

Linking NAMEA and I-O for 'Consumption vs Production Perspectives' Analyses

Evidence on emission efficiency and aggregation biases using the Italian and Spanish environmental accounts

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ABSTRACT

We integrate input-output and NAMEA tables for Spain and Italy in 1995, 2000 and 2005, in order to address the hot policy issue of sustainable consumption and production. A comparison of a production and consumption perspective may have relevant policy implications. We deal with the domestic technology assumption and primarily the aggregation bias that may result when calculating indirect emission using different sector aggregations in the analyses.

Extended Input output analysis provides analyses of the emissions embodied in domestic consumption and domestic production by considering the structure of intermediate inputs and environmental efficiency in each production sector. Our empirical findings show that different sectoral aggregation significantly biases the amount of emissions for the consumption perspective, though differently in the two countries. Our results thus suggest that special attention must be paid when interpreting the estimates of embodied emissions obtained with EE-IOA when the sectoral aggregation level has a low definition as considered in some recent similar studies.

BACKGROUND AND OBJECTIVES

- Accounting for environmental pressures induced by final consumption is an attractive alternative to standard 'production-based' indicators
- Moving from production-based environmental targets to consumption-based environmental targets will probably induce more radical changes in the structure of final demand and will help to mitigate the tendency to move 'brown' industries to countries with weak environmental regulation (Pollution Haven Hypothesis)

- Production perspective:** environmental pressures directly produced by domestic production activities
- Consumption perspective:** environmental pressures induced, either domestically or worldwide, by domestic final demand

- The exact computation of emissions embodied in imports requires very detailed information (I-O, sector emissions, trade flows) on trading partners and a worldwide multi-regional I-O model
- Limited data availability forced researchers to make specific assumption about countries with no coverage and to reduce the sector resolution (e.g. IEA/OECD MRIO models by Ahamd and Wyckoff (2003) and Nakano et al. (2009) which use a 16 sectors aggregation)
- Sector aggregation could potentially introduce relevant aggregation biases (Su et al., 2010)
- A common shortcut has been the use of the Domestic Technology Assumption to limit data requirements substantially but allowing for potentially great biases

Objectives of the paper:

- Comparing the amount of emissions generated by consumption activities with the amount of emissions induced (worldwide) by domestic consumption for Italy and Spain;
- Assessing the extent to which aggregation affects estimates of 'consumption-perspective' emissions.

METHODOLOGY AND DATA

Domestic Technology Assumption (DTA)

The DTA posits that imported goods (either as intermediate inputs or as final goods) are produced with the same mix of intermediate inputs ('technology' as described by the matrix of technical coefficients $L=(I-Z<x>^{-1})^{-1}$) and with the same environmental efficiency (as described by the vector of emissions intensity $b=e<x>^{-1}$) as domestically-produced goods. The consumption perspective is thus estimated by means of the following equation:

$$e_{cp} = (b' L <f_d>)'$$

Aggregation bias

Aggregation of sectors is generally due to limited availability of relevant data about either I-O tables or environmental extensions. Aggregation bias arises because, on the one hand, aggregated sectors could use different technology and could be characterized by different emissions coefficients relative to the underlying disaggregated sectors. On the other hand, the share of export in total final demand could differ among disaggregated sectors, making aggregated domestic final demand information unbalanced relative to the rest of the I-O model.

In this paper we artificially aggregate the 50-sectors basic data (used as benchmark) into a 30-sectors aggregation (results available in the full paper) and a 16 aggregation (roughly corresponding to the aggregation used in IEA/OECD MRIO models). Emissions for the consumption perspective are computed as follows:

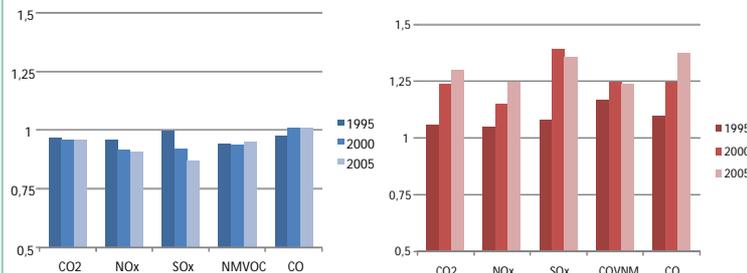
$$e_{cp}^{agg} = [(e' S' <S x>^{-1}) (I - S Z S' <S x>^{-1})^{-1} S <f_d> S']' \neq S e_{cp}$$

Data

We use input-output matrices (Eurostat) for Italy and Spain for year 1995, 2000 and 2005 and air emissions (NAMEA - Eurostat) for the same years. Input-output tables are available at the 2-digit Nace level (60 sectors) while NAMEA air emissions cover 50 sectors. The main advantage of using NAMEA (National Accounting Matrix including Environmental Accounts) instead of other environmental statistics is that NAMEA is built using the same definitions and classifications of national accounts, including input-output tables.

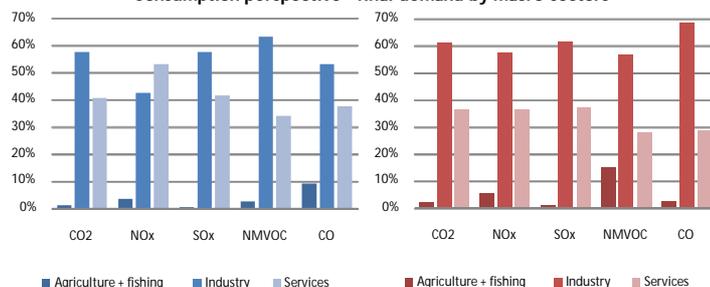
MAIN RESULTS (blue: Italy; red: Spain)

Ratio between consumption and production perspective



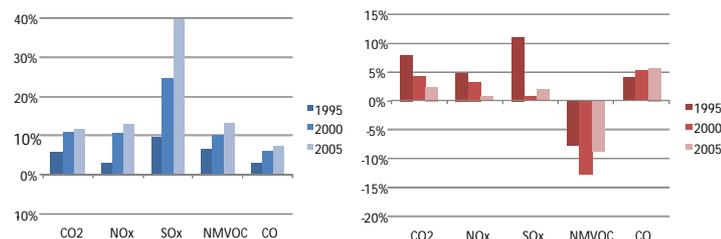
In our benchmark estimates (50-sectors), Italy appears as a balanced country (production perspective just slightly below consumption perspective) while Spain relies substantially (and increasingly) on emissions produced in foreign countries to satisfy its domestic final demand. These results are in line with previous evidence based on the DTA such as Moll et al. (2007). This divergence is due to the substantial drop of the contribution of manufacturing to GDP and labor force in Spain compensated by service sectors as opposed to the continuing important role of manufacturing in Italy. This divergence in the production structure has not been accompanied by any relevant divergence in the structure of final demand between the two countries.

Consumption perspective - final demand by macro-sectors



Looking at final demand macro categories (figures refer to 2005), we observe that the greatest proportion of air emissions (between 50% and 70%) is induced by final demand of industrial goods, the only exception being NOx emissions for Italy (where services, driven by the transportation sector, prevail). When comparing these results with the sectoral contribution to direct emissions (available upon request) we note that service sectors, despite their very low level of direct emissions, require relevant amounts of industrial goods. This aspect raises concerns about the environmental effects of the shift of many European countries toward a service-based economy.

Aggregation bias: (consumption perspective) 16 vs 50 sectors



Aggregation of raw data from 50-sectors to 16-sectors gave rise to substantial biases in the estimation of the consumption perspective. The bias is always positive and increasing through time for Italy while evidence is more mixed for Spain, with all positive biases except NMVOC emissions. The magnitude of the bias is much greater for Italy. When using the 16-sectors resolution, the consumption perspective of Italy is always greater than the production perspective. On the other hand, the unbalance of Spanish emissions rises slightly when employing the 16-sectors aggregation.

REFERENCES

- Ahmad N, Wyckoff, A (2003) Carbon Dioxide Emissions Embodied in International Trade of Goods, *OECD Science, Technology and Industry Working Papers* 2003/15, OECD, Paris
- Moll S, Vrgoc M, Watson D, Femia A, Pedersen OG, Villanueva A (2007) Environmental Input-Output Analyses based on NAMEA data - A comparative European study on environmental pressures arising from consumption and production patterns, *ETC/RWM working paper 2/2007*, Copenhagen, European Topic Centre - Resource and Waste Management
- Nakano S, Okamura A, Sukurai N, Suzuki M, Tojo Y, Yamano N (2009) The Measurement of CO2 Embodiments in International Trade: Evidence from the Harmonised Input-Output and Bilateral Trade Database, *Statistical Analysis of Science, Technology and Industry Working Paper* 2009/3, Paris: OECD
- Su B, Huang HC, Ang BW, Zhou P (2010) Input-output analysis of CO2 emissions embodied in trade: The effects of sector aggregation, *Energy Economics*, 32: 166-175