NEREUS

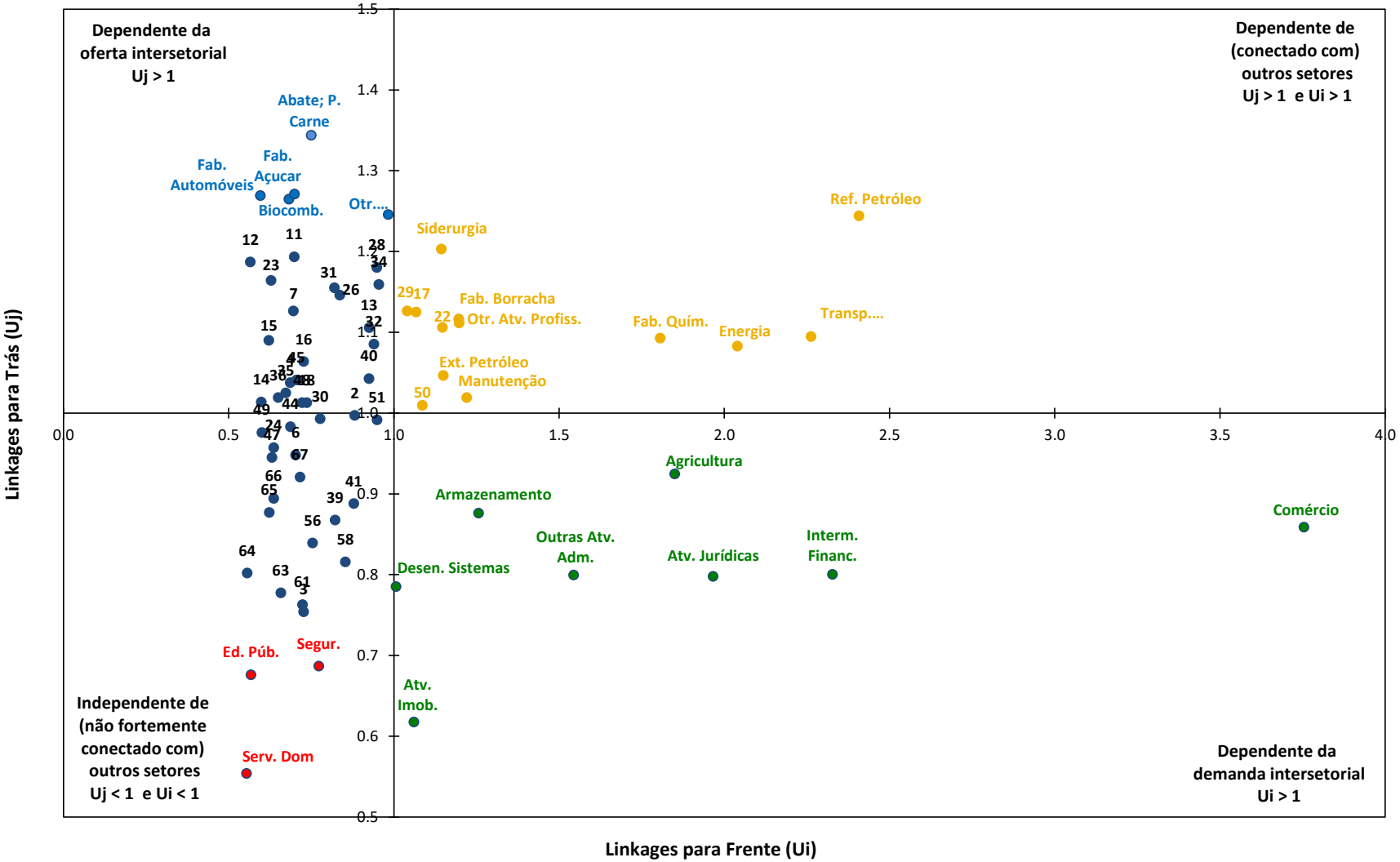
Núcleo de Economia Regional e Urbana
da Universidade de São Paulo

The University of São Paulo
Regional and Urban Economics Lab

Aula 4c: Extração Hipotética

Prof. Eduardo A. Haddad

Atividade – solução (MIP 2017, Brasil)



Modelos inter-regionais de IP

Modelo inter-regional

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

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

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

Introdução

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

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 $\mathbf{A}$ 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, $\mathbf{f}$, relativa ao setor extraído.

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

Formulação

Com isso, a <u>produção na economia sem o setor *j*</u> é dada por:

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

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 <u>modelo completo</u>, 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

Após realizar a extração, tem-se que:

$$\mathbf{T_j} = \boldsymbol{i}'\mathbf{X} - \boldsymbol{i}'\overline{\mathbf{X}}_{(\mathbf{j})}$$

em que $\mathbf{T_j}$ 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, $\boldsymbol{i}'\mathbf{X}$, não esteja incluída a produção original $\mathbf{X}_j$.

Formulação

Se $\mathbf{X}_j$ for omitido, temos que $\left(\boldsymbol{i}'\mathbf{X} - \mathrm{X}_j\right) - \boldsymbol{i}'\,\overline{\mathbf{X}}$ 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, $\boldsymbol{i}'\mathbf{X}$, e a multiplicação por 100 produz uma estimativa de uma diminuição percentual na atividade econômica total da ordem de:

$$\overline{\mathbf{T}}_j = 100\left[\boldsymbol{i}'\mathbf{X} - \boldsymbol{i}'\overline{\mathbf{X}}_{(j)}\right]/\boldsymbol{i}'\mathbf{X}$$

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

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Analysis of economic and environmental impacts of shutting down the Moroccan Refinery Samir: An interregional input-output approach

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Impacts of Shutting Down the Moroccan Refinery

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_2 emissions related to the refinery activities in a typical year of operation.

The Samir’s Mohammedia refinery

Location


MOROCCO, LOCATION OF REFINERY AND PORTS
Portugal
Spain
Tangier
Rabat
Mohammedia
Jorf Lasfar
Atlantic Ocean
Morocco
Agadir
Algeria
Laayoune
Western Sahara
Mauritiana
Dakhla
Capital
Port
Refinery
Mali

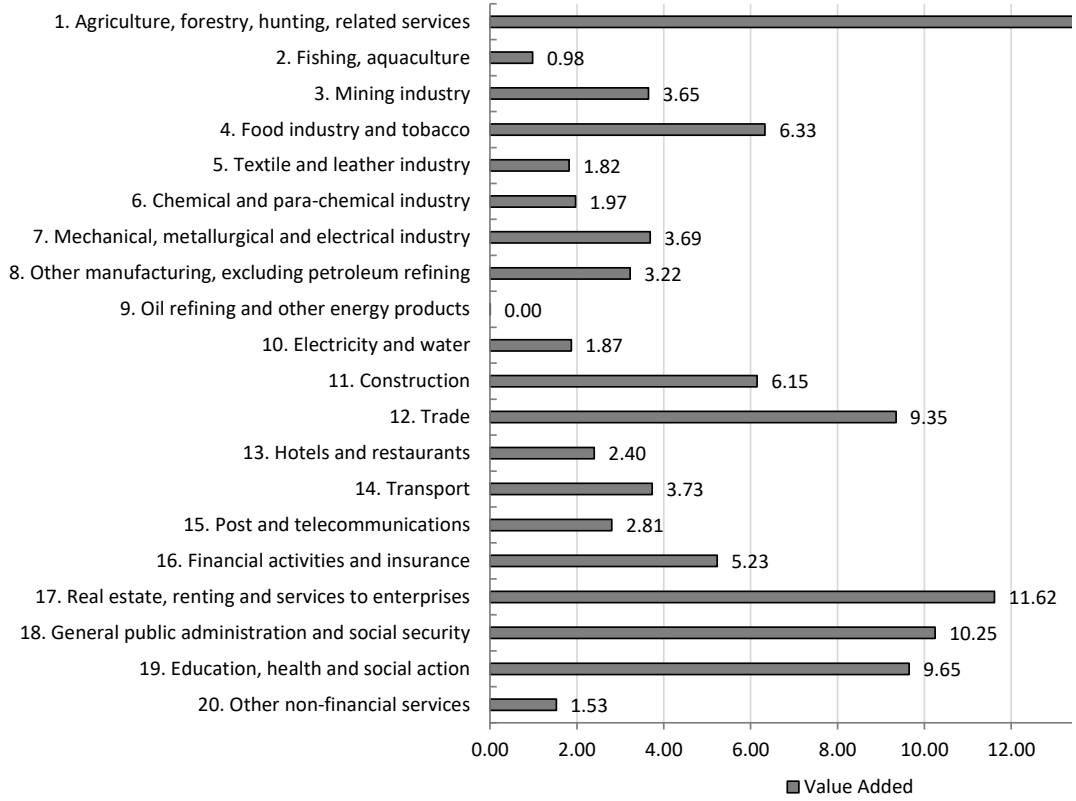

ISEDAK
COMCEC

Location

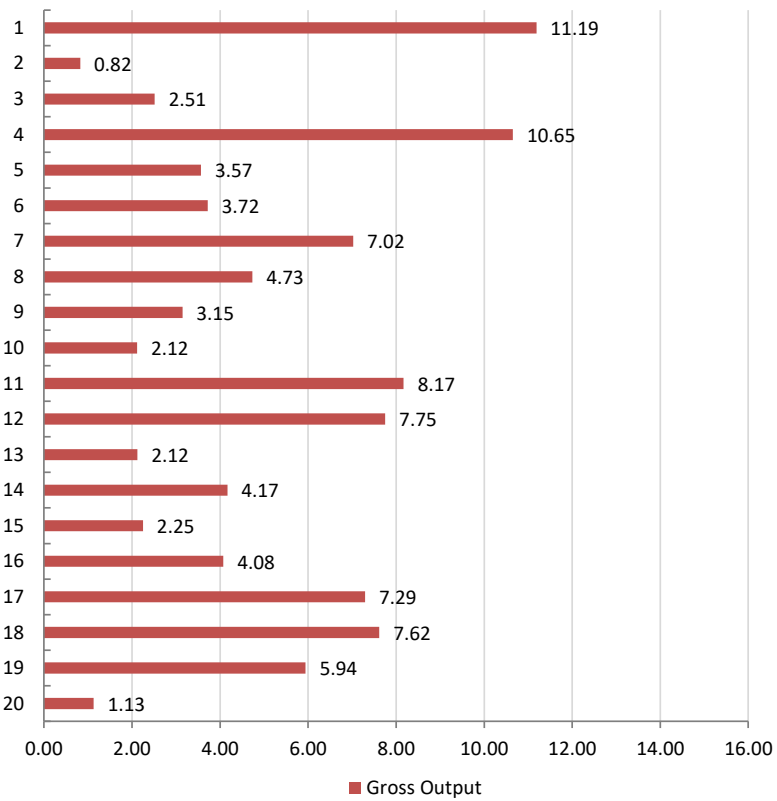

Location of the refinery
Spain
Mediterranean sea
Tangier
Atlantic Ocean
Mohammedia
Rabat
jorf lasfar
MOROCCO
AGADIR
Canary Islands
Algiers
Layoune
Mauritania
DAKHLA
CAPITAL
PORTS
REFINERY

Structure of the Moroccan economy

Value Added and Gross Output, 2013 (in %)

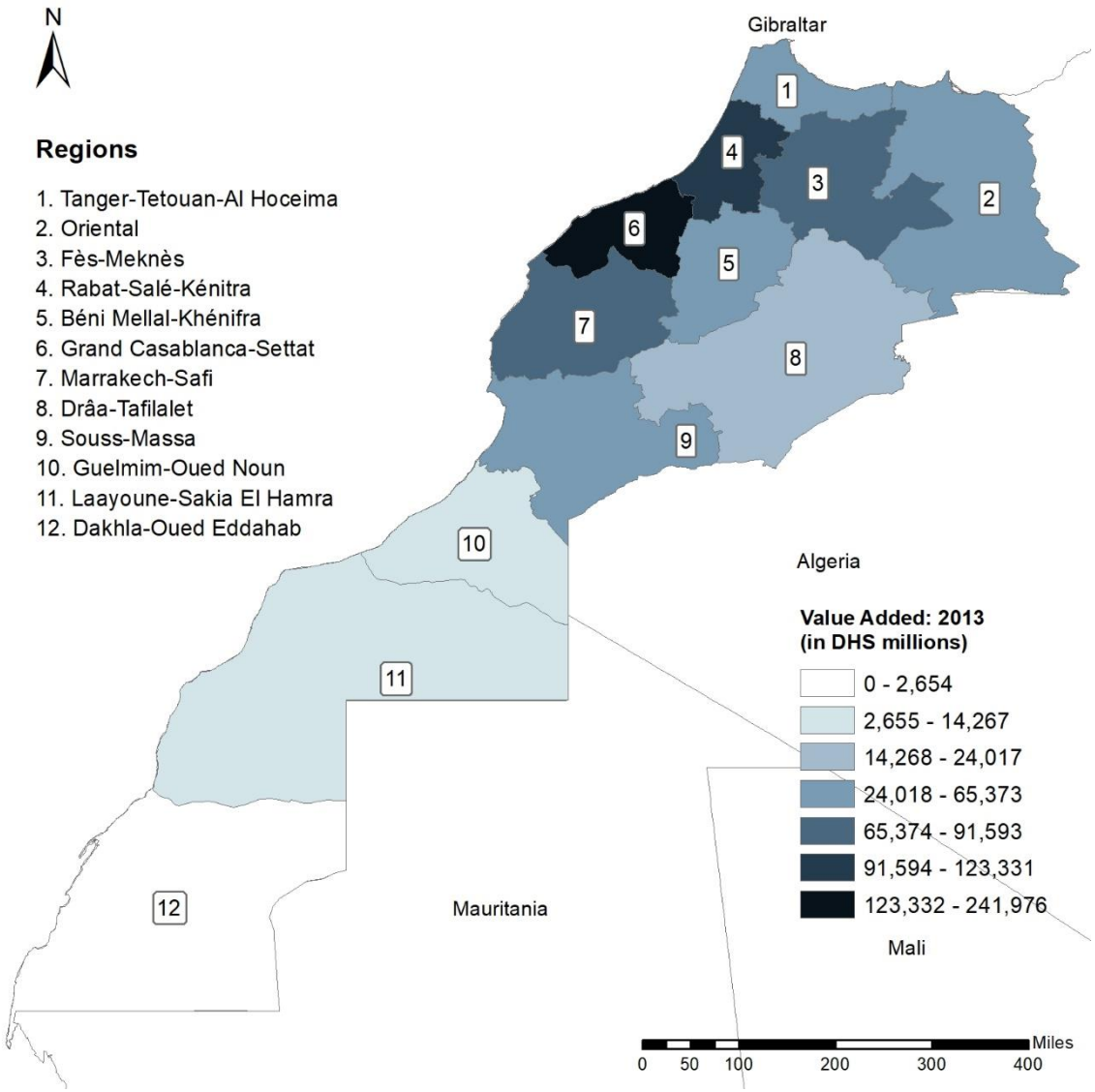


Value Added: Morocco 2013 (%)



Gross Output: Morocco 2013 (%)

Regional distribution of value added

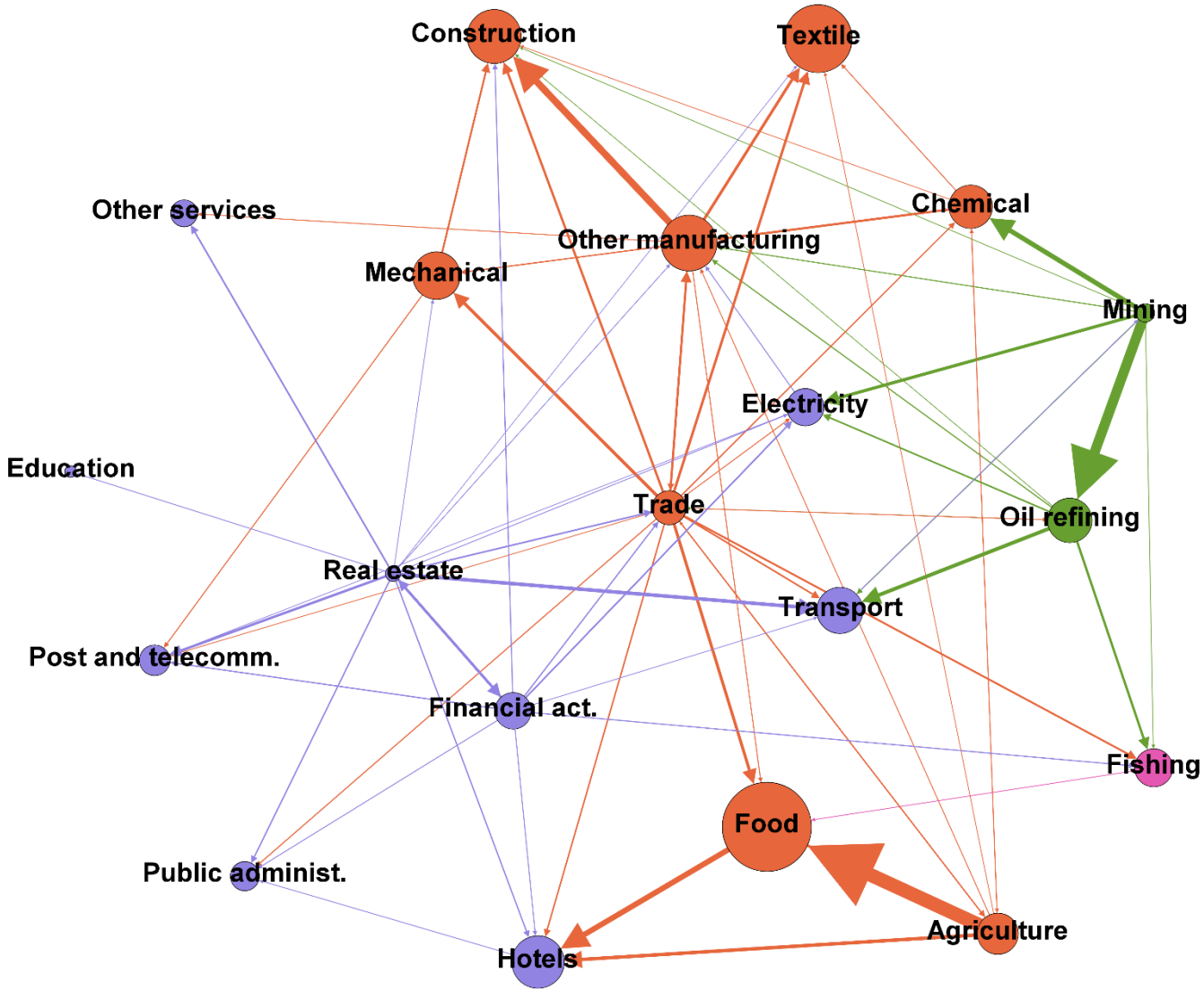


Oil refining sector in Morocco

Descriptive statistics – Summary

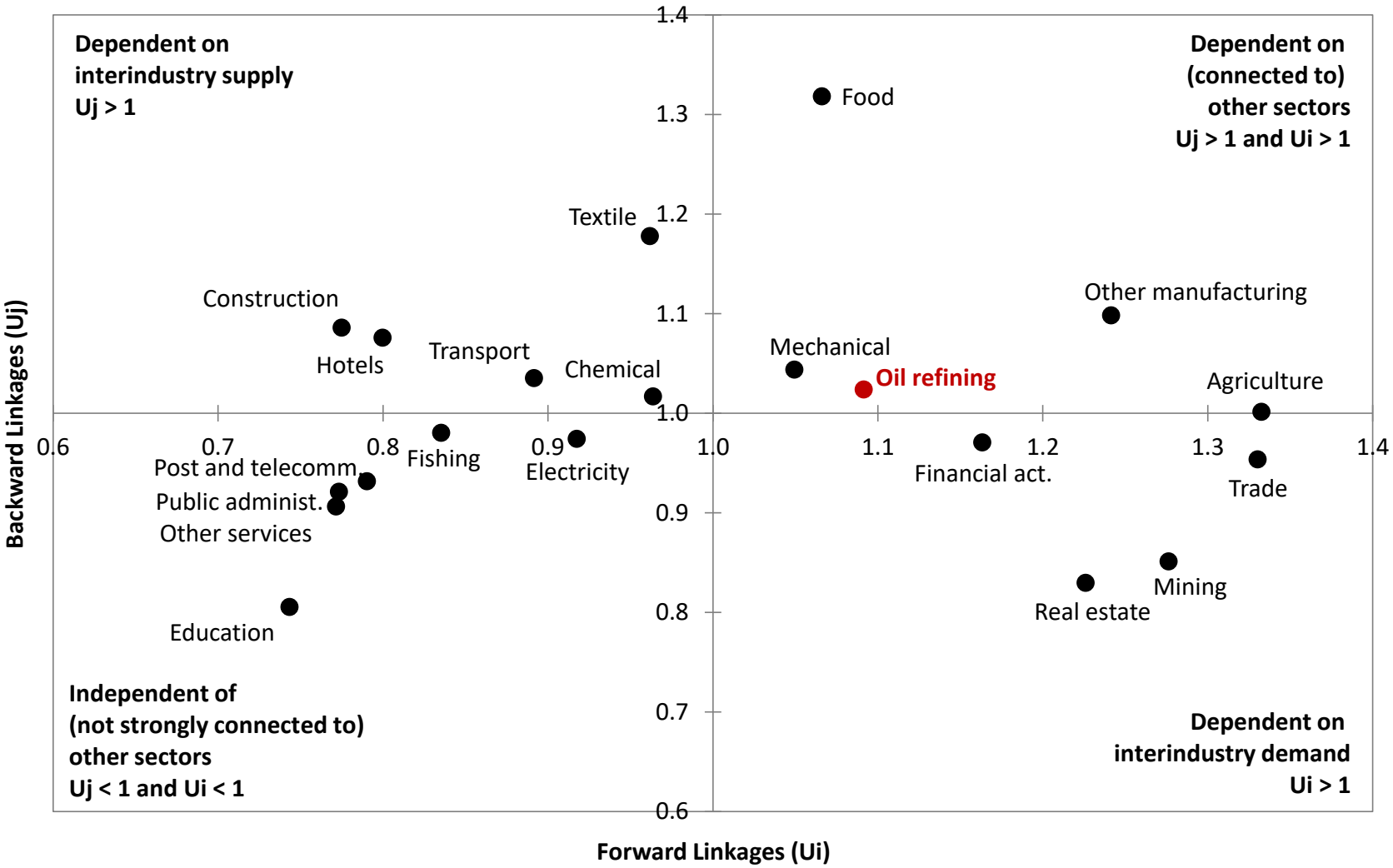
	Value (in DHS millions)	*Share (in %)*
Intermediate Consumption	22,700	47.43
Investment Demand	8	0.02
Household Demand	13,456	28.12
Government Demand	0	0.00
Foreing Exports	10,354	21.63
Statistical Discrepancies	1,342	2.80
Total Demand	**47,860**	**100.00**
Intermediate Consumption	16,391	34.25
Imports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

Production structure: output multipliers

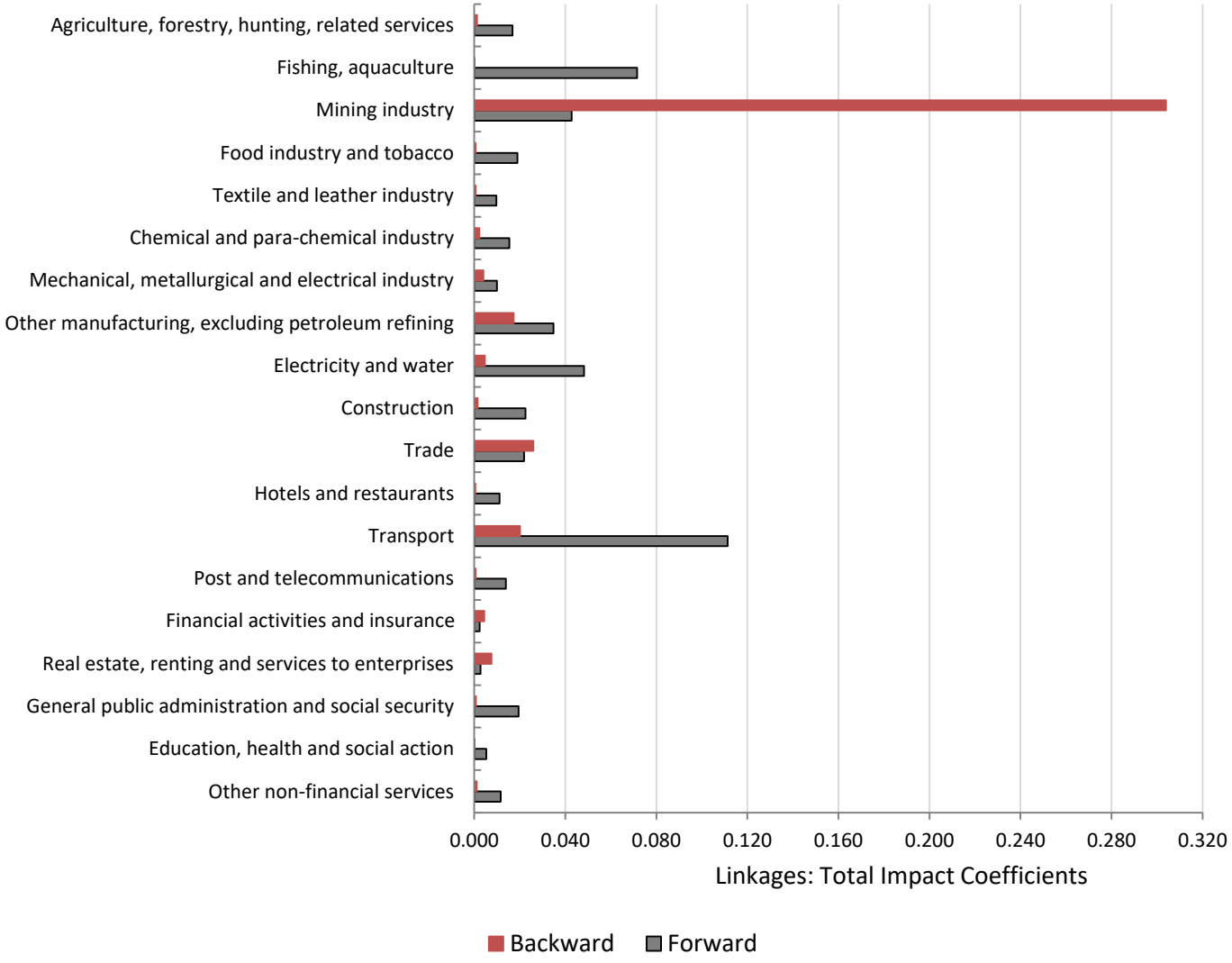


Note: …

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 (Aij) - Plan "A" Obs: Aij = Zij / Xj
2 Create an identity matrix (I) - Plan "I"
3 Calculate the (I - Aij) matrix - Plan "(I-A)"
4 Invert (I-Aij) and find the Leontief inverse (B) - Plan "B"
5 Calculate the vector of gross output by sectot (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 <u>to</u> and <u>from</u> 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 (X2) - Plan X

Regional and sectorial results

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

		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-Tafilalet	Souss-Massa	Guelmim-Oued Noun	Laayoune-Sakia El Hamra	Dakhla-Oued Eddahab	Marocco
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

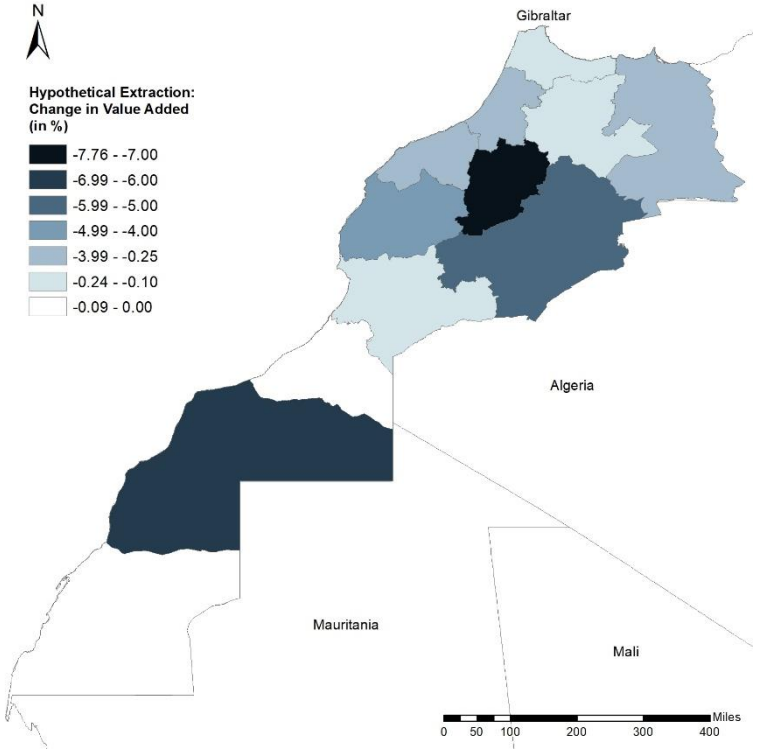
Hypothetical extraction: change in **value added** and **gross output** for Morocco, 2013 (in %)

		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-Tafilalet	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	-0.03
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	-0.01
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	-37.46
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	-0.02
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	0.00	-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	-0.19
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	-0.18
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	-1.13
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	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	-0.67
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	-0.06
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	-1.04
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	-0.06
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	-1.49
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	-0.08
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	-0.34
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	-0.32
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	-0.03
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	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	-0.29
	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	-1.66
	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	-4.38

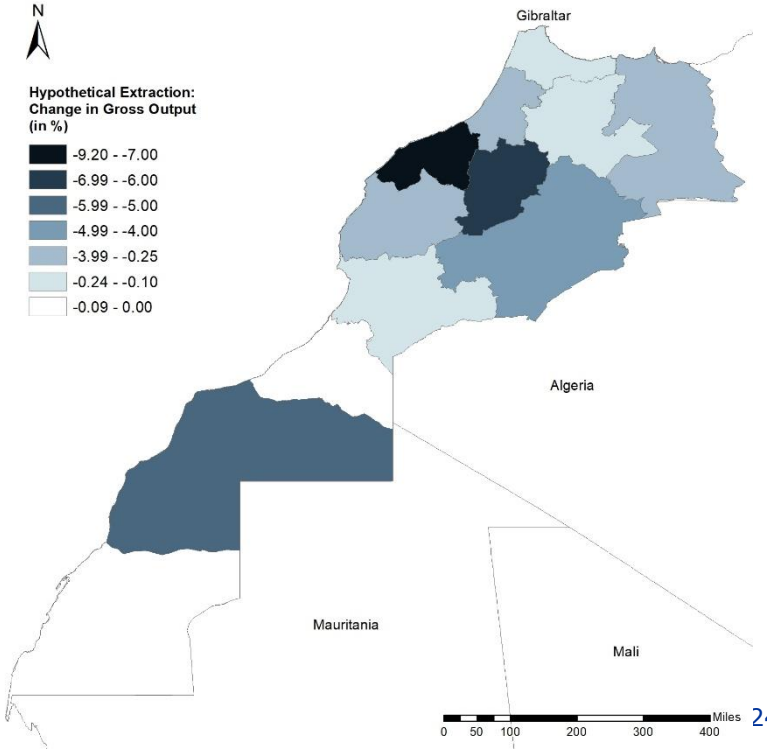
The geography of the impacts

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

(a) Value Added



(b) Gross Output



CO_2 emissions – sectors

Total change in Morocco CO_2-emissions in Mt
-1,169,018

	Agriculture and Fishing	Mining industry	Chemical industry	Other manufacturing	Oil refining and other energy products	Electricity and water	Trade	Transport	Other sectors
Change in CO_2-Emissions in Mt	-471	-55,481	-14,197	-15,516	-725,736	-126,279	-14,182	-207,024	-10,132
Change in CO_2-Emissions in %	0.0%	4.7%	1.2%	1.3%	62.1%	10.8%	1.2%	17.7%	0.9%

CO_2 emissions – regions

Tanger-Tetouan-Al Hoceima	-17,753 1.5%		-18,497 1.6%	**Souss-Massa**
Electricity (0.7%) Transport (0.6%) Other manufacturing (0.1%)				Transport (1.0%) Electricity (0.5%)
Oriental	-11,665 1.0%		-12,331 1.1%	**Laayoune-Sakia El Hamra**
Electricity (0.4%) Transport (0.3%) Mining industry (0.2%)				Mining industry (0.4%) Electricity (0.3%) Transport (0.2%)
Fès-Meknès	-27,338 2.3%	**Grand Casablanca-Settat**	-204 0.0%	**Dakhla-Oued Eddahab**
Transport (1.4%) Electricity (0.7%)		Oil refining and other energy products		
Drâa-Tafilalet	-20,049 1.7%	-725,736 62.1%	-1,973 0.2%	**Guelmim-Oued Noun**
Transport (0.8%) Mining industry (0.5%) Electricity (0.4%)				Transport (0.1%)
Béni Mellal-Khénifra	-67,786 5.8%		-87,371 7.5%	**Marrakech-Safi**
Transport (2.5%) Mining industry (1.8%) Electricity (1.3%) Trade (0.1%)				Transport (3.5%) Electricity (1.9%) Mining industry (1.7%) Other manufacturing (0.1%) Trade (0.1%)
Grand Casablanca-Settat	-116,372 10.0%		-61,944 5.3%	**Rabat-Salé-Kénitra**
Transport (4.6%) Electricity and water (2.5%) Other manufacturing (0.9%) Chemical industry (0.8%) Trade (0.7%) Mechanical (0.2%) Real estate (0.1%)				Transport (2.7%) Electricity (2.0%) Mining industry (0.1%) Chemical industry (0.1%) Other manufacturing (0.1%) Trade (0.1%)

Total change in Morocco CO_2-emissions in Mt	-1,169,018
Change in CO_2-Emissions	
in Mt	
in %	

Atividade: “O Brasil sem Minas Gerais”

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?

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Núcleo de Economia Regional e Urbana da Universidade de São Paulo

The University of São Paulo Regional and Urban Economics Lab

OCP POLICY CENTER

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Water Content in Trade: A Regional Analysis for Morocco

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

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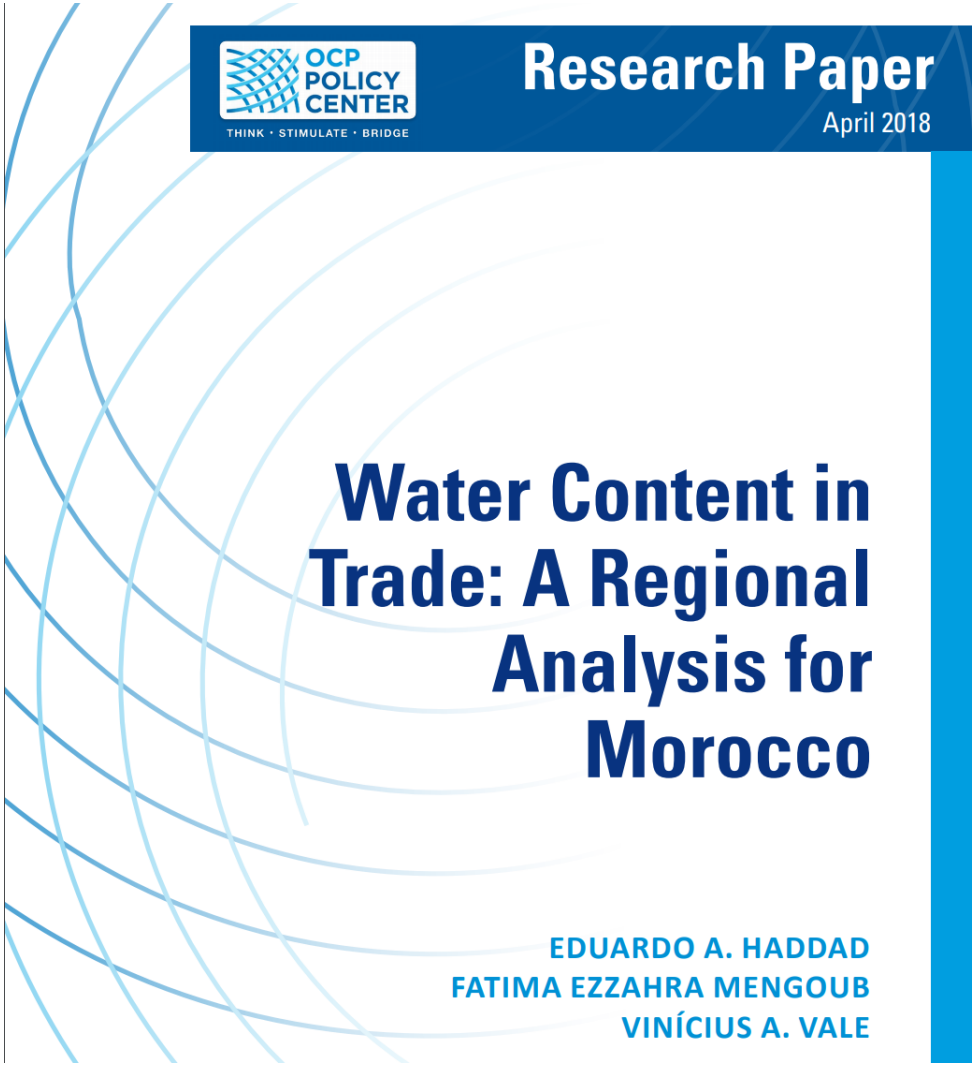
Senior Fellow at OCP Policy Center, Morocco

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



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Taylor & Francis Group

Check for updates

Water content in trade: a regional analysis for Morocco

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CLIMATE POLICY

IPCC lessons from Berlin

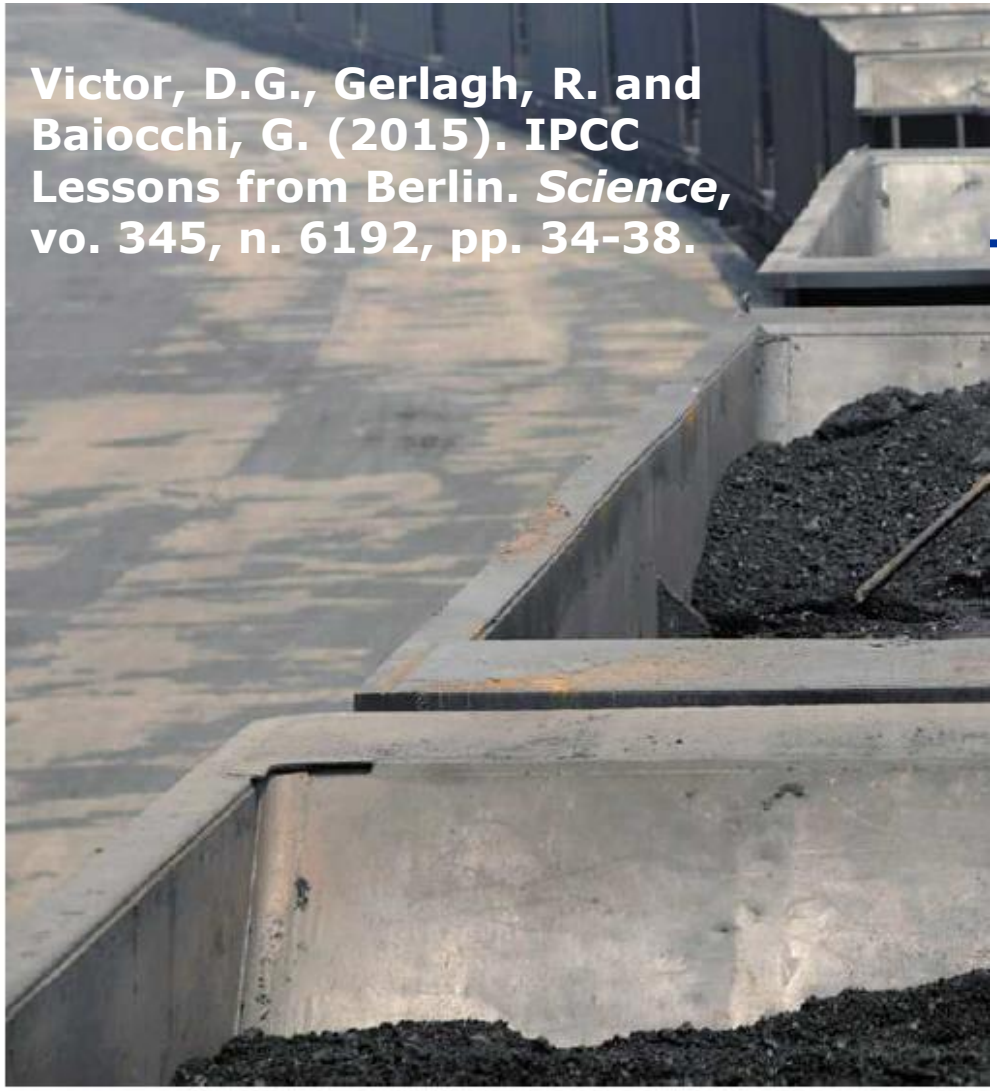
Did the "Summary for Policymakers" become a summary by policy-makers?

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. WGII 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 Policymakers" (SPM). The deleted content focused largely on historic emissions trends analyzed by country income groups and international cooperation. IPCC authors are instructed to be policy-relevant, without being

POLICY

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,[1,9] Reyer Gerlagh,[2,9] Giovanni Baiocchi[3,10]

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

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

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

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.

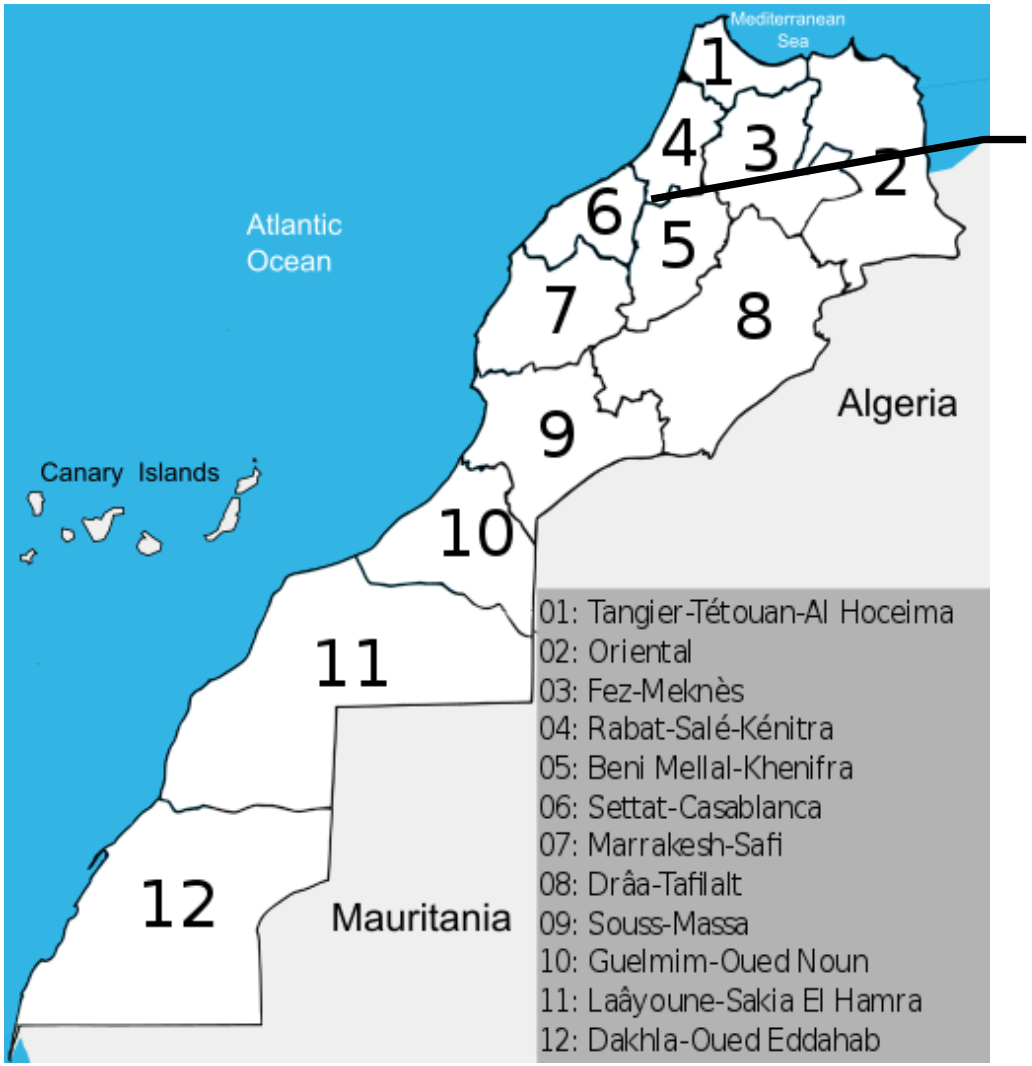
Polarization by Casablanca

Casablanca region – ~30% of national GDP.

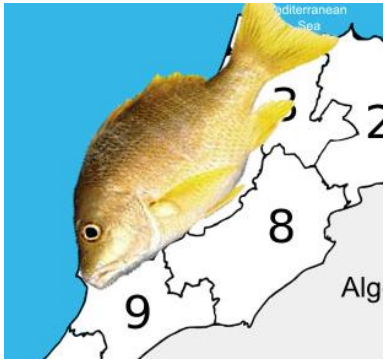
Asymmetries in the distribution of productive activity, with the primacy of Casablanca, serve to strengthen existing competitive advantages.

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

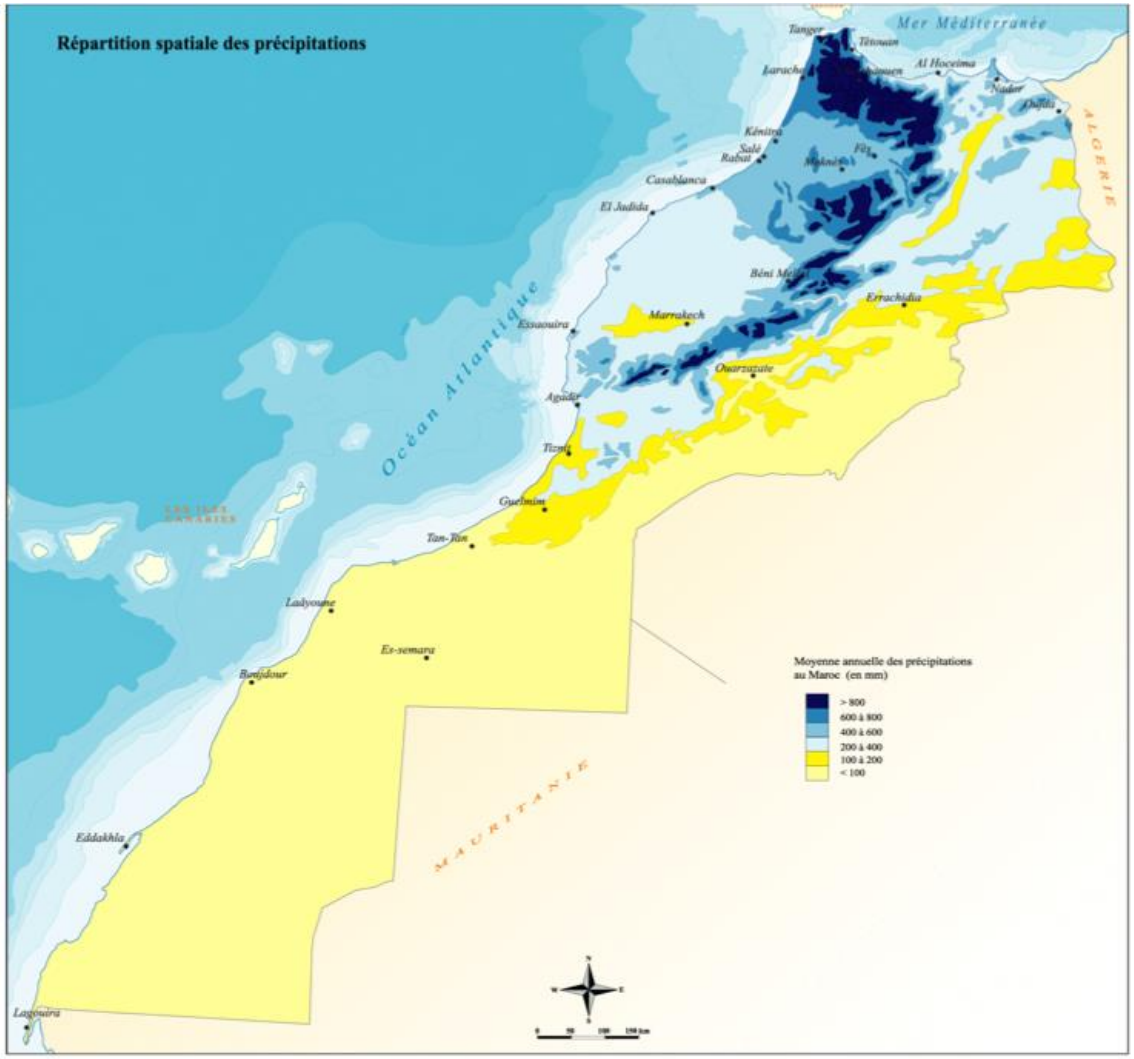
Source: Calculations by the authors.

81.6% of total domestic flows

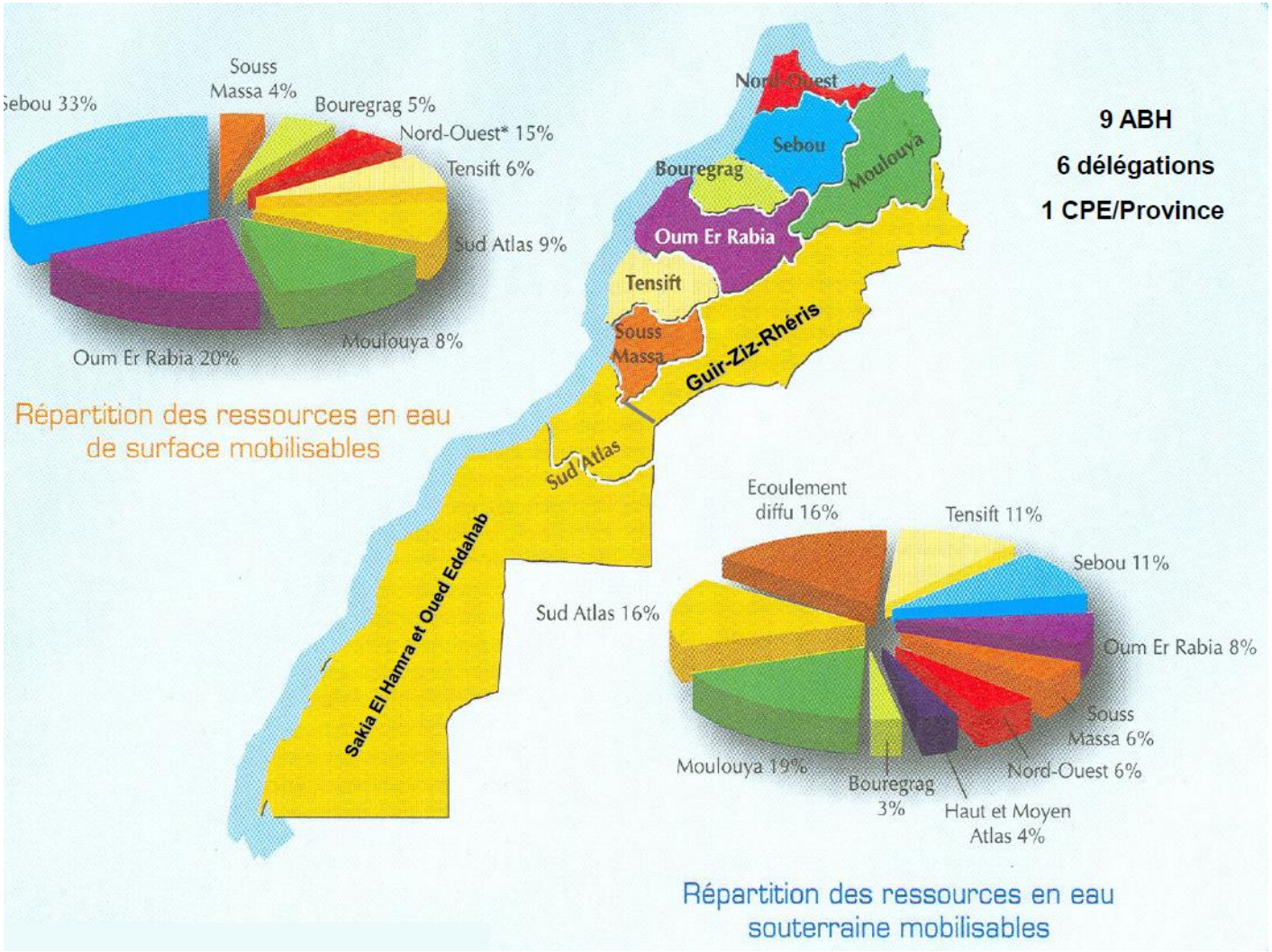
Morocco: geography

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

“Climate divide”



Water basins (ABH)



Virtual water

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

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{f} \tag{1}$$

and

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

where **x** and **f** are the vectors of gross output and final demand; **A** is a matrix with the input coefficients (a_{ij}); **I** is the identity matrix; and **L** is the Leontief inverse.[1]

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

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

and

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

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

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

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

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

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

Measurement of Domestic Value Added in Exports (cont.)

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

$$\mathbf{f}^*_{1,row} = \begin{bmatrix} \mathbf{f}^{11} & \cdots & \mathbf{f}^{1n} & \mathbf{0} \\ \vdots & \ddots & \vdots & \vdots \\ \mathbf{f}^{n1} & \cdots & \mathbf{f}^{nn} & \mathbf{f}^{nrow} \end{bmatrix} \tag{10}$$

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

$$DVA_{1,n} = GDP_1 - GDP^*_{1,n} \tag{11}$$

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

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

Similarly, we can attribute the amount of domestic value added in exports from region 1 to all regions (2, 3, …, n), and from each region to the n-regions (1, 2, …, 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_1	R_2	…	R_{n-1}	R_n	RoW
R_1		$DVA_{1,2}$	…	$DVA_{1,n-1}$	$DVA_{1,n}$	$DVA_{1,row}$
R_2	$DVA_{2,1}$		…	$DVA_{2,n-1}$	$DVA_{2,n}$	$DVA_{2,row}$
⋮	⋮	⋮		⋮	⋮	⋮
R_{n-1}	$DVA_{n-1,1}$	$DVA_{n-1,2}$	…		$DVA_{n-1,n}$	$DVA_{n-1,row}$
R_n	$DVA_{n,1}$	$DVA_{n,2}$	…	$DVA_{n,n-1}$		$DVA_{n,row}$

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_1	R_2	…	R_{n-1}	R_n	RoW
R_1		$DTW_{1,2}$	…	$DTW_{1,n-1}$	$DTW_{1,n}$	$DTW_{1,row}$
R_2	$DTW_{2,1}$		…	$DTW_{2,n-1}$	$DTW_{2,n}$	$DTW_{2,row}$
⋮	⋮	⋮		⋮	⋮	⋮
R_{n-1}	$DTW_{n-1,1}$	$DTW_{n-1,2}$	…		$DTW_{n-1,n}$	$DTW_{n-1,row}$
R_n	$DTW_{n,1}$	$DTW_{n,2}$	…	$DTW_{n,n-1}$		$DTW_{n,row}$

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_1	R_2	…	R_{n-1}	R_n	RoW
R_1		$I_{1,2}^{DVA}$	…	$I_{1,n-1}^{DVA}$	$I_{1,n}^{DVA}$	$I_{1,row}^{DVA}$
R_2	$I_{2,1}^{DVA}$		…	$I_{2,n-1}^{DVA}$	$I_{2,n}^{DVA}$	$I_{2,row}^{DVA}$
⋮	⋮	⋮		⋮	⋮	⋮
R_{n-1}	$I_{n-1,1}^{DVA}$	$I_{n-1,2}^{DVA}$	…		$I_{n-1,n}^{DVA}$	$I_{n-1,row}^{DVA}$
R_n	$I_{n,1}^{DVA}$	$I_{n,2}^{DVA}$	…	$I_{n,n-1}^{DVA}$		$I_{n,row}^{DVA}$

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_1	R_2	…	R_{n-1}	R_n	RoW
R_1		$I_{1,2}^{DTW}$	…	$I_{1,n-1}^{DTW}$	$I_{1,n}^{DTW}$	$I_{1,row}^{DTW}$
R_2	$I_{2,1}^{DTW}$		…	$I_{2,n-1}^{DTW}$	$I_{2,n}^{DTW}$	$I_{2,row}^{DTW}$
⋮	⋮	⋮		⋮	⋮	⋮
R_{n-1}	$I_{n-1,1}^{DTW}$	$I_{n-1,2}^{DTW}$	…		$I_{n-1,n}^{DTW}$	$I_{n-1,row}^{DTW}$
R_n	$I_{n,1}^{DTW}$	$I_{n,2}^{DTW}$	…	$I_{n,n-1}^{DTW}$		$I_{n,row}^{DTW}$

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_1	R_2	…	R_{n-1}	R_n	RoW
R_1		$TWI_{1,2}$	…	$TWI_{1,n-1}$	$TWI_{1,n}$	$TWI_{1,row}$
R_2	$TWI_{2,1}$		…	$TWI_{2,n-1}$	$TWI_{2,n}$	$TWI_{2,row}$
⋮	⋮	⋮		⋮	⋮	⋮
R_{n-1}	$TWI_{n-1,1}$	$TWI_{n-1,2}$	…		$TWI_{n-1,n}$	$TWI_{n-1,row}$
R_n	$TWI_{n,1}$	$TWI_{n,2}$	…	$TWI_{n,n-1}$		$TWI_{n,row}$

Location quotient of traded water to value added

Methodology

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.

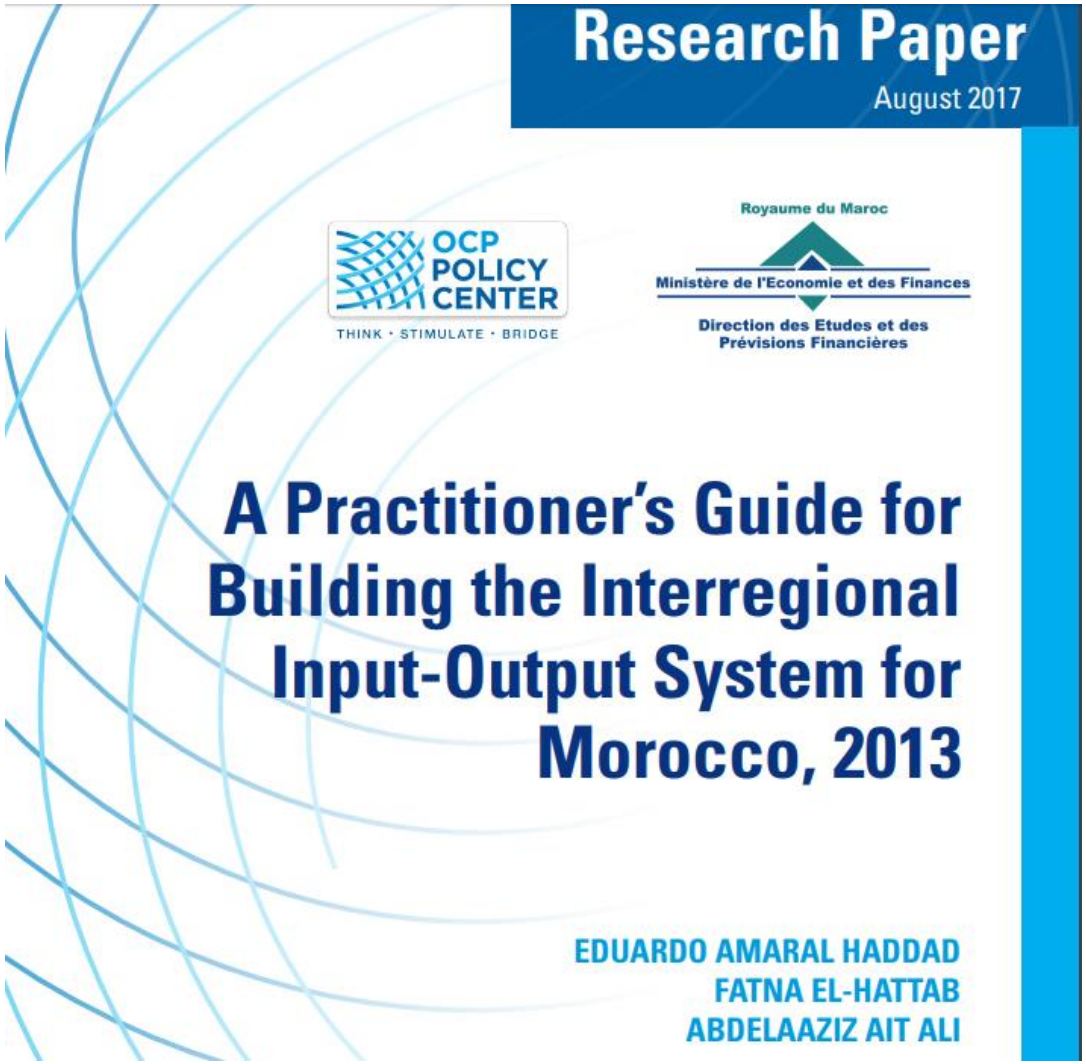
Database

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



Structure of Interregional IO models

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

Regional setting

Sectoral aggregation

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

Water:

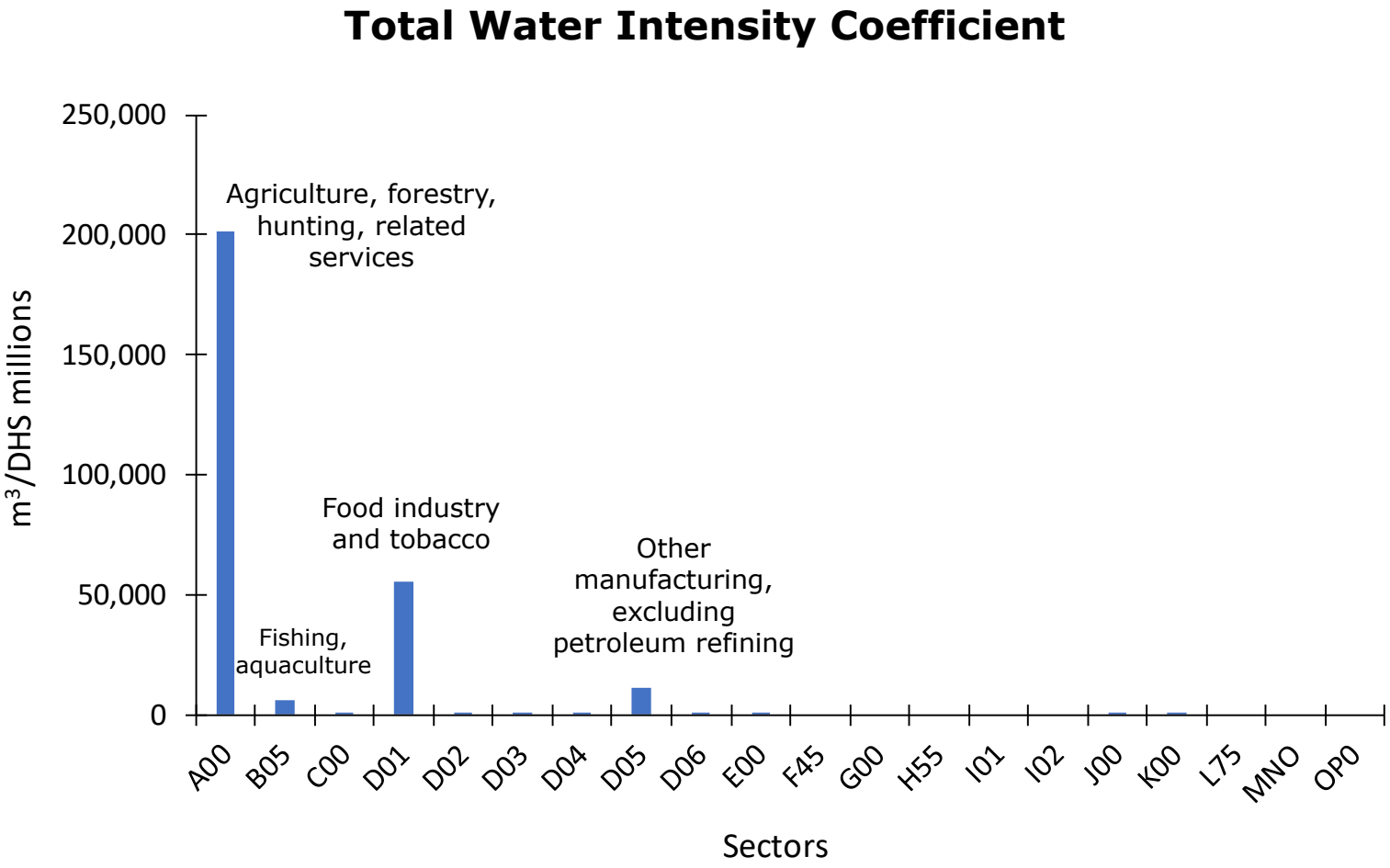
- Water footprint by crop demand; Water footprint of grazing [green]; Water footprint of animal supply [blue]; Water footprint of industrial production [blue grey]; Water footprint of domestic water supply [blue grey]

- Source:

  - **Eora**: a Global Multi-Region Input-Output Database – Lenzen et al. (2012; 2013).

- *Caveat*: national coefficients applied to regions.

Results


Total Water Intensity Coefficient
250,000
200,000
150,000
100,000
50,000
0
m3/DHS millions
Agriculture, forestry, hunting, related services
Fishing, aquaculture
Food industry and tobacco
Other manufacturing, excluding petroleum refining
A00
B05
C00
D01
D02
D03
D04
D05
D06
E00
F45
G00
H55
I01
I02
J00
K00
L75
MNO
OPO
Sectors

Regional structure (selected sectors)

		R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*TOTAL*
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
TOTAL		8.8	5.6	9.2	13.0	5.8	35.7	9.9	2.5	6.4	1.1	1.5	0.5	100.0

User share

Sectors	*Intermediate consumption*	*Investment demand*	*Household demand*	*Exports*	*Government demand*	*Total*
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_1	R_2	…	R_{n-1}	R_n	RoW
R_1		$DVA_{1,2}$	…	$DVA_{1,n-1}$	$DVA_{1,n}$	$DVA_{1,row}$
R_2	$DVA_{2,1}$		…	$DVA_{2,n-1}$	$DVA_{2,n}$	$DVA_{2,row}$
⋮	⋮	⋮		⋮	⋮	⋮
R_{n-1}	$DVA_{n-1,1}$	$DVA_{n-1,2}$	…		$DVA_{n-1,n}$	$DVA_{n-1,row}$
R_n	$DVA_{n,1}$	$DVA_{n,2}$	…	$DVA_{n,n-1}$		$DVA_{n,row}$

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; R**12** - Dakhla-Oued Eddahab; **RoW** - Rest of the World.

Methodology

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

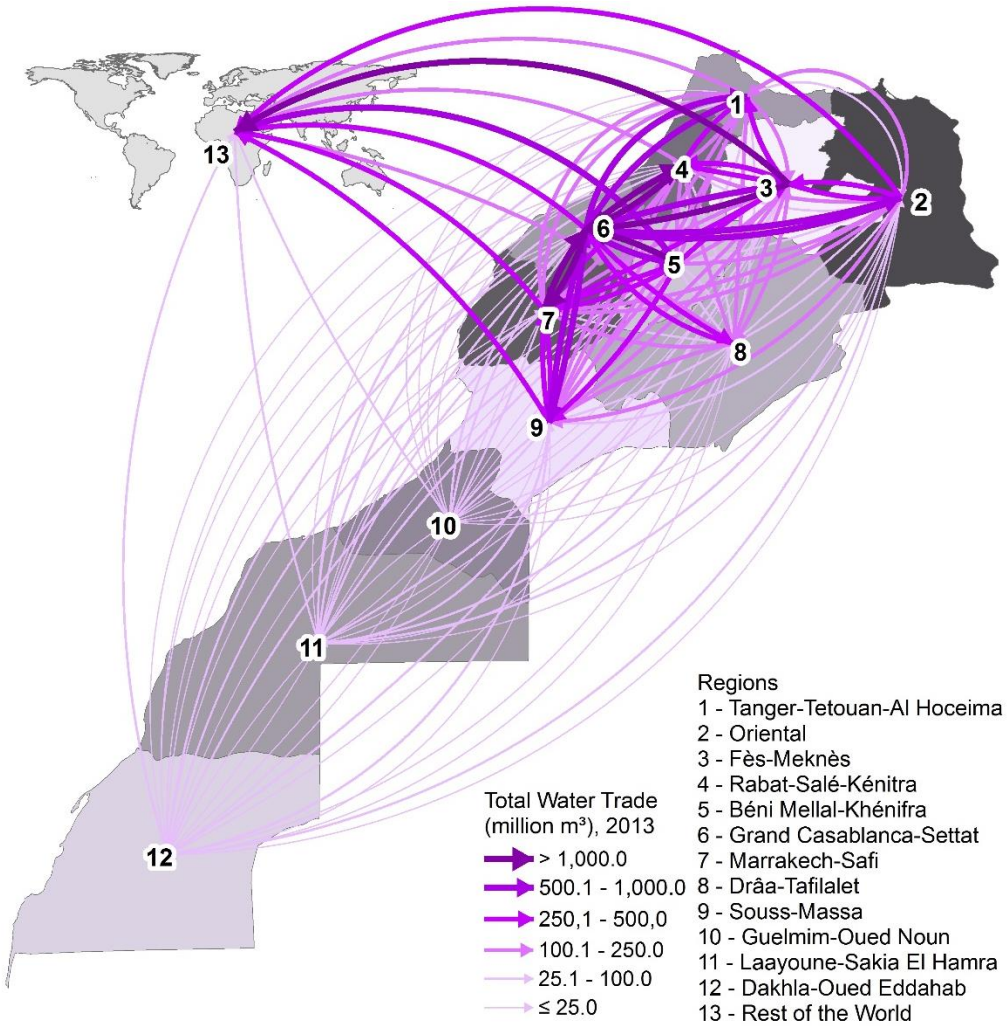
Hypothetical no export	to					
from	R_1	R_2	…	R_{n-1}	R_n	RoW
R_1		$DTW_{1,2}$	…	$DTW_{1,n-1}$	$DTW_{1,n}$	$DTW_{1,row}$
R_2	$DTW_{2,1}$		…	$DTW_{2,n-1}$	$DTW_{2,n}$	$DTW_{2,row}$
⋮	⋮	⋮		⋮	⋮	⋮
R_{n-1}	$DTW_{n-1,1}$	$DTW_{n-1,2}$	…		$DTW_{n-1,n}$	$DTW_{n-1,row}$
R_n	$DTW_{n,1}$	$DTW_{n,2}$	…	$DTW_{n,n-1}$		$DTW_{n,row}$

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; R**12** - Dakhla-Oued Eddahab; **RoW** - Rest of the World.

Results (DTW)

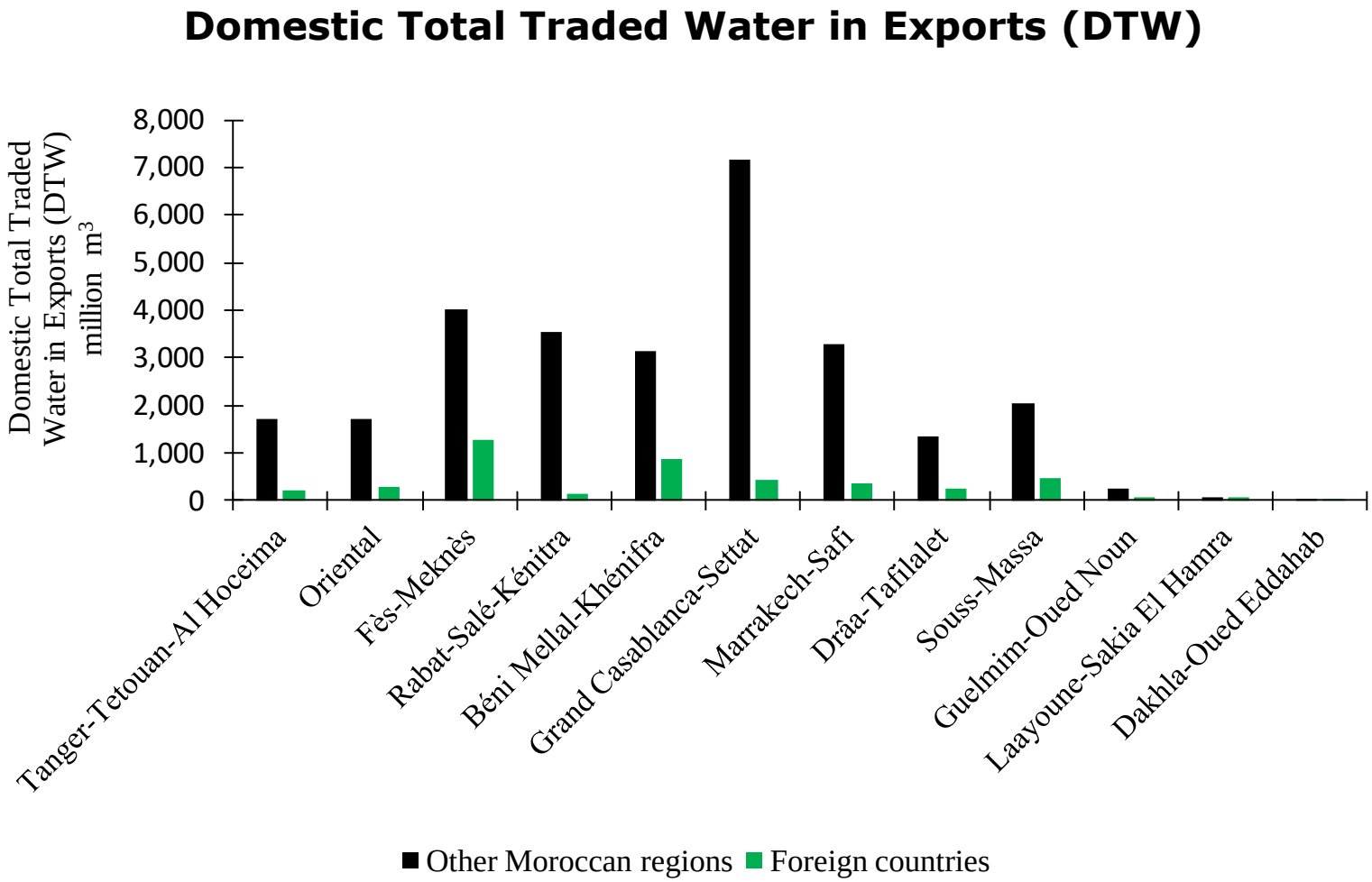

1
2
3
4
5
6
7
8
9
10
11
12
13
Total Water Trade
(million m³), 2013
> 1,000.0
500.1 - 1,000.0
250,1 - 500,0
100.1 - 250.0
25.1 - 100.0
≤ 25.0
Regions
1 - Tanger-Tetouan-Al Hoceima
2 - Oriental
3 - Fès-Meknès
4 - Rabat-Salé-Kénitra
5 - Béni Mellal-Khénifra
6 - Grand Casablanca-Settat
7 - Marrakech-Safi
8 - Drâa-Tafilalet
9 - Souss-Massa
10 - Guelmim-Oued Noun
11 - Laayoune-Sakia El Hamra
12 - Dakhla-Oued Eddahab
13 - Rest of the World

"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 m³)*			
	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
TOTAL	318.412	107.241	425.653	100,00	28.250	4.395	32.645	100,00

Results


Domestic Total Traded Water in Exports (DTW)
Domestic Total Traded Water in Exports (DTW) million m3
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Tanger-Tetouan-Al Hoceima
Oriental
Fès-Meknès
Rabat-Salé-Kénitra
Béni Mellal-Khénifra
Grand Casablanca-Settat
Marrakech-Safi
Drâa-Tafilalet
Souss-Massa
Guelmim-Oued Noun
Laayoune-Sakia El Hamra
Dakhla-Oued Eddahab
Other Moroccan regions
Foreign countries

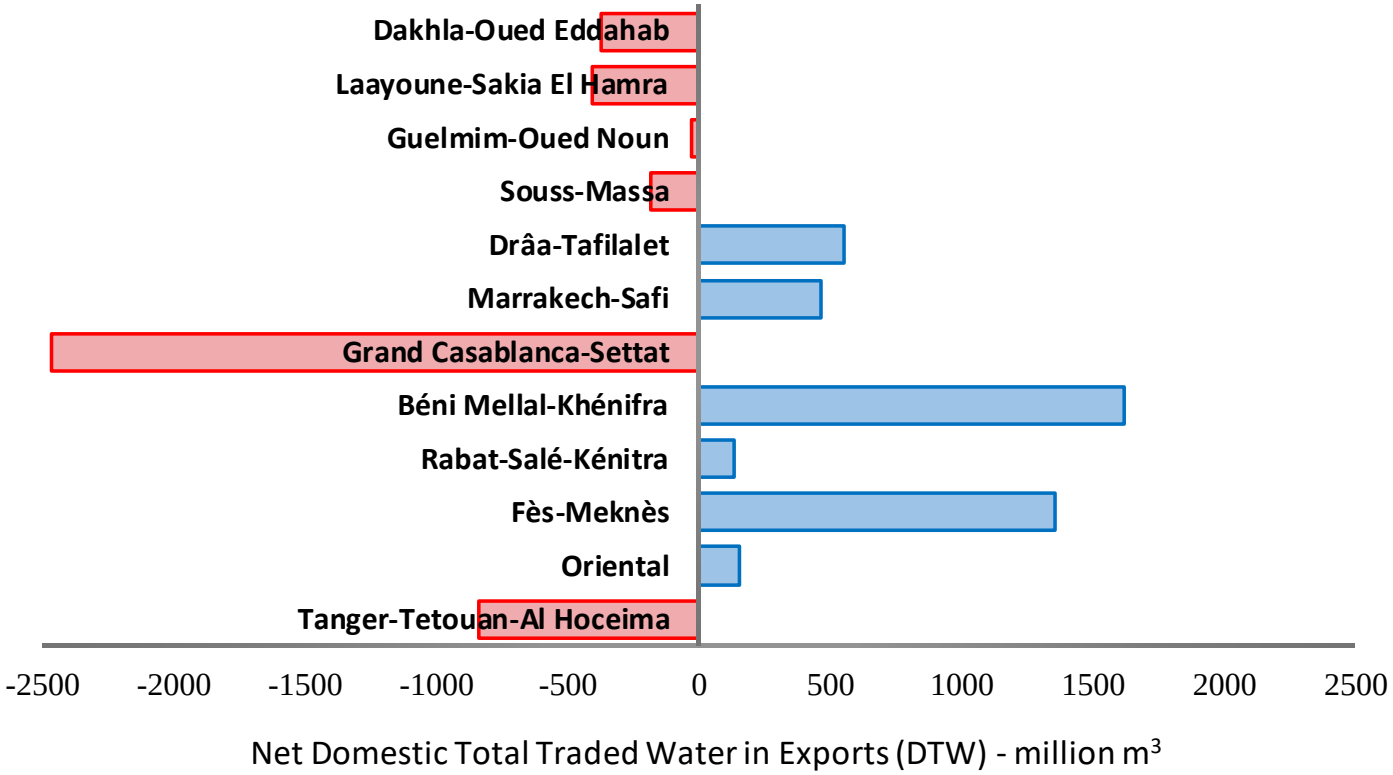
Results

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



net water savings

net water loss

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

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

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.

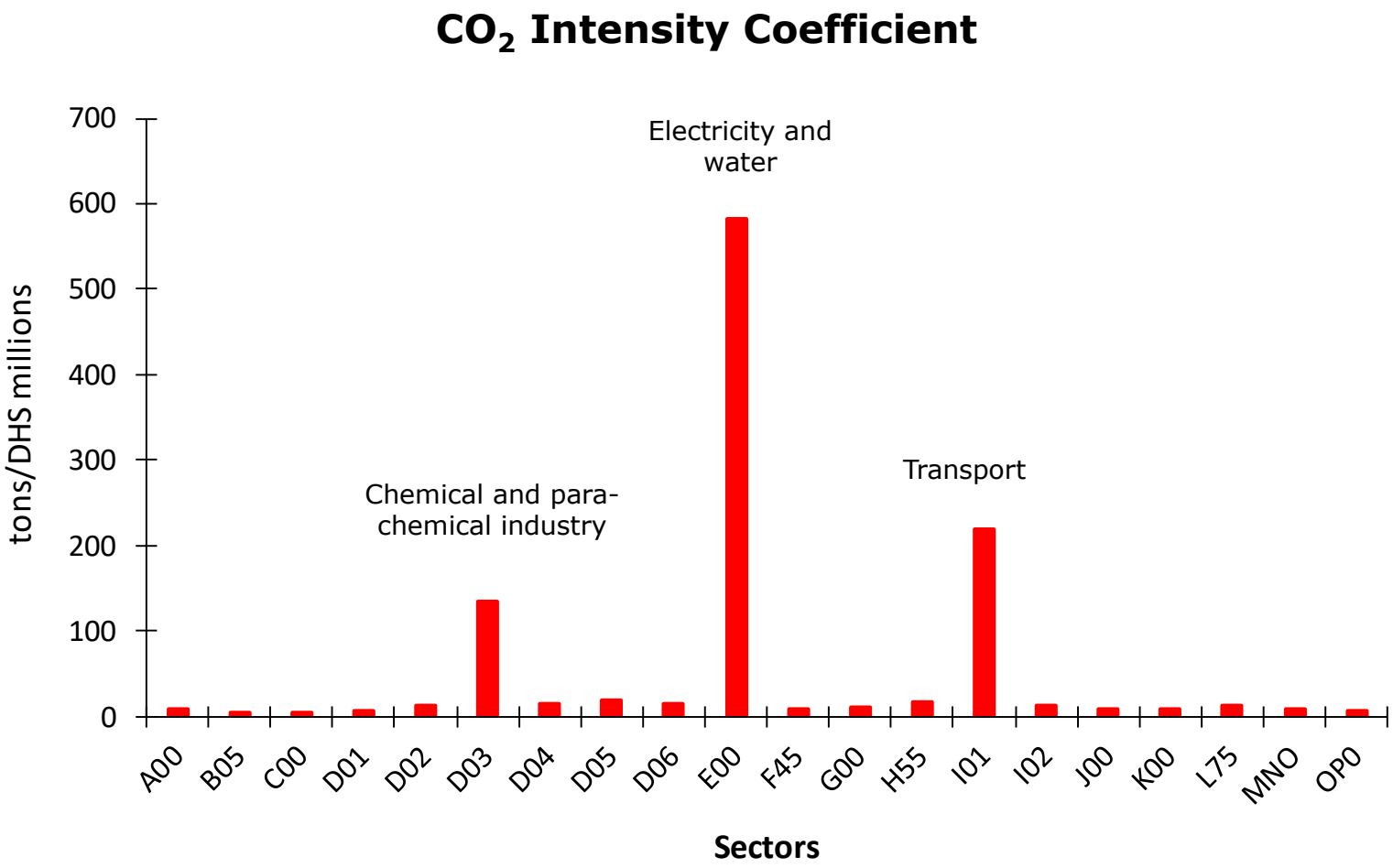
Similarly, we can calculate a **Trade-Based Index of CO_2 Emissions** based on DVA and DCO_2.

Database

Emissions:

- Global CO_2 emissions from fossil fuel use and cement production.
- Source:
  - EDGAR - **E**missions **D**atabase for **G**lobal **A**tmospheric **R**esearch - 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

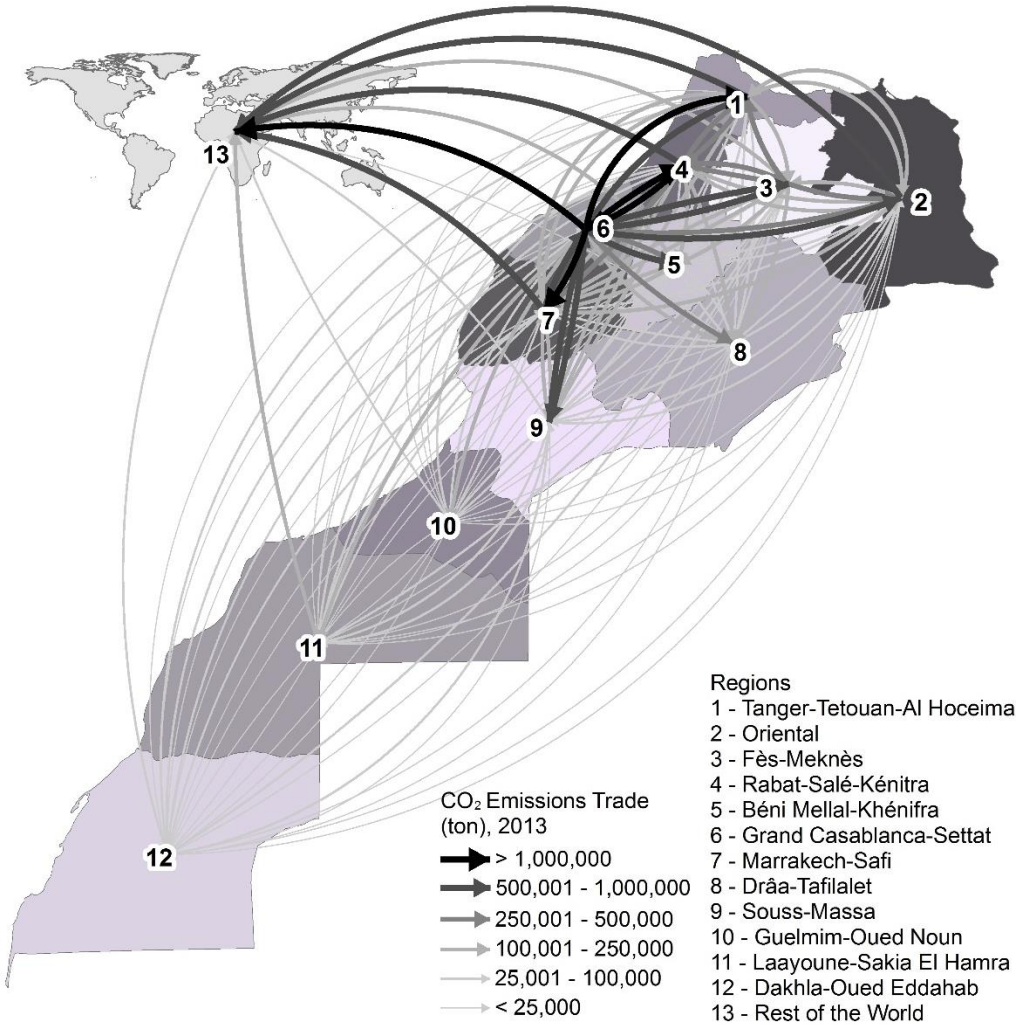

CO2 Intensity Coefficient
tons/DHS millions
700
600
500
400
300
200
100
0
Electricity and water
Chemical and para-chemical industry
Transport
A00
B05
C00
D01
D02
D03
D04
D05
D06
E00
F45
G00
H55
I01
I02
J00
K00
L75
MNO
OPO
Sectors

Results (DCO_2)

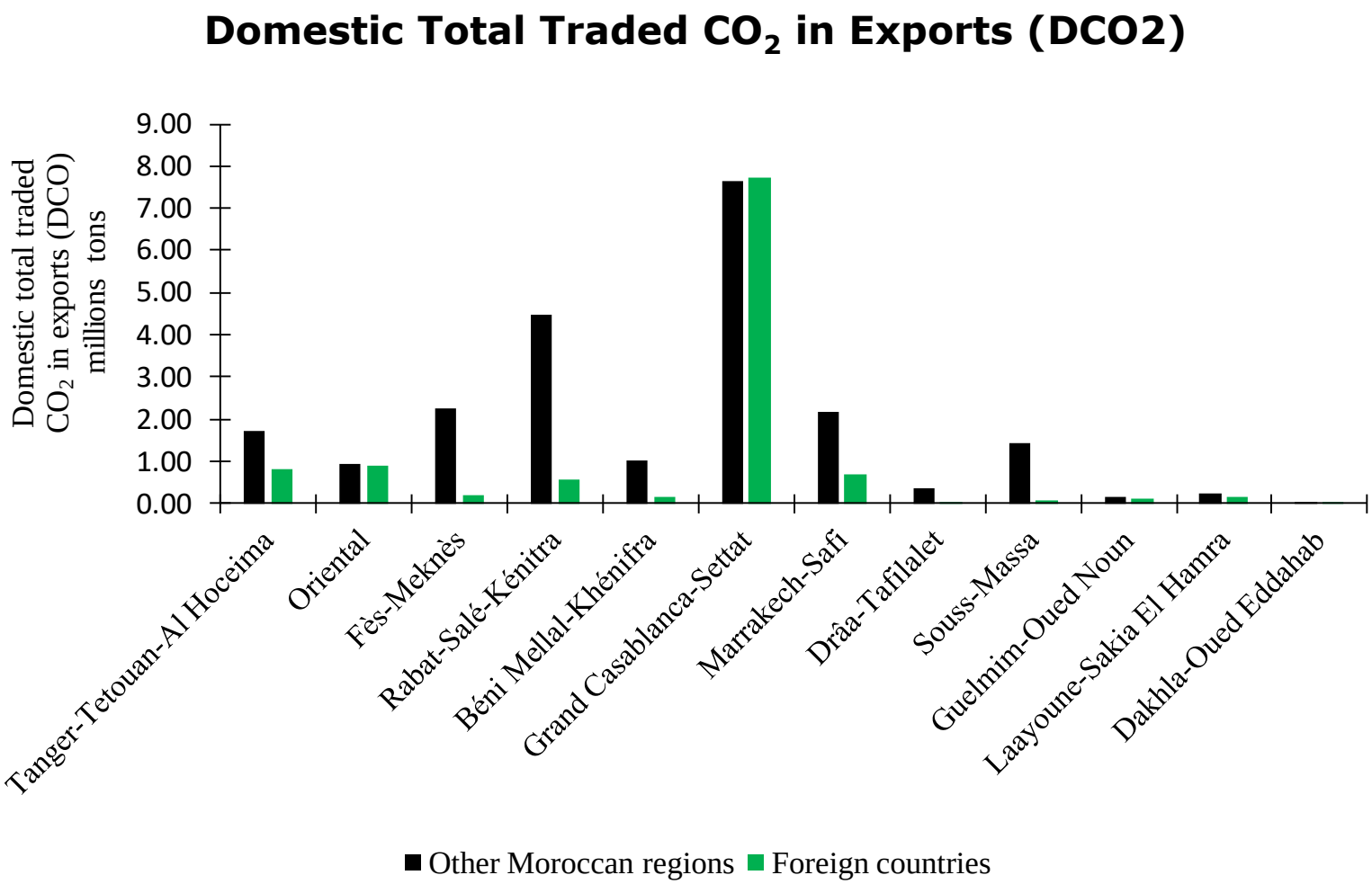
O | D	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	RoW
R1		139499,29	212331,29	257192,90	81206,56	677107,21	145154,03	66874,63	86754,78	16149,18	24800,31	25719,75	795123,11
R2	107633,93		179337,74	103170,51	50835,72	284054,53	72280,77	56768,71	45444,79	9071,69	16075,52	16408,80	892987,18
R3	254420,98	315516,26		300636,52	121108,36	827838,49	144144,84	120382,26	82101,71	15809,68	30497,47	28689,21	179131,64
R4	409381,85	206613,14	392004,07		172372,50	2655893,93	295368,86	101394,91	151879,09	27875,65	38314,71	36323,46	569523,20
R5	65208,86	51519,71	82437,53	91206,21		440937,55	155933,10	38473,01	63514,03	9432,67	14068,42	12826,64	162283,09
R6	1105904,72	600150,24	913494,62	1975022,62	662889,82		1216104,23	318454,35	564108,05	100604,48	111781,84	88435,41	7724316,38
R7	155199,27	111830,22	136902,61	223808,15	207195,67	945685,62		77327,31	203869,32	31517,14	43054,61	36219,56	689740,66
R8	32806,21	36303,28	52517,35	35423,96	25943,79	111310,30	38580,68		23531,18	3845,58	7558,11	7122,34	20179,17
R9	107277,89	86646,49	89181,67	132117,87	90964,62	502347,20	227049,50	50943,25		61953,81	56034,88	40020,97	80527,46
R10	9947,53	8139,38	8081,20	11998,05	7523,83	41253,31	17712,26	4683,31	30472,36		10973,84	6302,23	96350,89
R11	18896,04	13362,00	15359,06	15321,44	11051,65	84883,31	25160,14	9475,17	25735,29	10046,41		18554,43	142790,20
R12	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; R**12** - Dakhla-Oued Eddahab; **RoW** - Rest of the World.

Results (DCO_2)



Results


Domestic Total Traded CO_2 in Exports (DCO2)
Domestic total traded CO_2 in exports (DCO) millions tons
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Tanger-Tetouan-Al Hoceima
Oriental
Fès-Meknès
Rabat-Salé-Kénitra
Béni Mellal-Khénifra
Grand Casablanca-Settat
Marrakech-Safi
Drâa-Tafilalet
Souss-Massa
Guelmim-Oued Noun
Laayoune-Sakia El Hamra
Dakhla-Oued Eddahab
Other Moroccan regions
Foreign countries

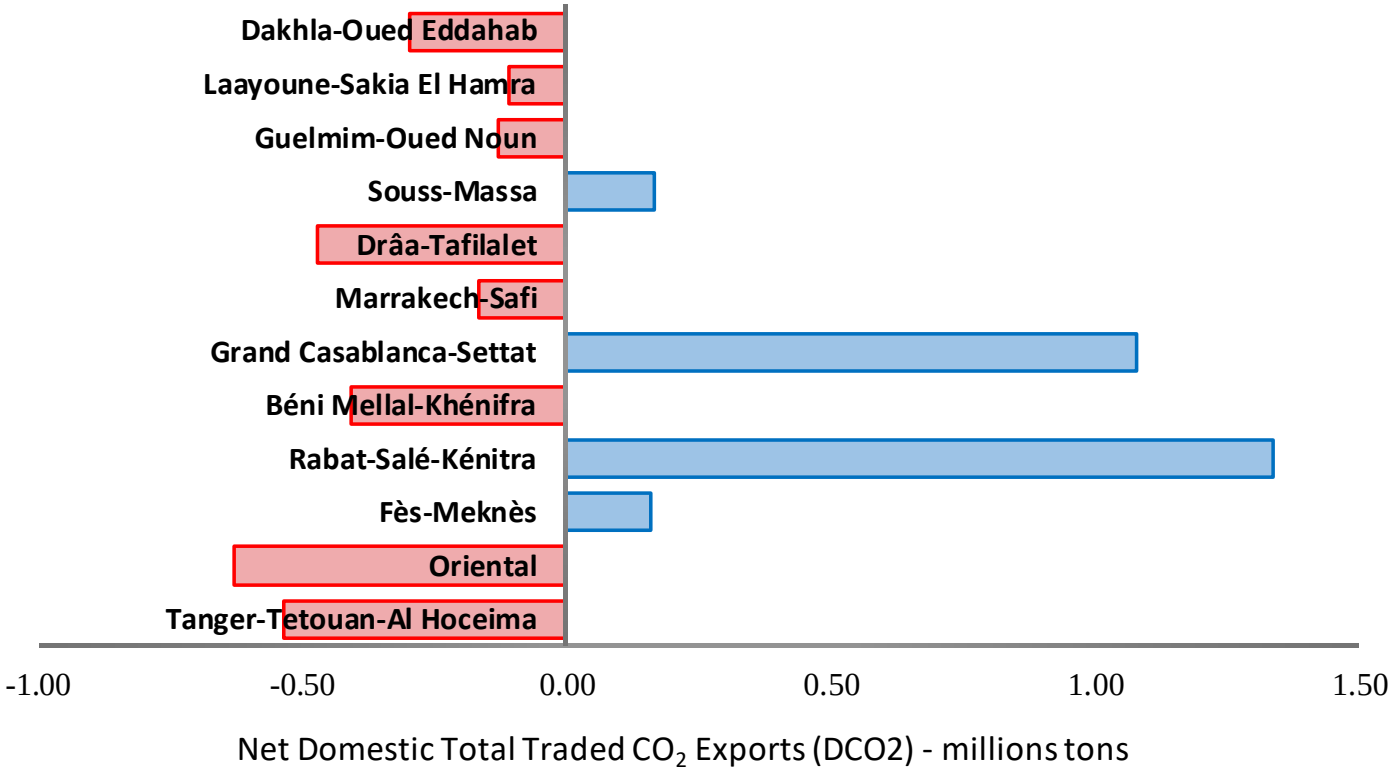
Results

Domestic Total Traded CO_2 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_2 in Exports (DCO2) to RoMOR



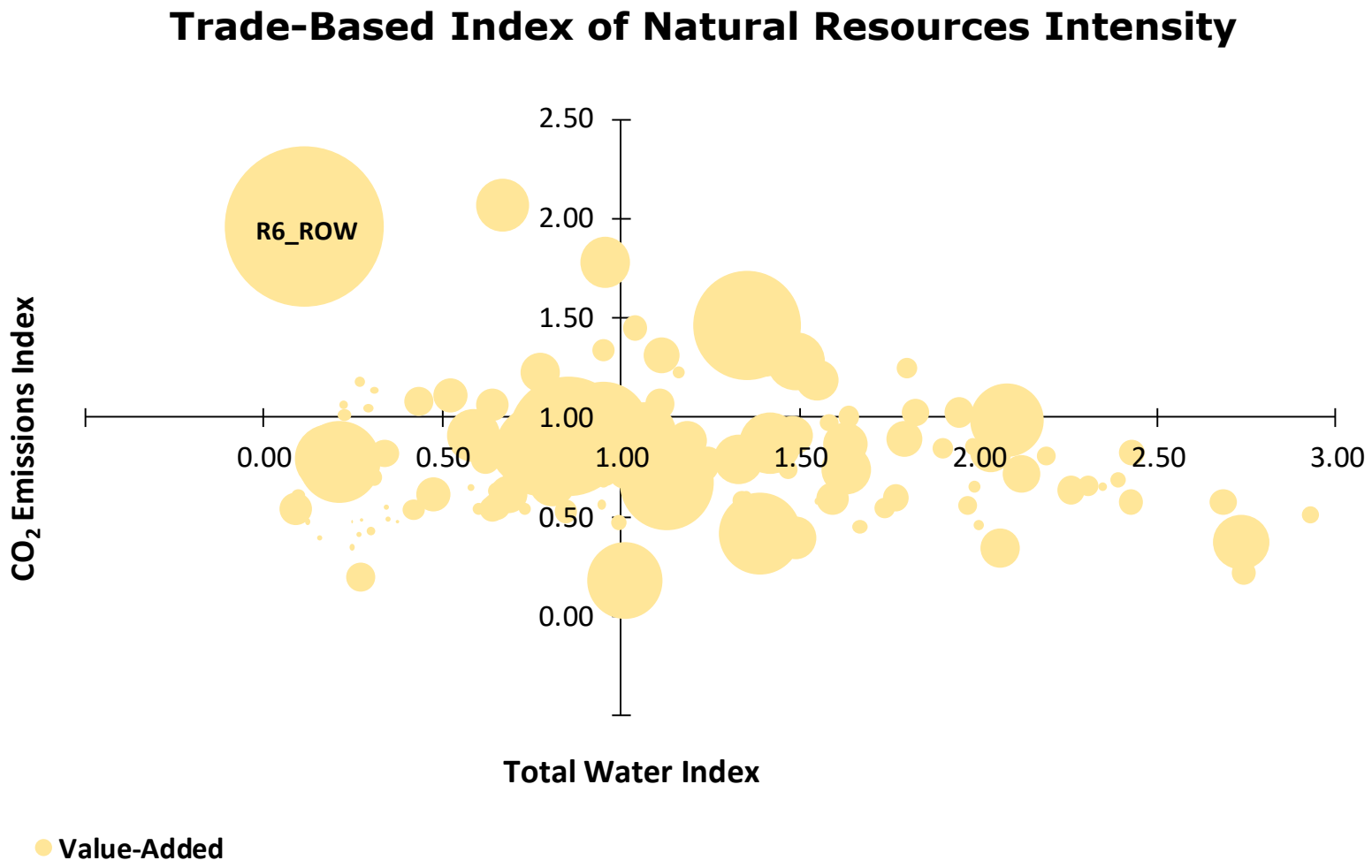
Results

CO_2 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

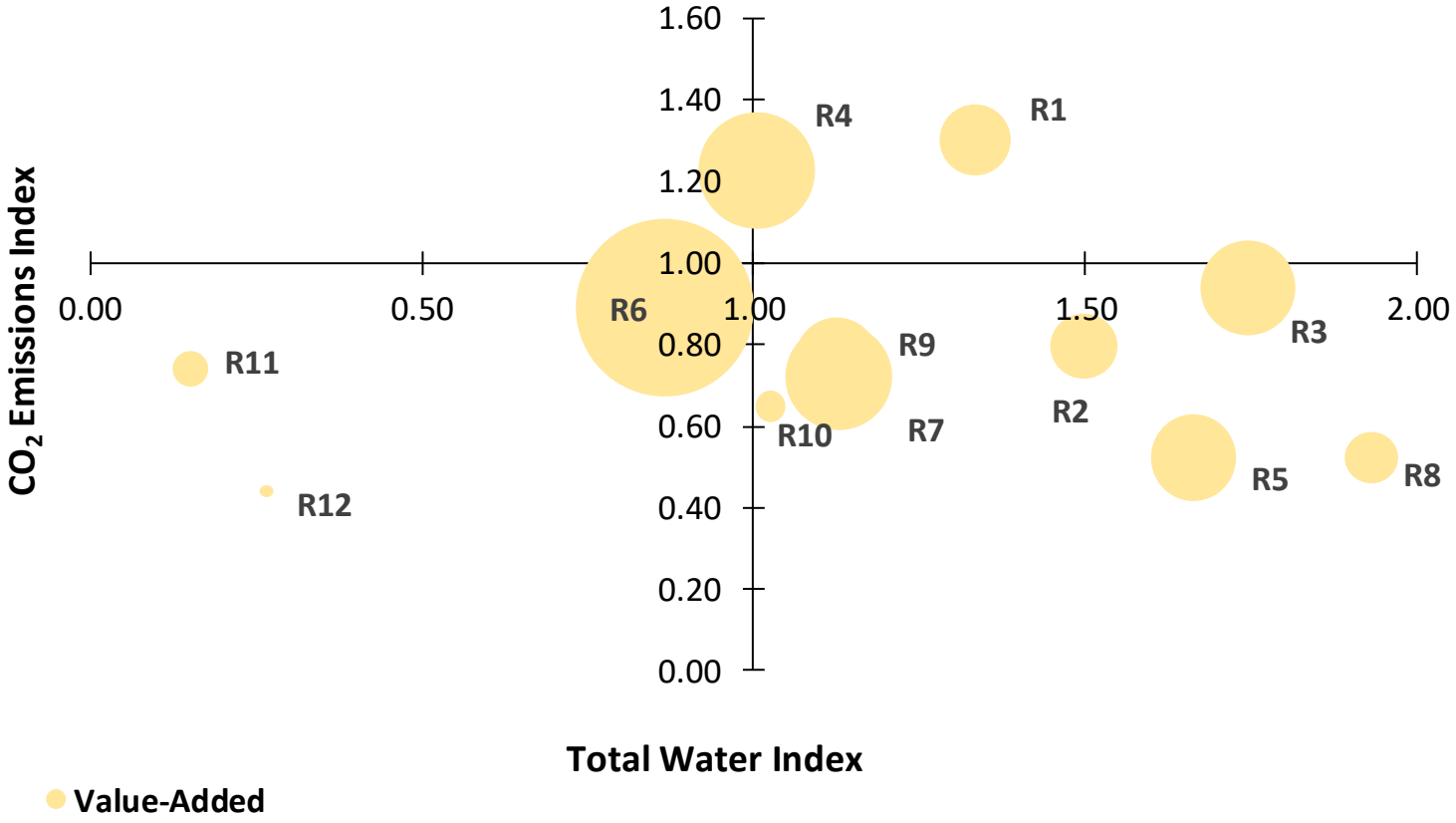
R1 - Tanger-Tetouan-Al Hoceima; **R2** - Oriental; **R3** - Fès-Meknès; **R4** - Rabat-Salé-Kénitra; **R5** - Béni Mellal-Khénifra; **R6** - Grand Casablanca-Settat; **R7** - Marrakech-Safi; **R8** - Drâa-Tafilalet; **R9** - Souss-Massa; **R10** - Guelmim-Oued Noun; **R11** - Laayoune-Sakia El Hamra; R**12** - Dakhla-Oued Eddahab; **RoW** - Rest of the World.

Trade-Based Indices of Natural Resources Intensity: Water *versus* CO_2 Emissions



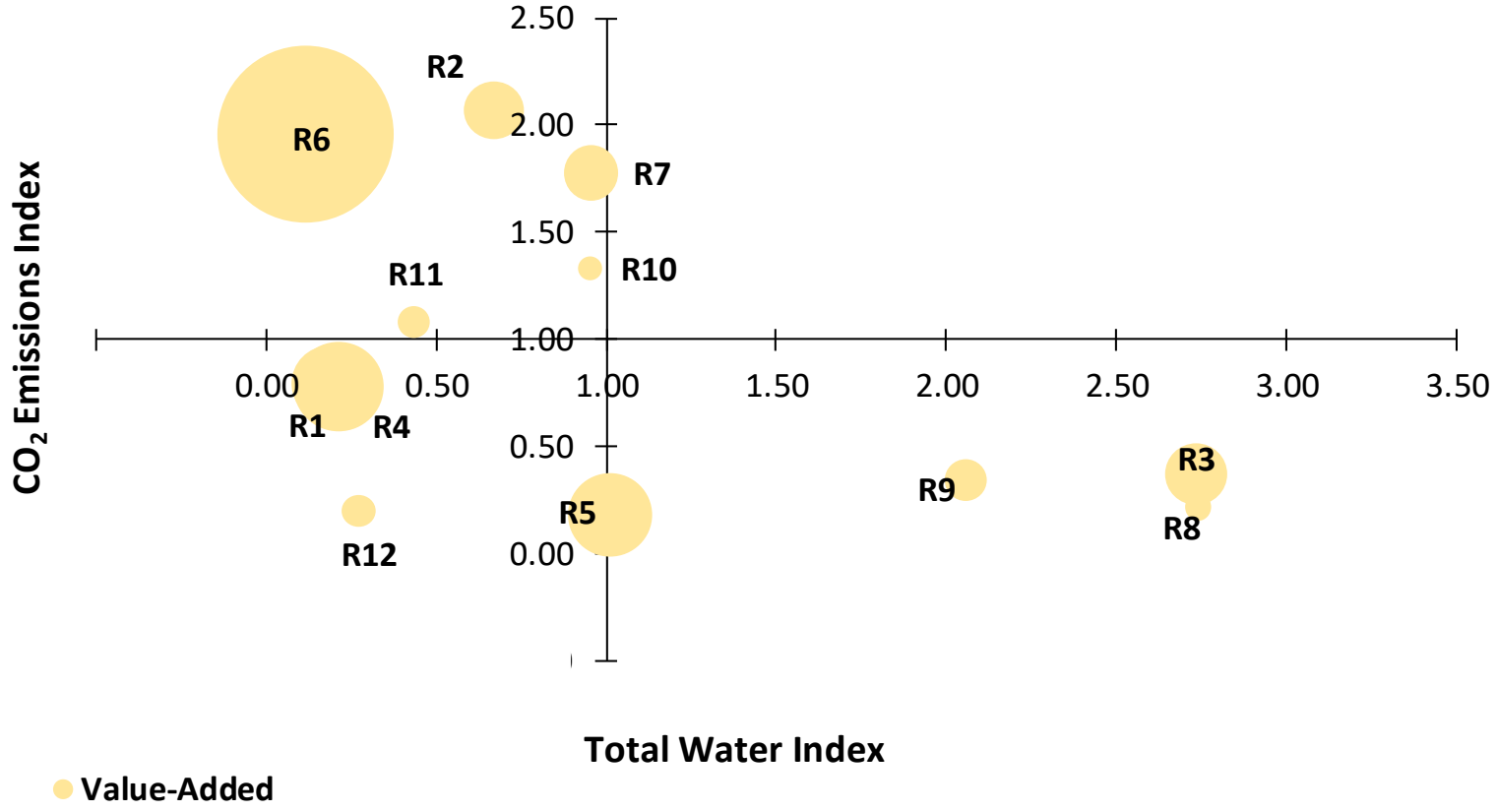
Trade-Based Indices of Natural Resources Intensity: Water *versus* CO_2 Emissions

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



Trade-Based Indices of Natural Resources Intensity: Water *versus* CO_2 Emissions

Trade-Based Index of Natural Resources Intensity (<u>in Exports to RoW</u>)



Final remarks

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

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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