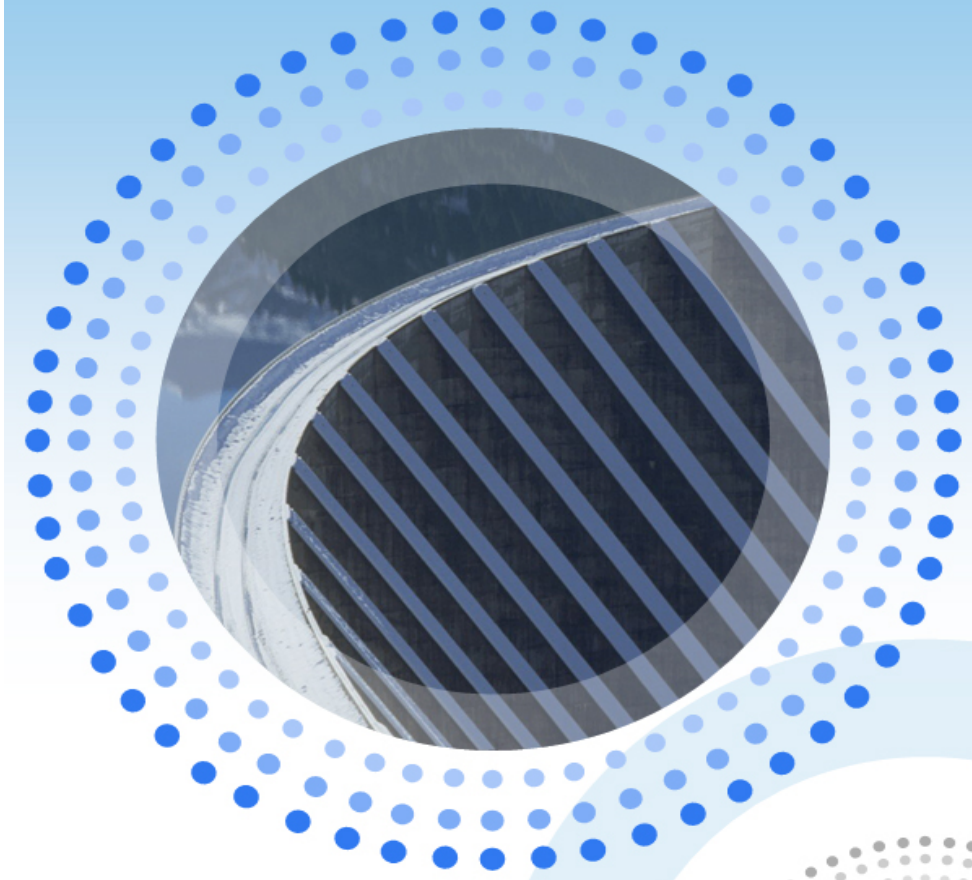

Econometric Analysis of the Paper Industry Competitiveness : The Role of Energy Costs

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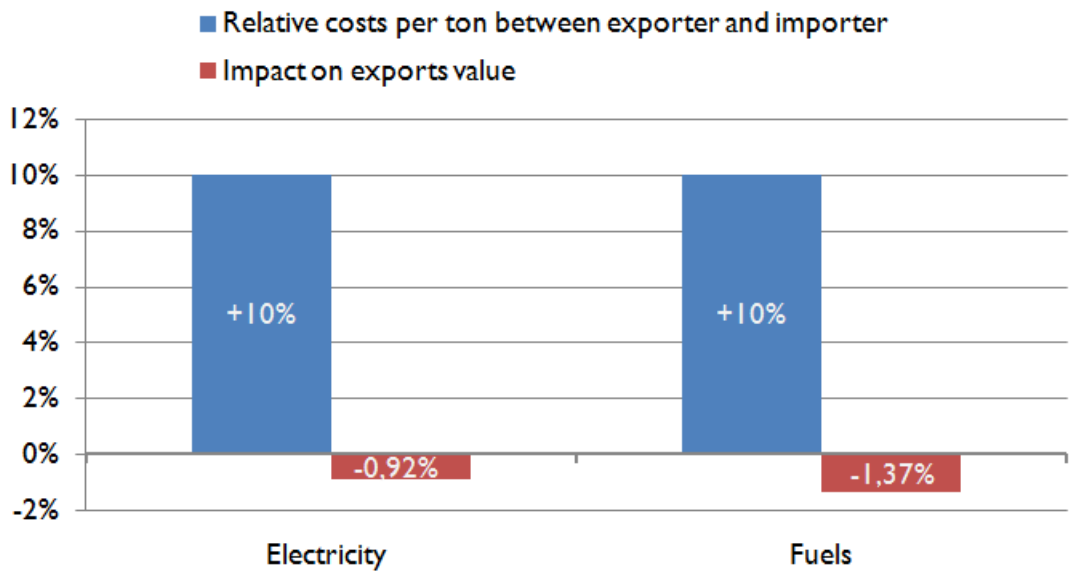
ECEEE Industrial Summer Study
on energy efficiency
Arnhem, 2-5 June 2014

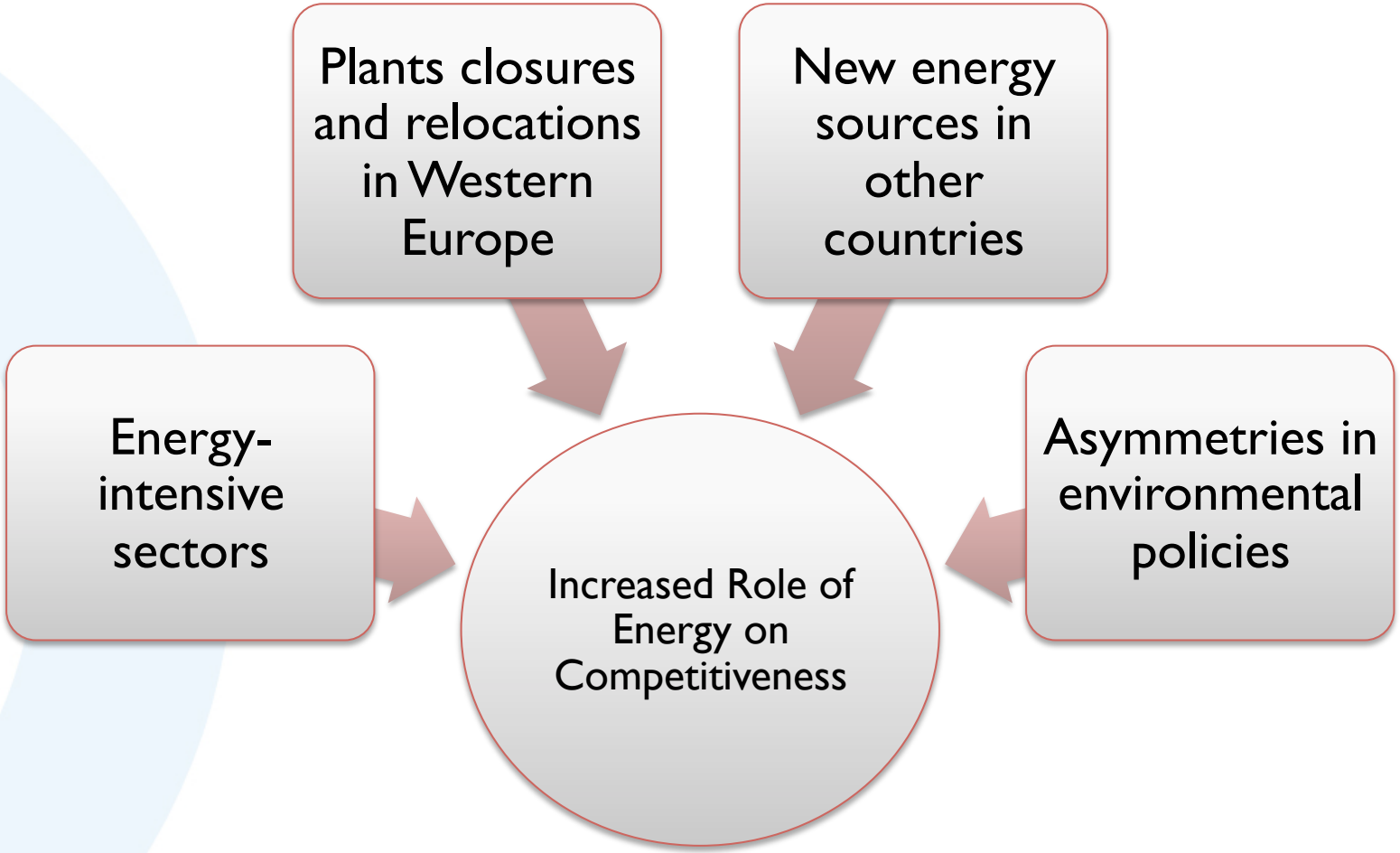
Influence of energy costs on competitiveness can be estimated for an industrial sector : **Paper Industry**

- **Higher energy costs reduce national paper exports** : **Demonstration** and **quantification** based on more than 11000 observations

- **A *relative* rise of 10 % in electricity or in fuel costs** (all else constant) results respectively in a **0.9% (elec.)** or **1.4% (fuel) decrease in exports**, in average.



Motivations : How industrial sectors are impacted by energy or environmental policies ?



- Focus on one energy-intensive sector : **Paper industry**
  A methodology applicable on other industrial sectors

A econometric *gravity* model to evaluate paper bilateral trade

- **Scope of the study**
  - **All types of paper** and paperboards products (Section 48 of HS.96)
  - **32** developed and emerging **countries** across the World (94% of World production in paper)
  - Period: **1995-2006** / To avoid global economic crisis period

- **Related literature** on the paper industry trade and location
  - Analysis of location determinants based on **classical trade theory** (Heckscher-Ohlin)
    - (Bonnefoi and Buongiorno, 1990; Leamer, 1984; Lundmark, 2010; Trefler, 1993)
  - Or on **industrial organization** and international trade economics
    - (Bergman and Johansson, 2002; Lundmark, 2001)
  - **Gravity models focused** on trade flows in forest products
    - (Kangas et al., 2003; Karikallio et al., 2011)

- **Our research** : To introduce **energy variables** in a **gravity model**
  - **Energy costs** ($/ton) : Price ($/toe)* Consumption per ton (toe/t)
  - All types of energy, excepted biomass
  - Energy costs in the **exporting** country / Energy costs in the **importing** country

Econometric specification

- **Theoretical framework :** Eaton & Kortum (2002) / Levchenko & Zhang (2011)
  - Ricardian model to **interpret bilateral trade** in gravity models
  - **Market shares are determined** by national productivity, trade barriers and production costs
- **Standard form of the gravity equation**
  - *F* : Bilateral trade flows in value (000$2005) | *Y* : countries' GDP | *d* : distance between countries

$$F_{i,j} = A * \frac{{Y_i}^{\alpha} * {Y_j}^{\beta}}{{d_{i,j}}^{\gamma}}$$

  - Add variables on **relative electricity and fuel costs per ton of paper** produced between the exporting and importing countries
  - Additional **dummy variables** : common official language, frontier or regional free trade agreement
- **Estimation methodology**
  - **Usual methods of panel data** : OLS, fixed (FE) and random (RE) effects for each country-pair
  - A method recommended by Fratianni et al. (2010) : **Combination of fixed (country and year) and random effects (country-pair)**
  - Time invariants are added | Robust standard errors | Only 3.8% of zero values for bilateral flows

Data

Table 1: Summary statistics (data sources, mean, standard deviation (Std. Dev.), minimum (Min.) and maximum (Max.)). The number of observations for each bilateral trade flow is T=12. This gives a total of 11456 observations.

Variable		Unity	Sources	Mean	Std. Dev.	Min.	Max.
Paper export flow	F	In value, 1000$ (2005$)	BACI (Gaulier and Zignago, 2010)	72 789	372 703	0	$10{,}8*10^6$
GDP	Y	1,000,000$ (2005$)	Enerdata, (Global Energy & CO2 Data, 2010)	1 094 940	1 997 576	73 410	$12.7*10^6$
GDP per capita	Y/L	1,000$/capita	Enerdata	19.7	16.1	0.47	66.4
Distance	d	Population weighted distance between countries (km)	CEPII (Mayer and Zignago, 2006)	7 331	4 841	80	19 370
Common language	Dl	First official language, no unit	CEPII	0.05	0.23	0.00	1.00
Common border	Db	No unit	CEPII	0.04	0.19	0.00	1.00
Common regional trade agreement	Dr	European Union, NAFTA, ASEAN, Mercosur	/	/	/	/	/
Electricity costs per ton of paper	El	$/t (2005$)	Enerdata	87	57	13	418
Fuel costs per ton of paper	Co	$/t (2005$)	Enerdata	27	17	2.1	81
Electricity costs ratio	$\left(\frac{El_i}{El_j}\right)$	No unit	/	1.44	1.59	0.03	29.24
Fuel costs ratio	$\left(\frac{Co_i}{Co_j}\right)$	No unit	/	1.89	3.11	0.02	40.01

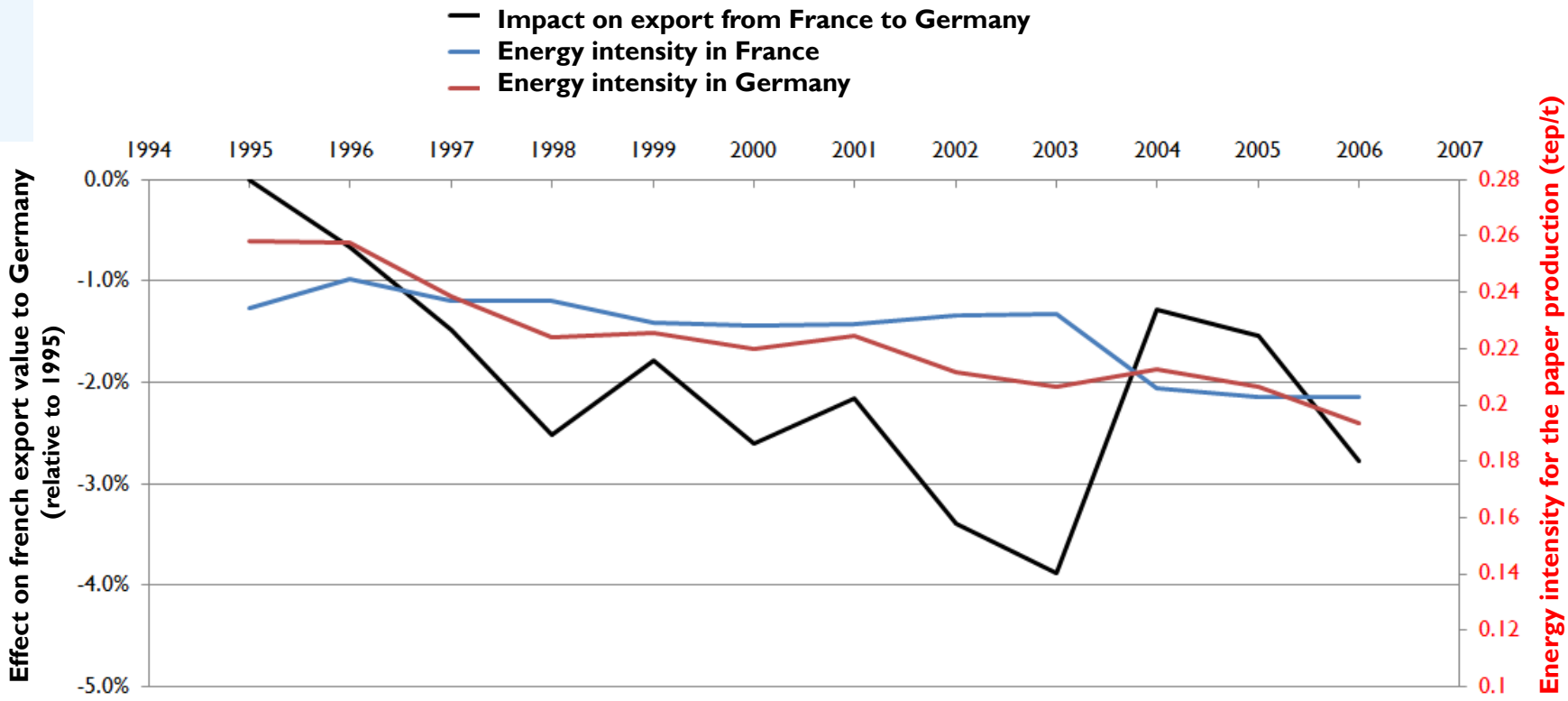
Estimation results

Explained variable: Paper bilateral exports	Ordinary Least Squares (OLS)	Fixed effects (FE)	Random effects (RE)	RE/FE	RE/FE (with income per capita)
Exporter's GDP	1.129 ***	0.861***	1.194***	0.851***	2.488***
	(0.016)	(0.232)	(0.051)	(0.233)	(0.951)
Importer's GDP	0.758***	1.459***	0.889***	1.464***	-1.412
	(0.017)	(0.262)	(0.055)	(0.262)	(0.863)
Exporter's GDP per capita	/	/	/	/	-1.734*
	/	/	/	/	(1.001)
Importer's GDP per capita	/	/	/	/	3.011***
	/	/	/	/	(0.853)
Distance	-1.411***	/	-1.544***	-1.923***	-1.931***
	(0.023)		(0.057)	(0.065)	(0.066)
Common language	1.185***	/	1.301***	1.086***	1.086***
	(0.066)		(0.217)	(0.189)	(0.189)
Common border	0.324***	/	0.239	-0.010	-0.014
	(0.081)		(0.275)	(0.191)	(0.191)
Ratio of electricity costs (exporter/importer)	-0.132***	-0.095**	-0.129***	-0.092***	-0.89**
	(0.024)	(0.039)	(0.034)	(0.039)	(0.039)
Ratio of fuel costs (exporter/importer)	-0.210***	-0.136***	-0.137***	-0.137***	-0.156***
	(0.020)	(0.035)	(0.032)	(0.035)	(0.034)
European Union	0.537***	/	0.265***	0.030	-0.009
	(0.058)		(0.058)	(0.059)	(0.061)
NAFTA	1.192***	/	0.857***	0.341	0.329
	(0.100)		(0.301)	(0.344)	(0.344)
Mercosur	2.795***	/	2.824***	2.333***	2.325***
	(0.178)		(0.532)	(0.317)	(0.317)
Asean	2.478***	/	2.630***	-1.074***	-1.087***
	(0.142)		(0.168)	(0.334)	(0.334)
Constant	-4.436***	-21.99***	-5.939***	-5.206	7.789
	(0.332)	(4.563)	(1.071)	(4.307)	(13.518)
Time Fixed Effects (FE)	No	Yes	Yes	Yes	Yes
Exporter & Importer Effects	No	No	No	Fixed	Fixed
Country-Pair Effects	No	Fixed	Random	Random	Random
N	11456	11456	11456	11456	11456
R-sq	0.518	0.916	0.515	0.790	0.791

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

An application : To measure energy efficiency impact on international competitiveness

Impact on export values for paper products from France to Germany of a relative gap in energy efficiency
(Reference year : 1995)



For the French paper industry, reduced improvements in energy efficiency has lead to a loss of about 36 M€ of exportations in 2006

Main Results

- **Demonstration and quantification of energy costs effects on the competitiveness**
  - One of the most energy-intensive sectors : **the paper industry**
  - **Higher energy costs** in the exporting country, relatively to the importing country, **decrease the level of paper exports**
  - **Negative Elasticities : -0.9 for electricity / -1.4 for fuels**

- **Results helpful to the design of an energy policy**
  - **Energy costs a relevant issue** for the paper industry competitiveness, but **may not be the deciding factor**
  - Importance of **raw materials prices**, **local market features** and **efficiency of the production process**
  - **To balance benefits and costs of energy efficiency improvements**

Next step : To extend this analysis to other energy intensive industries (e.g. Iron and steel industry)

Thank you!

Questions and suggestions?

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Bibliography

• **Bergman, M., & Johansson, P. (2002).** Large investments in the pulp and paper industry: a count data regression analysis. *Journal of Forest Economics* , 8 (1), pp. 29-52.

• **Bonnefoi, B., & Buongiorno, J. (1990).** Comparative advantage of countries in forest-products trade. *Forest Ecology and Management* , 36, pp. 1-17.

• **Eaton, J., & Kortum, S. (2002).** Technology, Geography and Trade. *Econometrica* , 70 (5), pp. 1741-1779.

• **Enerdata. (2010).** Global Energy & CO2 Data. *Retrieved from http://www.enerdata.net/*

• **Fratianni, M., Marchionne, F., & Hoon Oh, C. (2010)**. The Gravity Equation in International Economics and International Business Research: A Note.

• **Gaulier, G., & Zignago, S. (2009).** BACI: International Trade Database at the Product-level. The 1994-2007 Version. *Paris, France: Centre d'études prospectives et d'informations internationales.*

• **Kangas, K., & Niskanen, A. (2003).** Trade in forest products between European union and the Central and Eastern European access candidates. *Forest Policy and Economics* , 5, pp. 297-304.

• **Karikallio, H., Mäki-Fränti, P., & Suhonen, N. (2011).** Competition in the global pulp and paper industries - An evaluation based on three approaches. *Journal of Forest Economics* , 17, pp. 91-104.

• **Leamer, E. (1984).** Sources for International Comparative Advantage: Theory and Evidence. *Cambridge, MA, United States: MIT Press*.

• **Levchenko, A., & Zhang, J. (2011).** The evolution of comparative advantage: Measurement and welfare implications. *National Bureau of Economic Research.*

• **Lundmark, R. (2001).** Choice of location for investments in the European pulp and paper industry: the impact of wastepaper. *Resources, conservation and recycling* , 33, pp. 167-180.

• **Lundmark, R. (2010).** European Trade in forest products and fuels. *Journal of Forest Economics* , 16 (3), pp. 235-251.

• **Mayer, T., & Zignago, S. (2006).** Notes on CEPII's distances measures. *Paris, France: CEPII.*

•**Trefler, D. (1993).** International factor price difference: Leontief was right! *Journal of Political Economy* , 101 (6), pp. 961-987.