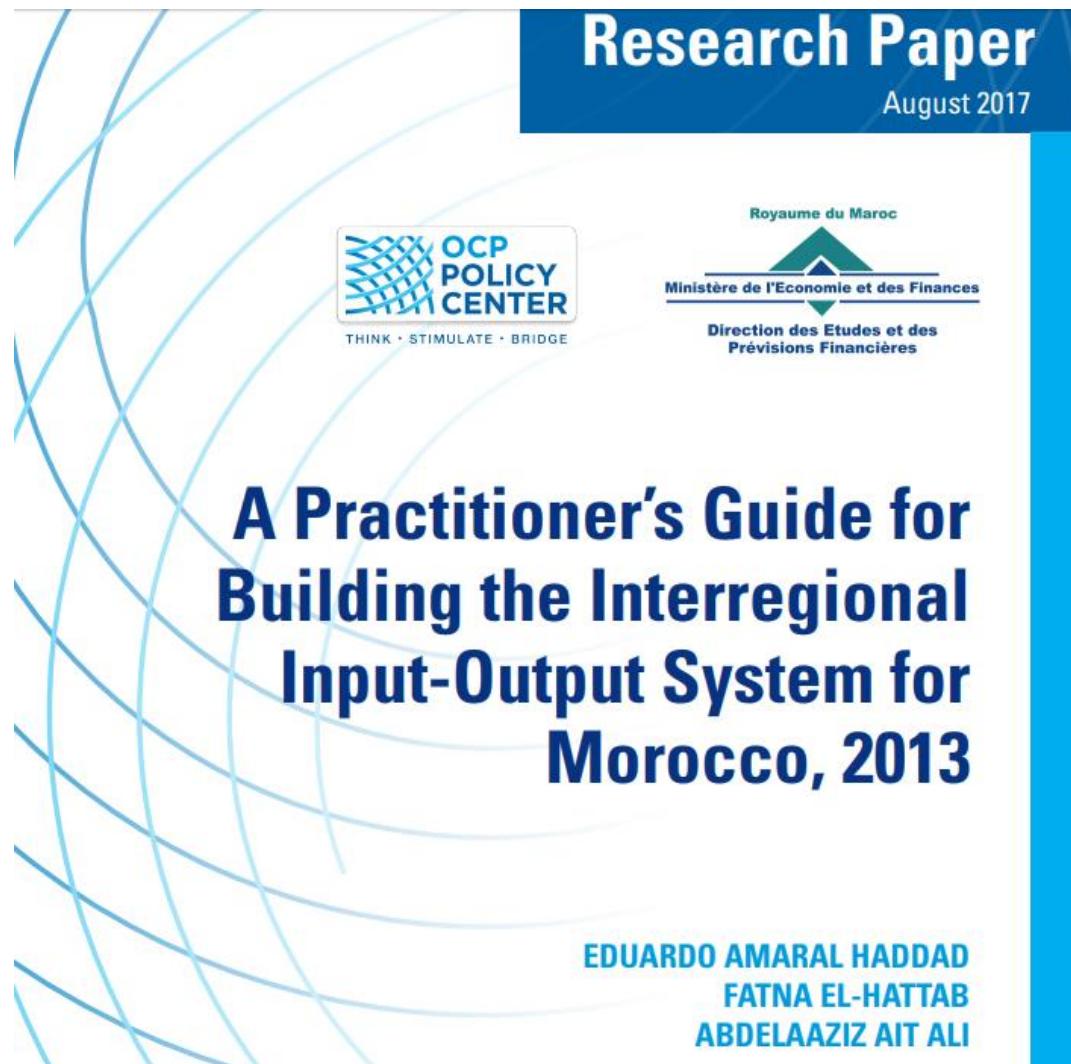
# Database

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## **Input-Output:**

- A fully specified interregional input-output database, considering 20 sectors in 12 Moroccan regions.
- Haddad, E.A., Ait-Ali, A. and El-Hattab, F. (2017). A Practitioner's Guide for Building the Interregional Input-Output System for Morocco, 2013, *OCP Policy Center Research Paper RP-17/02*.

# Publication



**Research Paper**  
August 2017

OCP POLICY CENTER  
THINK • STIMULATE • BRIDGE

Royaume du Maroc  
Ministère de l'Economie et des Finances  
Direction des Etudes et des Prévisions Financières

## A Practitioner's Guide for Building the Interregional Input-Output System for Morocco, 2013

EDUARDO AMARAL HADDAD  
FATNA EL-HATTAB  
ABDELAAZIZ AIT ALI

# Structure of Interregional IO models

		Buying Sectors Region L		Buying Sectors Region M	
		Interindustry Inputs		Interindustry Inputs	
		LL	LM	FD LL	FD LM
Selling sectors <b>Region L</b>		Interindustry Inputs LL	Interindustry Inputs LM	FD LL	FD LM
Selling sectors <b>Region M</b>		Interindustry Inputs ML	Interindustry Inputs MM	FD ML	FD MM
		Imports from the World	Imports from the World	M	M
		Sales Taxes	Sales Taxes	T	T
		Value Added	Value Added		
		Total Output L	Total Output M		

# Regional setting



# Sectoral aggregation

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1	A00	Agriculture, forêt et services annexes
2	B05	Pêche, aquaculture
3	C00	Industrie d'extraction
4	D01	Industries alimentaires et tabac
5	D02	Industries du textile et du cuir
6	D03	Industrie chimique et parachimique
7	D04	Industrie mécanique, métallurgique et électrique
8	D05	Autres industries manufac. hors raffinage pétrole
9	D06	Raffinage de pétrole et autres produits d'énergie
10	E00	Electricité et eau
11	F45	Bâtiment et travaux publics
12	G00	Commerce
13	H55	Hôtels et restaurants
14	I01	Transports
15	I02	Postes et télécommunications
16	J00	Activités financières et assurances
17	K00	Immobilier, location et serv. rendus entreprises
18	L75	Administration publique et sécurité sociale
19	MNO	Education, santé et action sociale
20	OP0	Autres services non financiers

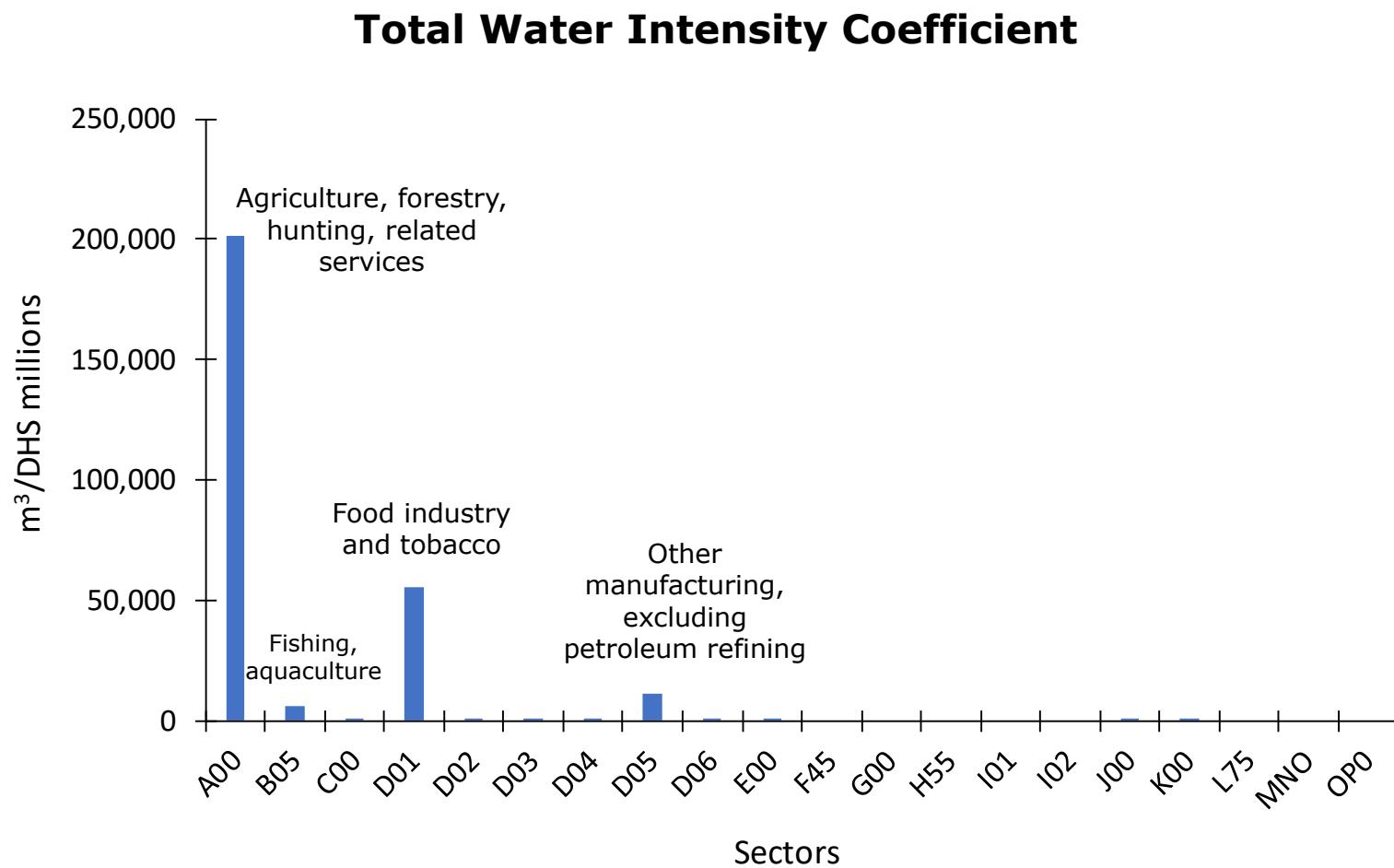
# Database

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## Water:

- Water footprint by crop demand; Water footprint of grazing [green]; Water footprint of animal supply [blue]; Water footprint of industrial production [blue grey]; Water footprint of domestic water supply [blue grey]
- Source:
  - **Eora**: a Global Multi-Region Input-Output Database
    - Lenzen et al. (2012; 2013).
- *Caveat*: national coefficients applied to regions.

# Results



# Regional structure (selected sectors)

	<i>R1</i>	<i>R2</i>	<i>R3</i>	<i>R4</i>	<i>R5</i>	<i>R6</i>	<i>R7</i>	<i>R8</i>	<i>R9</i>	<i>R10</i>	<i>R11</i>	<i>R12</i>	<i>TOTAL</i>
→ A00 Agriculture, forestry, hunting, related services	7.8	8.3	17.8	12.3	13.4	13.0	13.1	6.1	7.0	1.1	0.0	0.0	100.0
→ B05 Fishing, aquaculture	9.8	2.1	0.0	1.2	0.0	4.2	3.8	0.0	32.8	12.2	11.9	22.1	100.0
→ D01 Food industry and tobacco	5.3	1.8	9.9	5.6	3.6	52.3	5.8	0.4	12.6	0.7	1.5	0.6	100.0
D03 Chemical and para-chemical industry	2.7	1.0	3.1	5.1	0.3	75.3	9.3	0.1	1.5	0.0	1.6	0.0	100.0
→ D05 Other manufacturing, excluding petroleum refining	10.3	1.9	5.9	6.4	1.2	62.5	5.8	0.1	4.4	0.2	1.1	0.2	100.0
E00 Electricity and water	11.4	6.9	11.0	20.8	5.3	21.9	11.0	2.3	7.0	1.0	1.3	0.3	100.0
I01 Transport	8.4	8.6	10.9	15.1	4.8	29.1	10.1	2.7	7.0	1.6	1.3	0.4	100.0
<b>TOTAL</b>	<b>8.8</b>	<b>5.6</b>	<b>9.2</b>	<b>13.0</b>	<b>5.8</b>	<b>35.7</b>	<b>9.9</b>	<b>2.5</b>	<b>6.4</b>	<b>1.1</b>	<b>1.5</b>	<b>0.5</b>	<b>100.0</b>

# User share

<i>Sectors</i>	<i>Intermediate consumption</i>	<i>Investment demand</i>	<i>Household demand</i>	<i>Exports</i>	<i>Government demand</i>	<i>Total</i>
A00 Agriculture, forestry, hunting, related services	38.5	5.0	43.6	7.1	5.8	100.0
B05 Fishing, aquaculture	37.2	0.0	21.3	21.5	20.0	100.0
C00 Mining industry	52.7	5.8	0.7	29.4	11.4	100.0
D01 Food industry and tobacco	17.2	1.0	61.6	11.2	9.0	100.0
D02 Textile and leather industry	14.8	0.6	15.5	48.4	20.7	100.0
D03 Chemical and para-chemical industry	13.3	0.7	10.2	57.8	18.1	100.0
D04 Mechanical, metallurgical and electrical industry	17.5	18.4	5.6	48.1	10.3	100.0
D05 Other manufacturing, excluding petroleum refining	55.4	12.8	17.7	8.9	5.2	100.0
D06 Oil refining and other energy products	44.5	14.6	15.0	18.2	7.7	100.0
E00 Electricity and water	43.7	1.8	51.7	1.5	1.3	100.0
F45 Construction	1.6	95.1	3.0	0.2	0.2	100.0
G00 Trade	37.3	13.7	32.8	2.4	13.8	100.0
H55 Hotels and restaurants	17.6	0.0	78.3	2.1	1.9	100.0
I01 Transport	16.9	1.3	26.9	33.1	21.7	100.0
I02 Post and telecommunications	12.9	0.2	61.4	13.2	12.2	100.0
J00 Financial activities and insurance	57.9	0.2	38.0	2.0	2.0	100.0
K00 Real estate, renting and services to enterprises	28.8	9.7	29.4	16.8	15.2	100.0
L75 General public administration and social security	19.2	7.3	58.6	7.5	7.4	100.0
MNO Education, health and social action	2.9	0.0	97.1	0.0	0.0	100.0
OP0 Other non-financial services	16.3	0.3	81.6	0.9	0.9	100.0

# Methodology

**Table 1.** Domestic value added in exports (DVA)

Hypothetical no export	to					
from	R <sub>1</sub>	R <sub>2</sub>	...	R <sub>n-1</sub>	R <sub>n</sub>	RoW
R <sub>1</sub>		DVA <sub>1,2</sub>	...	DVA <sub>1,n-1</sub>	DVA <sub>1,n</sub>	DVA <sub>1,row</sub>
R <sub>2</sub>	DVA <sub>2,1</sub>		...	DVA <sub>2,n-1</sub>	DVA <sub>2,n</sub>	DVA <sub>2,row</sub>
:	:	:		:	:	:
R <sub>n-1</sub>	DVA <sub>n-1,1</sub>	DVA <sub>n-1,2</sub>	...		DVA <sub>n-1,n</sub>	DVA <sub>n-1,row</sub>
R <sub>n</sub>	DVA <sub>n,1</sub>	DVA <sub>n,2</sub>	...	DVA <sub>n,n-1</sub>		DVA <sub>n,row</sub>

# Results (DVA)

O   D	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	RoW
R1		1208,60	2071,14	2467,32	711,99	6643,63	1218,83	699,68	871,82	179,40	371,83	263,79	12862,57
R2	1727,83		2532,61	1725,72	655,64	4849,19	906,34	869,22	705,86	167,08	429,28	288,70	5425,75
R3	3687,17	3343,75		4766,08	1483,25	10580,30	1763,30	1728,80	1255,07	294,12	658,00	431,70	6000,08
R4	5664,46	2337,42	4689,91		2030,42	22826,16	3029,60	1557,51	1791,42	500,87	897,07	522,89	9028,55
R5	1377,33	764,12	1629,83	1937,43		13295,53	2739,46	654,07	1385,98	196,65	393,45	247,88	11228,28
R6	16561,20	8302,54	12595,07	27434,62	9022,06		16047,51	4972,15	7677,56	1595,71	2274,27	1488,71	49529,10
R7	2674,02	1525,95	2268,48	4195,71	2949,40	17718,26		1212,33	3113,25	629,89	1027,97	597,19	4871,06
R8	737,70	533,11	1147,15	814,07	472,43	3543,61	739,14		576,89	83,02	207,34	137,62	1162,18
R9	1907,40	1304,66	1666,90	2710,41	1416,04	7247,61	3141,50	904,83		1407,16	1303,44	673,53	2927,08
R10	204,57	116,85	180,37	278,63	130,62	721,67	297,09	91,28	658,70		255,20	105,93	906,12
R11	284,24	160,56	236,93	316,04	130,14	1981,05	311,69	104,60	343,31	134,19		197,21	1658,53
R12	50,07	38,19	57,70	54,31	27,20	144,83	48,71	23,05	61,50	15,69	63,80		1641,85

**R1** - Tanger-Tetouan-Al Hoceima; **R2** - Oriental; **R3** - Fès-Meknès; **R4** - Rabat-Salé-Kénitra; **R5** - Béni Mellal-Khénifra; **R6** - Grand Casablanca-Settat; **R7** - Marrakech-Safi; **R8** - Drâa-Tafilalet; **R9** - Souss-Massa; **R10** - Guelmim-Oued Noun; **R11** - Laayoune-Sakia El Hamra; **R12** - Dakhla-Oued Eddahab; **RoW** - Rest of the World.

# Methodology

**Table 2.** Domestic total traded water in exports (DTW)

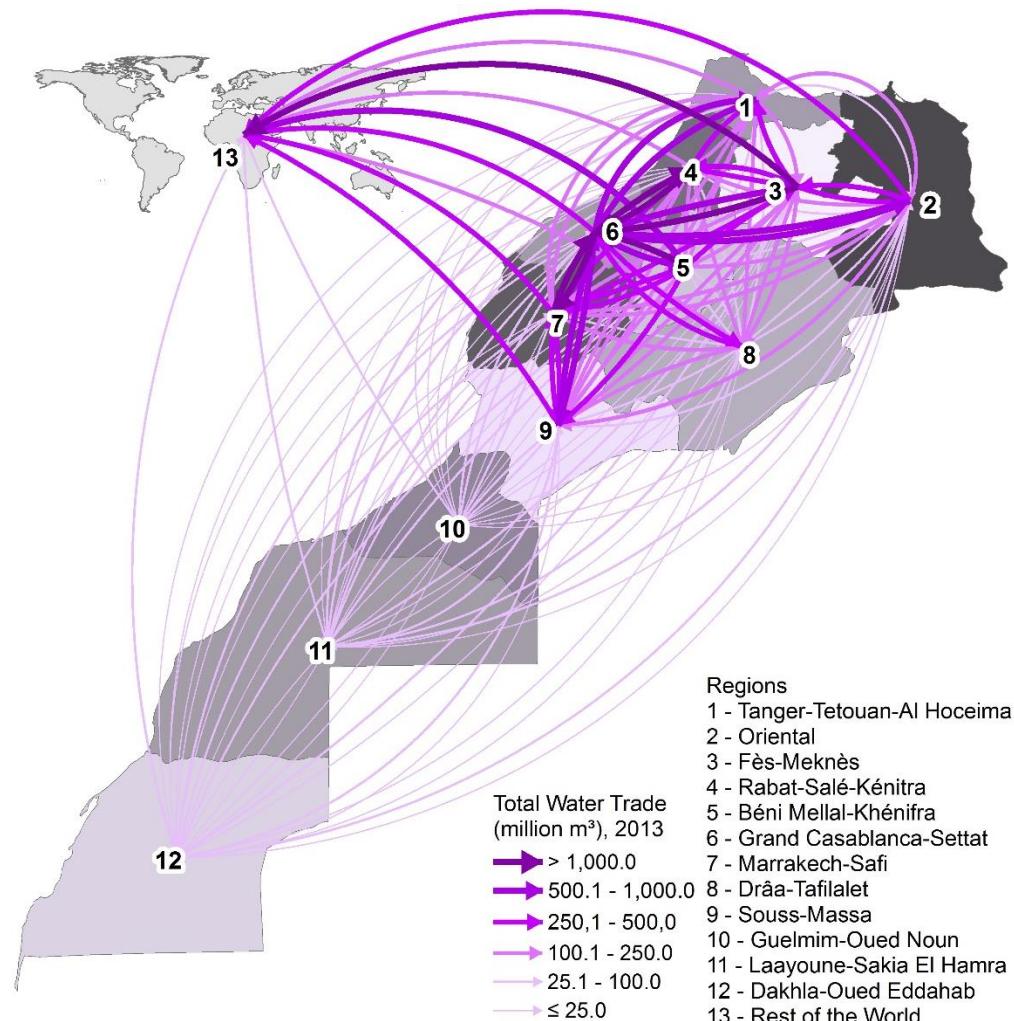
Hypothetical no export		to				
from	R <sub>1</sub>	R <sub>2</sub>	...	R <sub>n-1</sub>	R <sub>n</sub>	RoW
R <sub>1</sub>		DTW <sub>1,2</sub>	...	DTW <sub>1,n-1</sub>	DTW <sub>1,n</sub>	DTW <sub>1,row</sub>
R <sub>2</sub>	DTW <sub>2,1</sub>		...	DTW <sub>2,n-1</sub>	DTW <sub>2,n</sub>	DTW <sub>2,row</sub>
:	:	:		:	:	:
R <sub>n-1</sub>	DTW <sub>n-1,1</sub>	DTW <sub>n-1,2</sub>	...		DTW <sub>n-1,n</sub>	DTW <sub>n-1,row</sub>
R <sub>n</sub>	DTW <sub>n,1</sub>	DTW <sub>n,2</sub>	...	DTW <sub>n,n-1</sub>		DTW <sub>n,row</sub>

# Results (DTW)

O   D	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	RoW
R1		96,35	222,94	210,40	68,60	759,03	127,87	42,67	120,28	11,05	27,48	23,48	208,52
R2	164,55		348,38	153,33	79,60	606,62	113,76	51,78	118,51	10,07	32,70	27,23	278,04
R3	460,14	397,09		485,86	207,55	1686,91	263,01	154,30	233,64	21,40	55,48	48,11	1258,61
R4	255,30	93,43	288,10		99,67	2366,46	179,81	40,35	152,27	11,83	28,79	22,38	125,62
R5	186,75	111,41	282,38	236,50		1414,26	445,36	73,52	285,29	20,35	50,34	37,81	870,65
R6	982,73	565,04	929,32	1792,90	581,76		1170,44	271,85	627,46	75,89	83,04	93,52	434,95
R7	208,14	101,81	213,05	259,12	268,36	1531,26		70,62	485,66	31,41	66,69	48,18	356,90
R8	111,49	81,12	213,62	108,47	86,58	404,56	130,71		129,52	9,86	31,83	24,79	244,38
R9	156,80	94,70	139,38	142,20	119,61	787,94	356,33	66,38		70,17	63,75	49,35	462,18
R10	13,25	6,68	13,07	12,85	9,44	67,07	23,64	4,07	67,55		14,31	7,39	66,04
R11	4,21	3,59	3,67	2,34	2,21	13,38	5,40	2,47	5,70	1,77		4,04	54,90
R12	1,15	1,02	1,09	0,65	0,57	3,34	1,28	0,66	1,26	0,30	0,59		34,10

**R1** - Tanger-Tetouan-Al Hoceima; **R2** - Oriental; **R3** - Fès-Meknès; **R4** - Rabat-Salé-Kénitra; **R5** - Béni Mellal-Khénifra; **R6** - Grand Casablanca-Settat; **R7** - Marrakech-Safi; **R8** - Drâa-Tafilalet; **R9** - Souss-Massa; **R10** - Guelmim-Oued Noun; **R11** - Laayoune-Sakia El Hamra; **R12** - Dakhla-Oued Eddahab; **RoW** - Rest of the World.

# Results (DTW)

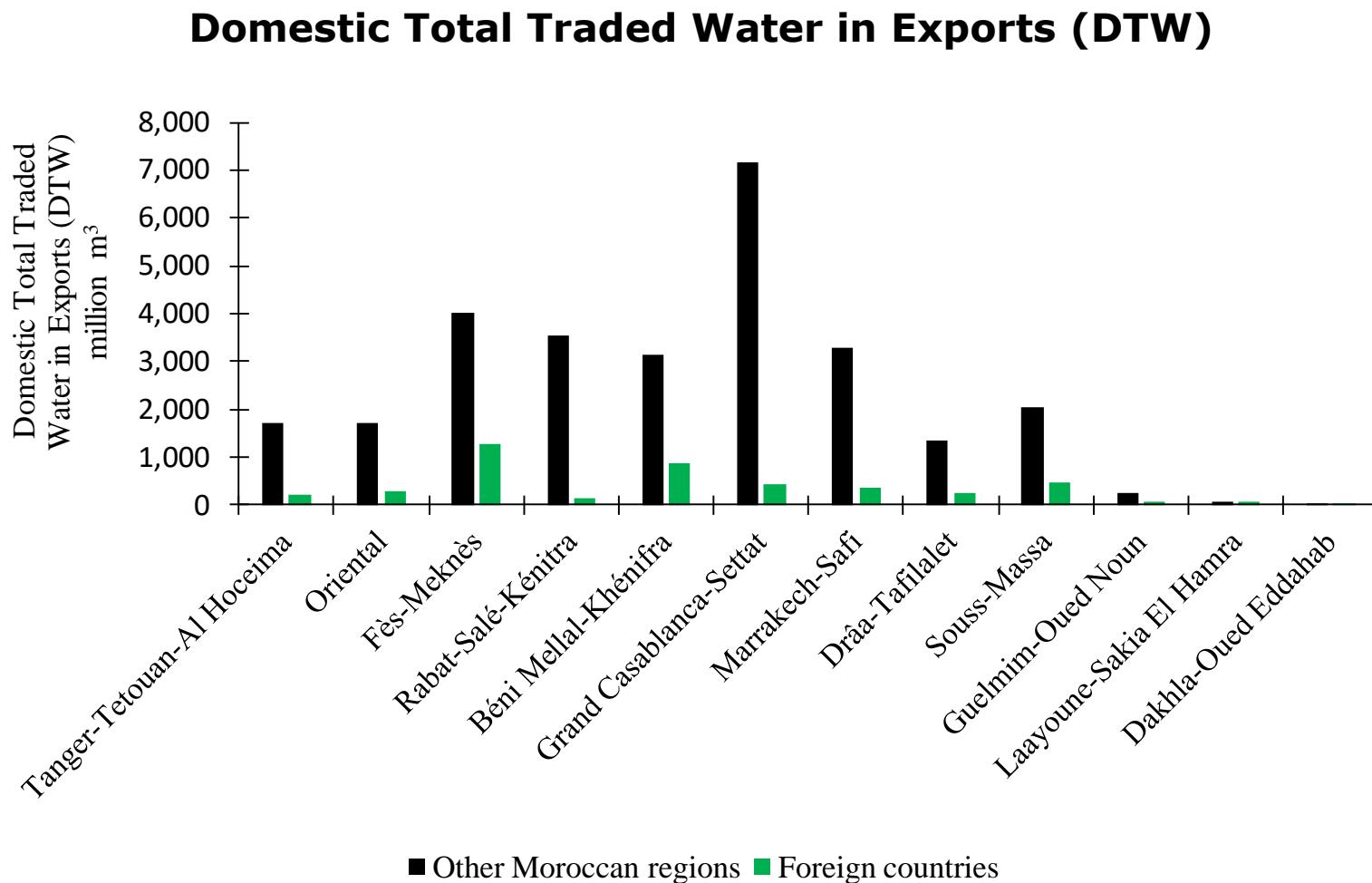


**“H-O result”:** each region exports the good that makes relatively intensive use of its relatively abundant factor

**Table 11. Regional Traded Value Added and Water in Exports, by Destination**

Region	Value Added (million DHS)				Water (million m <sup>3</sup> )			
	Domestic	Foreign	Total	%	Domestic	Foreign	Total	%
Tanger-Tetouan-Al Hoceima	16.708	12.863	29.571	6,95	1.710	209	1.919	5,88
Oriental	14.857	5.426	20.283	4,77	1.707	278	1.985	6,08
Fès-Meknès	29.992	6.000	35.992	8,46	4.014	1.259	5.272	16,15
Rabat-Salé-Kénitra	45.848	9.029	54.876	12,89	3.538	126	3.664	11,22
Béni Mellal-Khénifra	24.622	11.228	35.850	8,42	3.144	871	4.015	12,30
Grand Casablanca-Settat	107.971	49.529	157.501	37,00	7.174	435	7.609	23,31
Marrakech-Safi	37.912	4.871	42.783	10,05	3.284	357	3.641	11,15
Drâa-Tafilalet	8.992	1.162	10.154	2,39	1.333	244	1.577	4,83
Souss-Massa	23.683	2.927	26.611	6,25	2.047	462	2.509	7,69
Guelmim-Oued Noun	3.041	906	3.947	0,93	239	66	305	0,93
Laayoune-Sakia El Hamra	4.200	1.659	5.859	1,38	49	55	104	0,32
Dakhla-Oued Eddahab	585	1.642	2.227	0,52	12	34	46	0,14
<b>TOTAL</b>	<b>318.412</b>	<b>107.241</b>	<b>425.653</b>	<b>100,00</b>	<b>28.250</b>	<b>4.395</b>	<b>32.645</b>	<b>100,00</b>

# Results



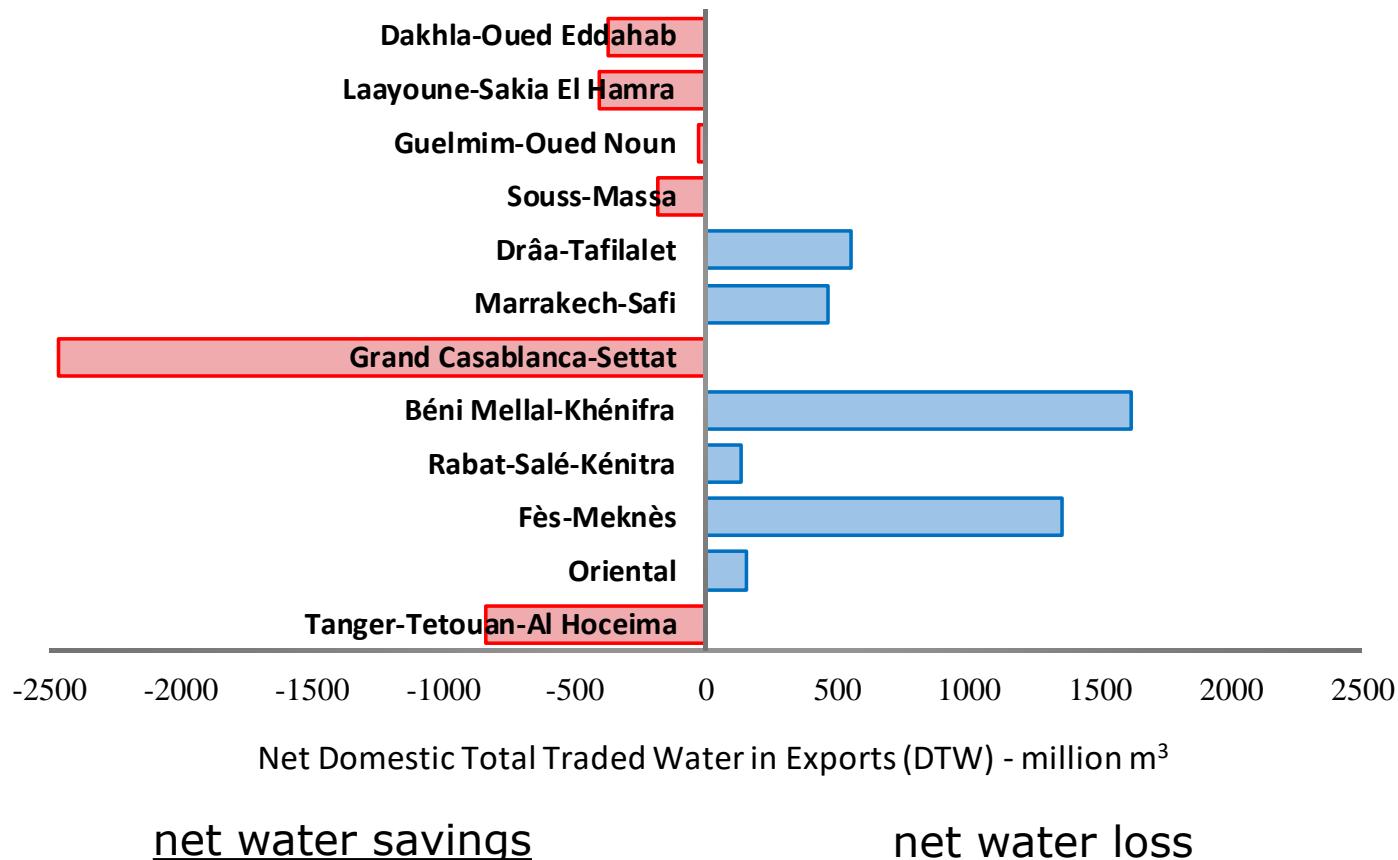
# Results

## Domestic Total Traded Water in Exports (DTW)

Origin   Destination	Other Moroccan regions	Foreign countries
Tanger-Tetouan-Al Hoceima	89.13%	10.87%
Oriental	85.99%	14.01%
Fès-Meknès	76.13%	23.87%
Rabat-Salé-Kénitra	96.57%	3.43%
Béni Mellal-Khénifra	78.31%	21.69%
Grand Casablanca-Settat	94.28%	5.72%
Marrakech-Safi	90.20%	9.80%
Drâa-Tafilalet	84.50%	15.50%
Souss-Massa	81.58%	18.42%
Guelmim-Oued Noun	78.37%	21.63%
Laayoune-Sakia El Hamra	47.05%	52.95%
Dakhla-Oued Eddahab	25.89%	74.11%

# Physical balance of traded water by Moroccan region

## Balance of Domestic Total Traded Water in Exports (DTW) to RoMOR



# Trade-Based Index of Water Intensity (TWI)

**Total Water Index**



O   D	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	RoW
R1		<b>1.039</b>	<b>1.404</b>	<b>1.112</b>	<b>1.256</b>	<b>1.490</b>	<b>1.368</b>	<b>0.795</b>	<b>1.799</b>	<b>0.803</b>	<b>0.963</b>	<b>1.161</b>	<b>0.211</b>
R2	<b>1.242</b>		<b>1.794</b>	<b>1.158</b>	<b>1.583</b>	<b>1.631</b>	<b>1.637</b>	<b>0.777</b>	<b>2.189</b>	<b>0.786</b>	<b>0.993</b>	<b>1.230</b>	<b>0.668</b>
R3	<b>1.627</b>	<b>1.548</b>		<b>1.329</b>	<b>1.825</b>	<b>2.079</b>	<b>1.945</b>	<b>1.164</b>	<b>2.427</b>	<b>0.949</b>	<b>1.099</b>	<b>1.453</b>	<b>2.735</b>
→ R4	<b>0.588</b>	<b>0.521</b>	<b>0.801</b>		<b>0.640</b>	<b>1.352</b>	<b>0.774</b>	<b>0.338</b>	<b>1.108</b>	<b>0.308</b>	<b>0.418</b>	<b>0.558</b>	<b>0.181</b>
→ R5	<b>1.768</b>	<b>1.901</b>	<b>2.259</b>	<b>1.592</b>		<b>1.387</b>	<b>2.120</b>	<b>1.466</b>	<b>2.684</b>	<b>1.350</b>	<b>1.668</b>	<b>1.989</b>	<b>1.011</b>
→ R6	<b>0.774</b>	<b>0.887</b>	<b>0.962</b>	<b>0.852</b>	<b>0.841</b>		<b>0.951</b>	<b>0.713</b>	<b>1.066</b>	<b>0.620</b>	<b>0.476</b>	<b>0.819</b>	<b>0.115</b>
R7	<b>1.015</b>	<b>0.870</b>	<b>1.225</b>	<b>0.805</b>	<b>1.186</b>	<b>1.127</b>		<b>0.760</b>	<b>2.034</b>	<b>0.650</b>	<b>0.846</b>	<b>1.052</b>	<b>0.955</b>
R8	<b>1.971</b>	<b>1.984</b>	<b>2.428</b>	<b>1.737</b>	<b>2.390</b>	<b>1.489</b>	<b>2.306</b>		<b>2.927</b>	<b>1.549</b>	<b>2.001</b>	<b>2.349</b>	<b>2.742</b>
R9	<b>1.072</b>	<b>0.946</b>	<b>1.090</b>	<b>0.684</b>	<b>1.101</b>	<b>1.418</b>	<b>1.479</b>	<b>0.957</b>		<b>0.650</b>	<b>0.638</b>	<b>0.955</b>	<b>2.059</b>
R10	<b>0.845</b>	<b>0.745</b>	<b>0.945</b>	<b>0.601</b>	<b>0.942</b>	<b>1.212</b>	<b>1.037</b>	<b>0.582</b>	<b>1.337</b>		<b>0.731</b>	<b>0.910</b>	<b>0.950</b>
→ R11	<b>0.193</b>	<b>0.292</b>	<b>0.202</b>	<b>0.097</b>	<b>0.222</b>	<b>0.088</b>	<b>0.226</b>	<b>0.308</b>	<b>0.217</b>	<b>0.172</b>		<b>0.267</b>	<b>0.432</b>
→ R12	<b>0.300</b>	<b>0.348</b>	<b>0.246</b>	<b>0.156</b>	<b>0.274</b>	<b>0.300</b>	<b>0.343</b>	<b>0.372</b>	<b>0.267</b>	<b>0.246</b>	<b>0.121</b>		<b>0.271</b>

R1 - Tanger-Tetouan-Al Hoceima; R2 - Oriental; R3 - Fès-Meknès; R4 - Rabat-Salé-Kénitra; R5 - Béni Mellal-Khénifra; R6 - Grand Casablanca-Settat; R7 - Marrakech-Safi; R8 - Drâa-Tafilalet; R9 - Souss-Massa; R10 - Guelmim-Oued Noun; R11 - Laayoune-Sakia El Hamra; R12 - Dakhla-Oued Eddahab; RoW - Rest of the World.

# Epilogue: Natural Resources Intensity

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The proposed index, TWI, can be compared to similar metrics related to **other natural resources**.

Economic activity demand different scarce resources whose **availability varies across regions** within a country.

Similarly, we can calculate a **Trade-Based Index of CO<sub>2</sub> Emissions** based on DVA and DCO<sub>2</sub>.

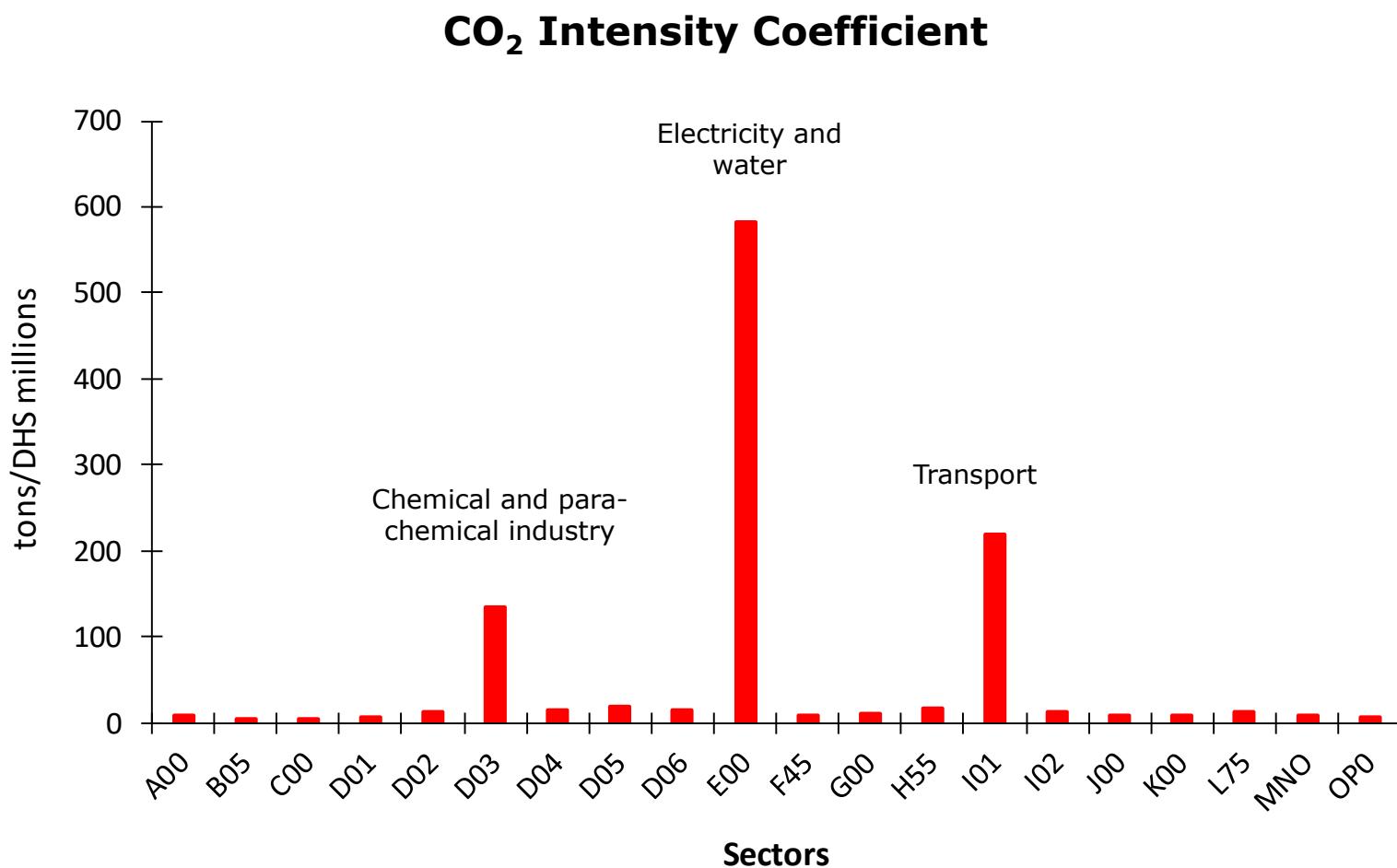
# Database

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## Emissions:

- Global CO<sub>2</sub> emissions from fossil fuel use and cement production.
- Source:
  - EDGAR - **Emissions Database for Global Atmospheric Research** - European Commission, Joint Research Centre (JRC).
  - **Eora**: a Global Multi-Region Input-Output Database – Lenzen et al. (2012; 2013).
- *Caveat*: national coefficients applied to regions.

# Results

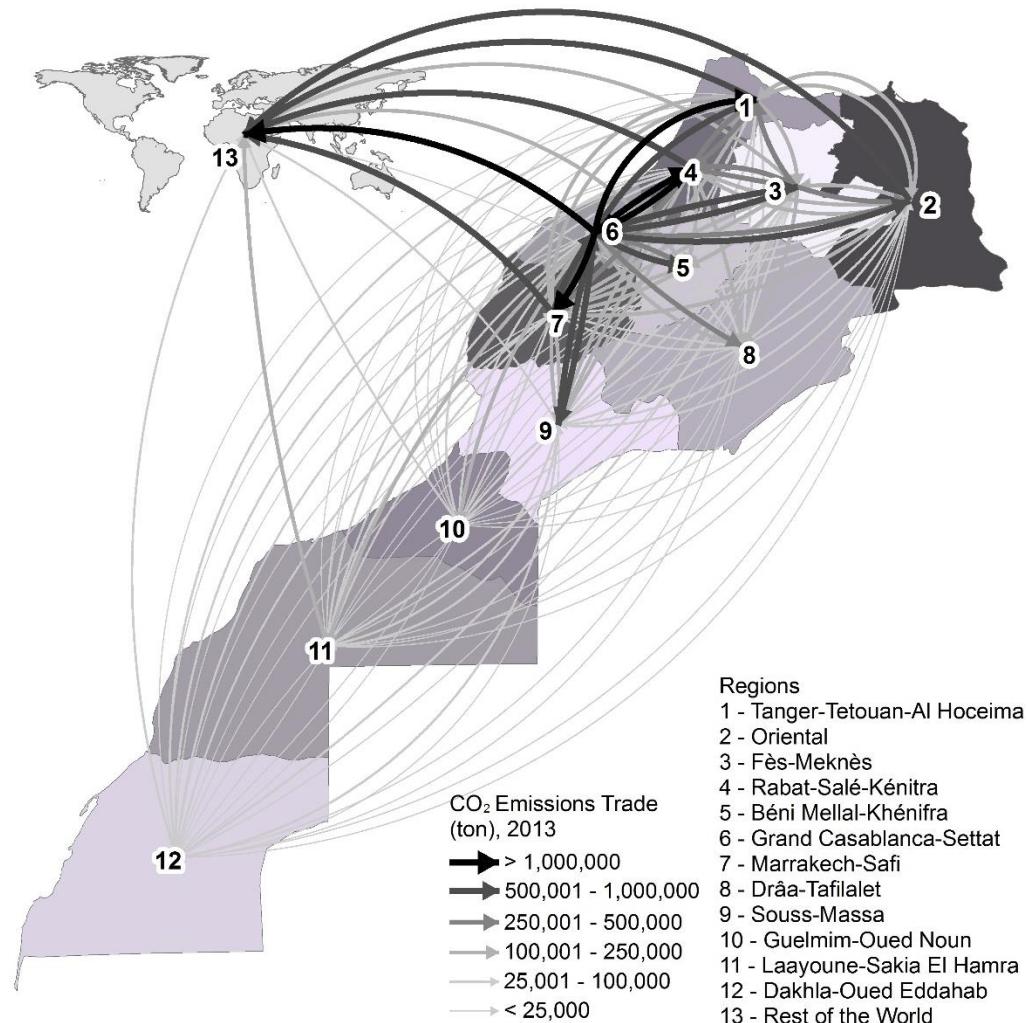


# Results (DCO<sub>2</sub>)

O   D	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	RoW
<b>R1</b>	139499,29	212331,29	257192,90	81206,56	677107,21	145154,03	66874,63	86754,78	16149,18	24800,31	25719,75	795123,11	
<b>R2</b>	107633,93		179337,74	103170,51	50835,72	284054,53	72280,77	56768,71	45444,79	9071,69	16075,52	16408,80	892987,18
<b>R3</b>	254420,98	315516,26		300636,52	121108,36	827838,49	144144,84	120382,26	82101,71	15809,68	30497,47	28689,21	179131,64
<b>R4</b>	409381,85	206613,14	392004,07		172372,50	2655893,93	295368,86	101394,91	151879,09	27875,65	38314,71	36323,46	569523,20
<b>R5</b>	65208,86	51519,71	82437,53	91206,21		440937,55	155933,10	38473,01	63514,03	9432,67	14068,42	12826,64	162283,09
<b>R6</b>	1105904,72	600150,24	913494,62	1975022,62	662889,82		1216104,23	318454,35	564108,05	100604,48	111781,84	88435,41	7724316,38
<b>R7</b>	155199,27	111830,22	136902,61	223808,15	207195,67	945685,62		77327,31	203869,32	31517,14	43054,61	36219,56	689740,66
<b>R8</b>	32806,21	36303,28	52517,35	35423,96	25943,79	111310,30	38580,68		23531,18	3845,58	7558,11	7122,34	20179,17
<b>R9</b>	107277,89	86646,49	89181,67	132117,87	90964,62	502347,20	227049,50	50943,25		61953,81	56034,88	40020,97	80527,46
<b>R10</b>	9947,53	8139,38	8081,20	11998,05	7523,83	41253,31	17712,26	4683,31	30472,36		10973,84	6302,23	96350,89
<b>R11</b>	18896,04	13362,00	15359,06	15321,44	11051,65	84883,31	25160,14	9475,17	25735,29	10046,41		18554,43	142790,20
<b>R12</b>	1721,64	1483,34	1595,48	1704,91	1043,60	4951,87	2113,75	867,47	2020,09	592,27	2423,19		25921,52

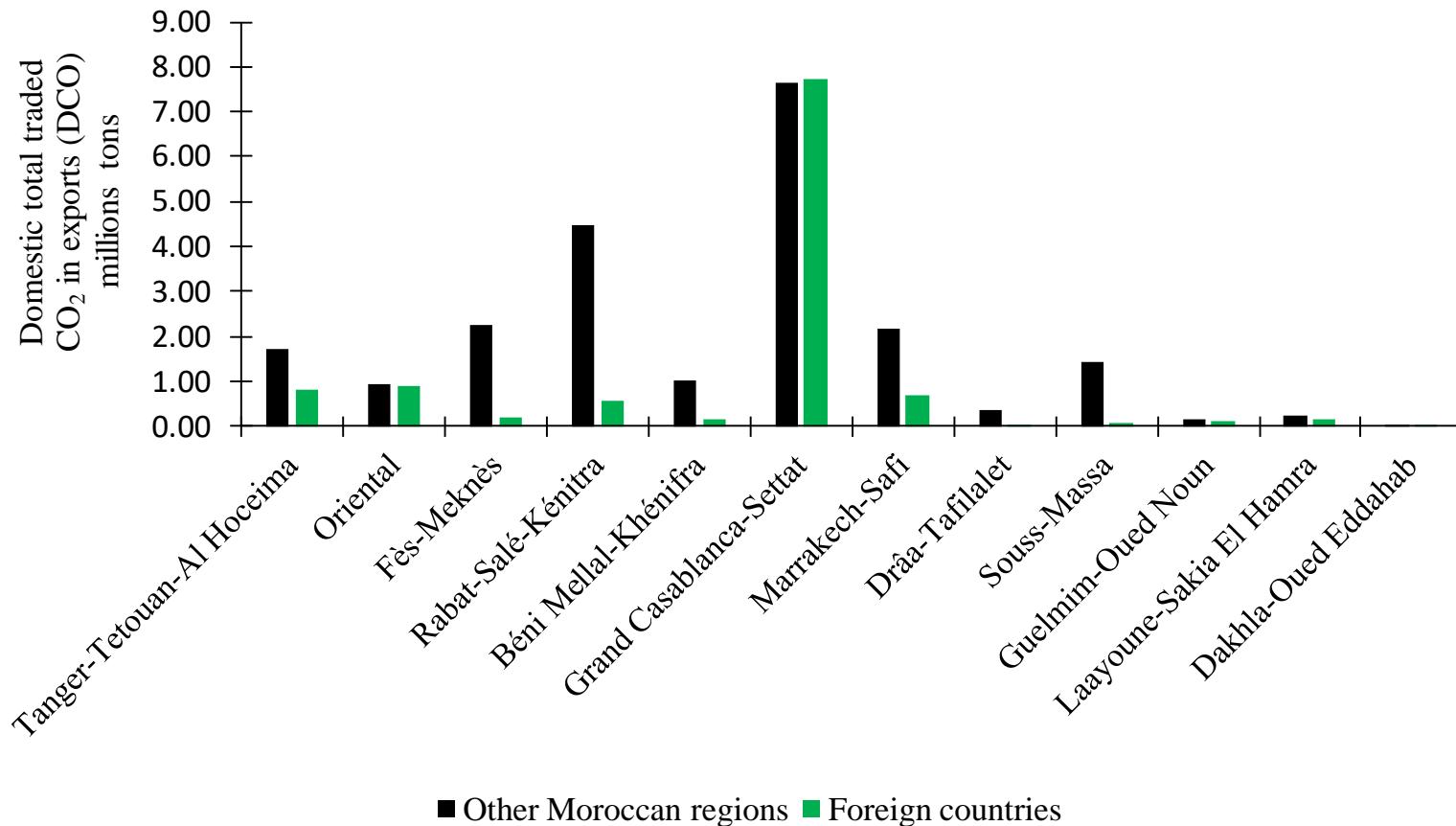
**R1** - Tanger-Tetouan-Al Hoceima; **R2** - Oriental; **R3** - Fès-Meknès; **R4** - Rabat-Salé-Kénitra; **R5** - Béni Mellal-Khénifra; **R6** - Grand Casablanca-Settat; **R7** - Marrakech-Safi; **R8** - Drâa-Tafilalet; **R9** - Souss-Massa; **R10** - Guelmim-Oued Noun; **R11** - Laayoune-Sakia El Hamra; **R12** - Dakhla-Oued Eddahab; **RoW** - Rest of the World.

# Results (DCO<sub>2</sub>)



# Results

## Domestic Total Traded CO<sub>2</sub> in Exports (DCO2)



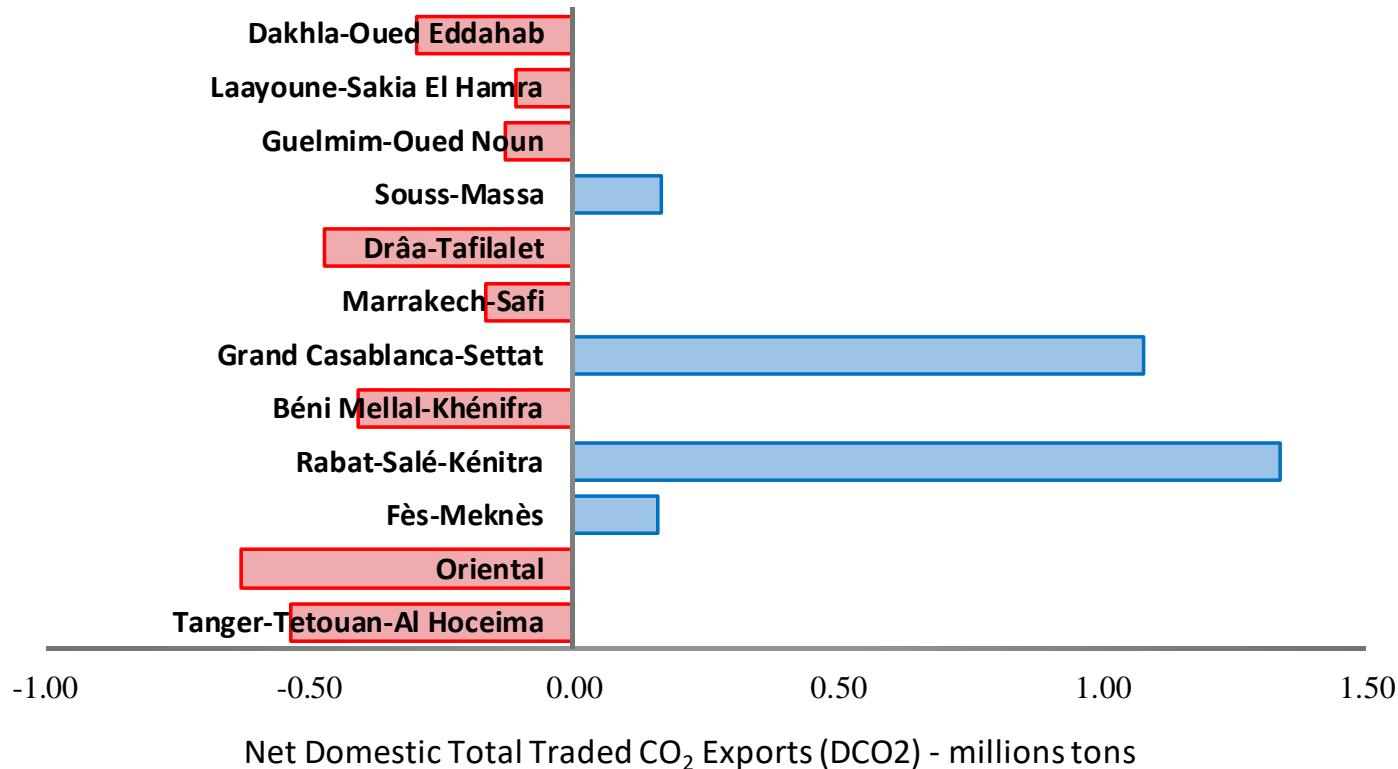
# Results

## Domestic Total Traded CO<sub>2</sub> in Exports (DCO2)

Origin   Destination	Other Moroccan regions	Foreign countries
Tanger-Tetouan-Al Hoceima	68.55%	31.45%
Oriental	51.31%	48.69%
Fès-Meknès	92.60%	7.40%
Rabat-Salé-Kénitra	88.74%	11.26%
Béni Mellal-Khénifra	86.34%	13.66%
Grand Casablanca-Settat	49.78%	50.22%
Marrakech-Safi	75.90%	24.10%
Drâa-Tafilalet	94.89%	5.11%
Souss-Massa	94.72%	5.28%
Guelmim-Oued Noun	61.98%	38.02%
Laayoune-Sakia El Hamra	63.45%	36.55%
Dakhla-Oued Eddahab	44.18%	55.82%

# Results

## Balance of Domestic Total Traded CO<sub>2</sub> in Exports (DCO2) to RoMOR



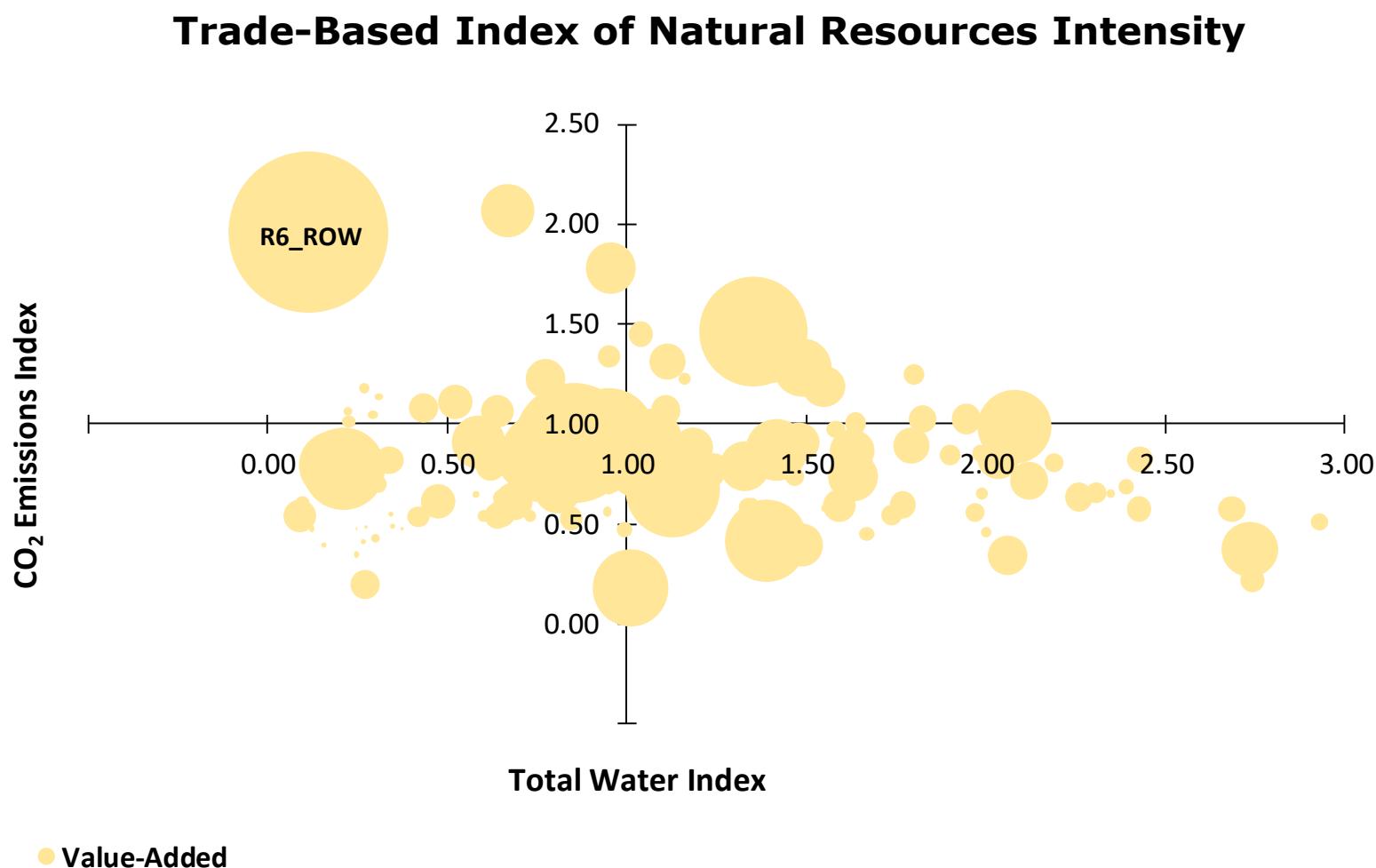
# Results

## CO<sub>2</sub> Emissions Index

O   D	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	RoW
R1	1.450	1.288	1.310	1.433	1.280	1.496	1.201	1.250	1.131	0.838	1.225	0.777	
R2	0.783		0.890	0.751	0.974	0.736	1.002	0.820	0.809	0.682	0.470	0.714	2.068
R3	0.867	1.185		0.792	1.026	0.983	1.027	0.875	0.822	0.675	0.582	0.835	0.375
R4	0.908	1.110	1.050		1.067	1.462	1.225	0.818	1.065	0.699	0.537	0.873	0.792
R5	0.595	0.847	0.635	0.591		0.417	0.715	0.739	0.576	0.603	0.449	0.650	0.182
R6	0.839	0.908	0.911	0.904	0.923		0.952	0.805	0.923	0.792	0.617	0.746	1.959
R7	0.729	0.921	0.758	0.670	0.883	0.671		0.801	0.823	0.629	0.526	0.762	1.779
R8	0.559	0.856	0.575	0.547	0.690	0.395	0.656		0.512	0.582	0.458	0.650	0.218
R9	0.707	0.834	0.672	0.612	0.807	0.871	0.908	0.707		0.553	0.540	0.746	0.346
R10	0.611	0.875	0.563	0.541	0.724	0.718	0.749	0.645	0.581		0.540	0.747	1.336
R11	0.835	1.046	0.814	0.609	1.067	0.538	1.014	1.138	0.942	0.941		1.182	1.082
R12	0.432	0.488	0.347	0.394	0.482	0.430	0.545	0.473	0.413	0.474	0.477		0.198

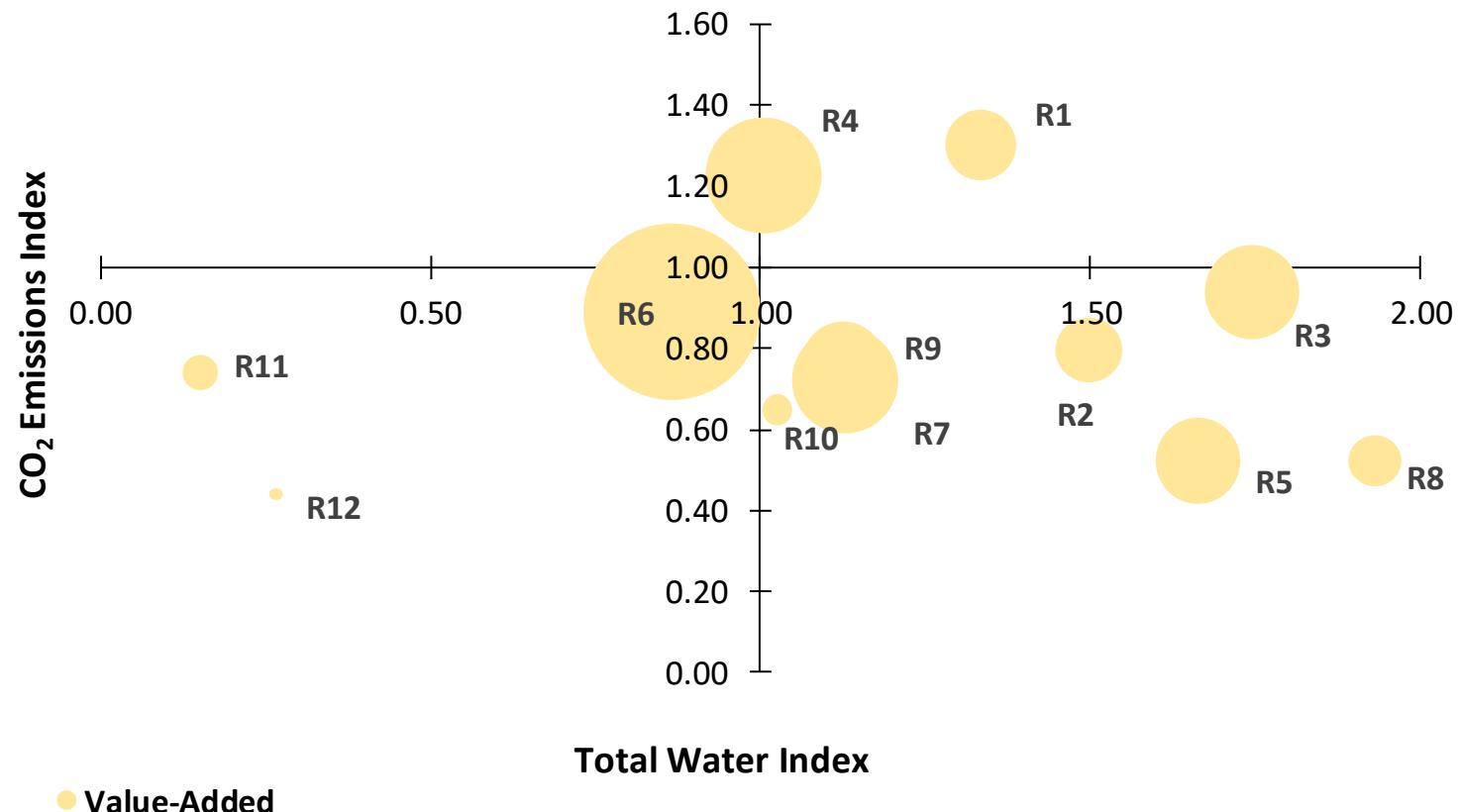
**R1** - Tanger-Tetouan-Al Hoceima; **R2** - Oriental; **R3** - Fès-Meknès; **R4** - Rabat-Salé-Kénitra; **R5** - Béni Mellal-Khénifra; **R6** - Grand Casablanca-Settat; **R7** - Marrakech-Safi; **R8** - Drâa-Tafilalet; **R9** - Souss-Massa; **R10** - Guelmim-Oued Noun; **R11** - Laayoune-Sakia El Hamra; **R12** - Dakhla-Oued Eddahab; **RoW** - Rest of the World.

# Trade-Based Indices of Natural Resources Intensity: Water *versus* CO<sub>2</sub> Emissions



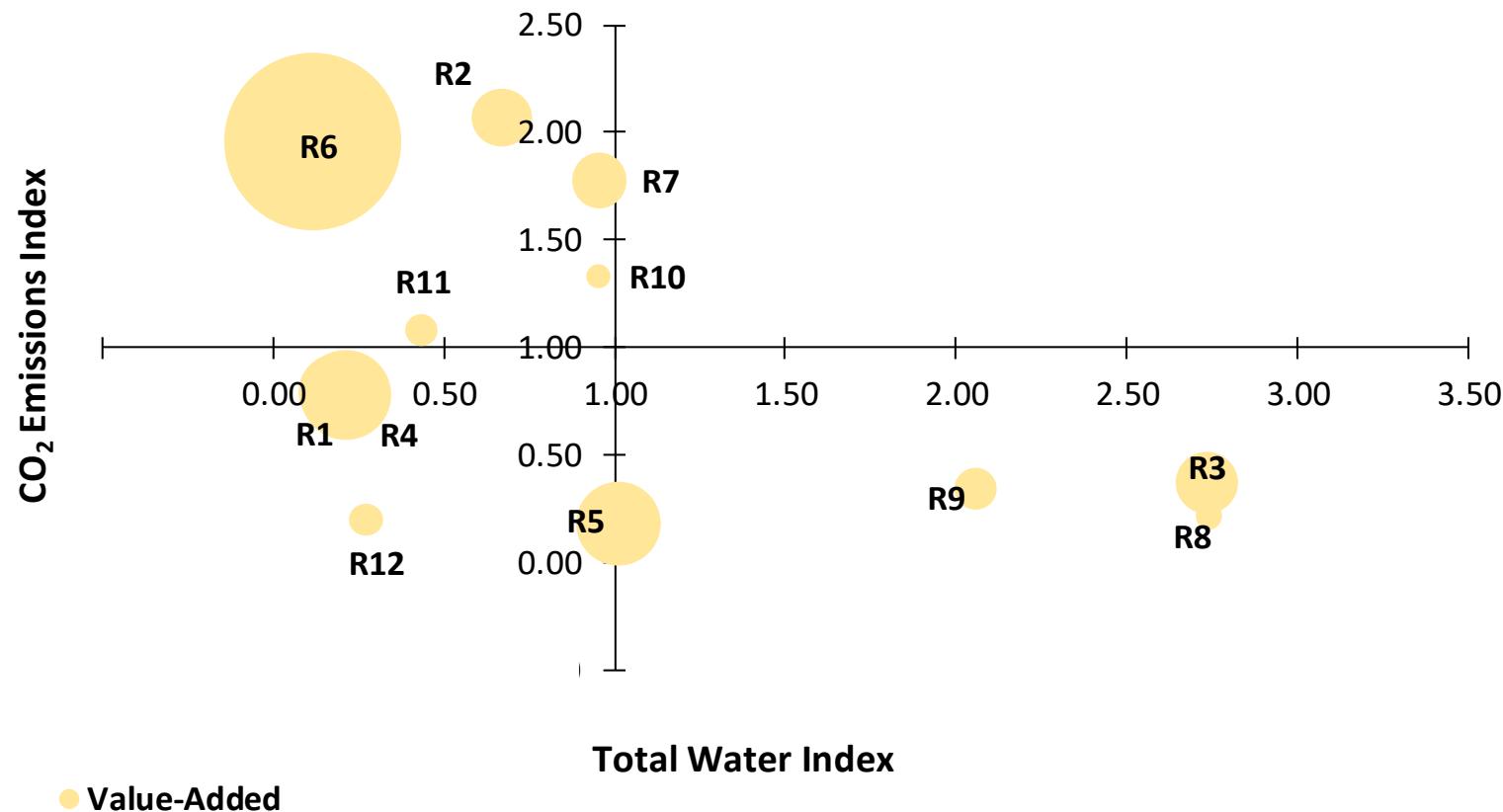
# Trade-Based Indices of Natural Resources Intensity: Water *versus* CO<sub>2</sub> Emissions

## Trade-Based Index of Natural Resources Intensity (in Exports to RoMOR)



# Trade-Based Indices of Natural Resources Intensity: Water *versus* CO<sub>2</sub> Emissions

## Trade-Based Index of Natural Resources Intensity (in Exports to RoW)



## Final remarks

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We add to the existing literature on virtual water flows by encompassing the intra-country perspective in the case study of a country that shows a “climate divide”: while a great part of the Southern territory is located in the Sahara Desert, with serious water constraint, the Northern part is relatively more privileged with access to this natural resource.

Results point to different ratios of water use to value added, not only when aggregate domestic trade flows are compared to Moroccan international exports, but also to differences within the country.

# Final remarks

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Ongoing project with many potential applications

Input-output applications

- Moroccan regions (how do they relate?), structural decomposition analysis (historical estimation, updating), main drivers of sectoral and regional growth, impact of interregional government transfers, impact analysis...

Interregional CGE applications

- **Economic impacts of drought, regional impacts of climate change (agriculture)**, specific transportation projects (accessibility), simulate TFP-enhancing policies (sectors and regions), other usual CGE applications, ...

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