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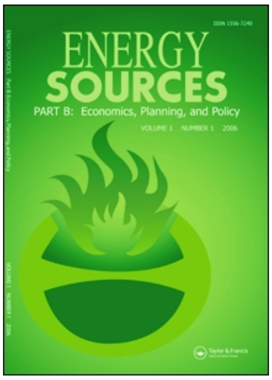

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Assessing drivers of energy consumption and progress towards energy targets in Italy

Abstract

The objectives of this study are to provide new insights on (i) the drivers of changes in final energy consumption in Italy over the period from 1995–2015 by employing a multi-sectoral decomposition analysis approach—Logarithmic Mean Divisia Index I (LMDI-I); and (ii) the progress of Italy towards the indicative energy efficiency and mandatory energy-saving targets set for 2020.

The decomposition results show that from 1995 to 2015, an increase in final energy consumption caused by activity effects has been almost totally offset by structural changes. Energy intensity improvements occurred during the period from 2006 to 2015 when most of the energy efficiency policies in Italy were implemented.

However, unlike the *ex ante* estimates of energy savings reported by the Italian government, the LMDI-I analysis shows that Italy is not on track to achieve the 2020 energy efficiency and energy saving targets. Challenges and opportunities in policymaking are discussed.

Keywords: energy efficiency; energy saving; energy consumption; Index Decomposition Analysis; LMDI; Italy.

1. Introduction

As global interest in reducing CO_2 emissions, energy dependence, and energy costs continues to rise, there is a growing need for policies aimed at stimulating energy efficiency investments. The underlying assumption is that greater energy efficiency reduces energy demand and related CO_2 emissions, which, in turn, lower the burden of energy costs by using less energy to provide the same service and contribute to improved energy security by reducing dependence on foreign energy sources (Sorrell 2015). In addition, the 'multiple benefits' framing of energy efficiency (e.g., health and well-being, poverty alleviation) expand the range of benefits traditionally associated with energy efficiency, and thereby increase its role in policymaking (Fawcett and Killip 2019; Ryan and Campbell 2012). These benefits of energy efficiency have been acknowledged by the European Union, who has committed itself to "Efficiency First" as a fundamental principle applied to policymaking, planning and investment in the energy sector (European Commission 2016a).

To keep track of progress on energy efficiency, its contribution to reducing energy consumption, and the impact and effectiveness of energy efficiency policies, many governments have set energy efficiency and saving targets. At the EU level, under the Energy Efficiency Directive 2012/27/EU (EED), each Member State was required to set up concrete measures in the third NEEAP (National Energy Efficiency Action Plan) to achieve its own indicative national energy efficiency target (Article 3) and minimum cumulative end-use energy-saving target (Article 7) for 2020 (Economidou et al. 2018; Bertoldi et al. 2015; European Parliament 2012). To measure progress towards the mandatory energy-saving target (2014-2020), EU Member States rely on *ex ante* engineering estimates of expected energy savings induced by specific policy measures aimed at improving energy efficiency. However, the energy savings that are realized in practice due to energy efficiency improvements generally fall short of these *ex ante* engineering estimates. Several studies indicate that engineering calculations may be prone to overstating the energy savings from energy efficiency investments because they cannot account for rebound effects and other behavioral adjustments or implementation challenges, leading to less energy savings than would be expected (Gillingham et al. 2018; Valentová et al. 2018; Gillingham and Palmer 2014; Sorrell 2007). In addition, the principle of 'additionality' on which these calculations are based on – counting only the energy savings that are effectively additional as a consequence of specific policy interventions – raise further concerns regarding their reliability due to the difficulties of avoiding double-counting issues (e.g., actions that are counted twice under the same measure or actions receiving incentives from two different measures - Labanca and Bertoldi 2016), and potential complementarities or trade-offs with other national, regional, and local policy measures or technology and market developments.

On the other hand, the national indicative energy efficiency target (2011-2020) is not based on absolute energy savings, but on a theoretical portion of future energy consumption, which differs from a scenario in which no measure supporting energy efficiency is implemented over the period 2011-2020; therefore, a reduction of energy use is assumed to be driven by existing and planned energy efficiency policies. However, while achieving efficiency typically means saving energy, the opposite is not necessarily true; the reduction in energy consumption in the chemical industry, for example, might be because of decreased economic activity and not as a result of energy efficiency interventions.

Against this background, the objectives of this study are to provide new insights on (i) the causes of variation in final energy consumption in Italy from 1995 to 2015, by employing a multi-sectoral decomposition analysis approach using the Logarithmic Mean Divisia Index I (LMDI-I); and (ii) the progress of Italy towards the indicative energy efficiency and mandatory energy-saving targets set for 2020.

The advantage of the *ex post* decomposition analysis is that it disentangles and separates variations in actual energy consumption over time into changes of economic activity, structure, and energy intensity across multiple sectors and sub-sectors/end-uses (Ang and Wang 2015; Ang 2015; 2005). By isolating the changes in energy intensity (at a disaggregated level) from other factors affecting changes in energy consumption, it is possible to account for all the energy efficiency-related factors that have influenced energy savings. These measures of intensity closely approximate changes in the underlying efficiency of energy use (Goh and Ang 2018; Xu and Ang 2014), and can be assessed against progress towards the national energy efficiency and energy-saving targets.

Other than the cross-country comparison analyses at the EU level (Trotta 2019; Reuter et al. 2018; Economidou 2017; González 2015; Obadi and Korček 2015; González et al. 2014; Marrero and Ramos-Real 2013) and the international level (IEA 2018; Voigt et al. 2014), there are no LMDI-I decomposition studies that investigate the drivers of change in energy consumption over a long time period in the specific case of Italy. In addition, to the best of the author's knowledge, this is the first study that quantifies the energy savings in Italy to track the progress towards the 2020 energy targets and that assesses the estimates reported by the Italian government to the European Commission (EC). Unlike most previous studies, which employed decomposition analysis to assess economy-wide energy efficiency trends (e.g. Román-Collado and Colinet 2018; Xu et al. 2017; Carmona and Collado 2016; Kim and Heo 2016; Winyuchakrit and Limmeechokchai 2016a; Winyuchakrit and Limmeechokchai 2016b; Yilmaz and Atak 2010; Ma and Stern 2008), in this study, the calculated energy savings with LMDI-I are used to provide a more accurate indication of the actual progress towards the national energy targets and the sectoral impacts of energy efficiency policies.

Italy is an interesting case to analyze as it is one of the most energy-consuming (Eurostat 2018a), dependent on imported fossil fuels (Eurostat 2018b), and polluting EU Member States

(Eurostat 2018c), with one of the highest final electricity (Eurostat 2018d) and gas prices (Eurostat 2018e). Despite its energy-related structural problems, according to many commentators, Italy has become a leader in the domain of energy efficiency. In the 2018 State of Energy Efficiency Report of the American Council for an Energy-Efficient Economy (Berg et al. 2018), which evaluated the energy efficiency policies and performance of the world's top energy-consuming countries using 36 metrics spread over four categories (buildings, industry, transportation, and overall national energy efficiency), Italy, together with Germany, is ranked first. Additionally, the main Italian energy efficiency policy measures, namely, the White Certificate and tax deduction schemes, are often mentioned as best practices at the EU and international levels (IEA 2018; Trotta et al. 2018; European Commission 2017; Tromop 2017; Oikonomou et al. 2012) because of their ability to promote both easy and complex projects (Association Technique Energie Environnement 2015) and to spread the culture of energy efficiency at local levels (IEA 2014). In addition to market-based instruments, the 2018 IEA's integrated metric – the 'Efficiency Policy Progress Index' – indicates that in recent years, Italy has registered significant increases in the coverage and strength of mandatory energy efficiency policies (IEA 2018). However, while these metrics are informative and enable comparisons across countries, they are unable to quantify the impacts of policies.

The results of this study will inform policy-makers about trends and where to prioritize efforts to improve energy efficiency if the energy targets are to be met. Identifying the types and levels of causation influencing energy consumption is crucial for targeting future energy efficiency measures that have a greater impact.

This work provides a number of novel findings. First, from 1995 to 2015, an increase in final energy consumption caused by activity effects has been almost totally offset by structural changes. Energy intensity improvements contributed to reduce energy consumption during the period 2006-2015, when the majority of the energy efficiency policies in Italy were implemented; however, savings in the industrial, passenger transport, and agricultural sector have been partially counterbalanced by energy intensity increases in the freight transport, services, and residential sectors. Second, despite the relative effectiveness of the implemented energy efficiency policies in reducing energy consumption, the decomposition results indicate that Italy is not on track to meet the energy saving and efficiency targets set for 2020.

The paper is structured as follows: Section 2 describes the data and empirical strategies used for the Italian case study; Section 3 shows the empirical results, in which the causes of variation in final energy consumption and the progress towards the energy efficiency and energy savings targets are examined; and Section 4 presents the conclusions.

2. Material and Methods

The dataset is composed of the final energy consumption by sector (industry, transport, residential, services, agricultural) and sub-sector/end-use (e.g., chemical industry, cars, water heating, etc.) of Italy, the number of households, the floor area of dwellings, passengers and freight traffic data, the stock of dwellings permanently occupied, and the stock of large appliances. The data cover the period from 1995 to 2015. The primary data source is the Odyssee database (2018). Odyssee data are complemented with data on the value added taken from the World Bank (The World Bank, World Development Indicators 2018a; 2018b; 2018c; 2018d). Descriptive statistics are provided in Table 1.

Table 1. Descriptive statistics.

Variables	Unit[1]	N (years)	Mean	Std Dev	Min	Max
Total final energy consumption	Mtoe	21	118.5	7.5	108.2	129.2
Final consumption industry	Mtoe	21	34.4	5.1	25.3	40.2
Chemical	Mtoe	21	5.2	1	3.3	6.6
Primary metals	Mtoe	21	7.3	1	5.3	8.4
Non-metallic minerals	Mtoe	21	7	1.4	4.5	8.9
Paper, pulp and printing	Mtoe	21	2.5	0.2	2	2.9
Food	Mtoe	21	3.1	0.4	2.7	3.8
Textile and leather	Mtoe	21	2.0	0.6	1.1	2.7
Machinery	Mtoe	21	4.6	0.6	3.7	5.3
Mining	Mtoe	21	0.2	0	0.1	0.2
Construction	Mtoe	21	0.2	0.1	0.2	0.4
Other industries	Mtoe	21	2.2	0.5	1.5	2.9
Final consumption transport	Mtoe	21	37	2	33	40
Passenger transport	Mtoe	21	23.6	1.9	20.1	25.6
Cars	Mtoe	21	21.4	1.9	17.8	23.5
Buses	Mtoe	21	1.2	0	1.1	1.3
Rail transport of passenger	Mtoe	21	0.3	0	0.3	0.4
Domestic air transport	Mtoe	21	0.7	0.1	0.5	0.8
Passenger traffic	Gpkm	21	845.3	53.4	750.4	943.5
Car traffic	Gpkm	21	681.4	48.9	578.7	768.3
Road traffic for public modes	Gpkm	21	98.0	5.4	87.1	103
Rail passenger traffic	Gpkm	21	53.0	3.5	46.7	59.5
Domestic air traffic	Gpkm	21	12.8	3.4	7.1	17.8
Transport of goods	Mtoe	21	13.4	1.6	10.5	16.3
Trucks & light vehicles	Mtoe	21	12.2	1.3	10	14.7
Rail transport of goods	Mtoe	21	0.2	0	0.2	0.3
Inland waterways transport	Mtoe	21	1.1	0.3	0.2	1.4
Traffic of goods	Gtkm	21	192.6	29.2	137.6	236.6
Road goods traffic	Gtkm	21	169.4	27.2	116.8	211.8
Rail goods traffic	Gtkm	21	23.2	2.7	18.6	27.4
Inland waterways goods traffic	Gtkm	21	43960.6	6972.8	32517	53852
Final consumption residential	Mtoe	21	29.7	2.7	24.5	33.3
Space heating climate corrected	Mtoe	21	22.0	2.4	17.3	25.3
Water heating	Mtoe	21	3.9	0.1	3.5	4.2
Cooking	Mtoe	21	1.8	0.2	1.5	2.0
Air cooling	Mtoe	21	0.1	0	0	0.2
Large appliances	Mtoe	21	2.0	0.1	1.7	2.1
Number of households	k	21	23111.3	1512.4	20755.1	25078.7
Floor area of dwellings (average)	m^2	21	94.9	0.8	93	96
Stock of dwellings permanently occupied	k	21	22784.9	1359.7	20736	24577.9
Stock of large appliances	k	21	60764.8	7955.1	47531.3	71352.3
Final consumption services	Mtoe	21	14.3	2.5	10.2	17.6
Final consumption agriculture	Mtoe	21	3.1	0.2	2.6	3.3
Gross value added	KD	21	1.9E+12	8.9E+10	1.7E+12	2.0E+12
Services value added	KD	21	1.3E+12	7.7E+10	1.2E+12	1.4E+12
Agriculture value added	KD	21	3.8E+10	1.2E+09	3.5E+10	4.0E+10
Industry value added	KD	21	4.8E+11	3.0E+10	4.3E+11	5.3E+11

[1] 'Mtoe' - Million tons of oil equivalent; 'Gpkm' - Gigapassenger-kilometre or 10^9 passenger-kilometre; 'Gtkm' - Gigatonne-kilometre or 10^9 tonne-kilometre; 'k' - thousand; 'm^2' - square meters; 'KD' - constant 2010 US$.

The Logarithmic Mean Divisia Index I (LMDI-I) decomposition approach in the additive form is employed to estimate the drivers of variation in the final energy consumption of Italy from 1995 to 2015. Among all the different decomposition methods developed in the last years, the Logarithmic Mean Divisia Index I (LMDI-I), and especially the LMDI-I in the additive form, presents several advantages, and it is therefore used in this study. In particular, the LMDI-I is the only method that possesses all the desirable properties of a good index number (Goh and Ang 2018; Ang and Wang 2015; Xu and Ang 2014; Ang 2015; 2005; 2004): (i) perfect in decomposition (passing the time and factor-reversal tests in index number theory whereby the results obtained do not contain a residual term); (ii) consistent in aggregation (allowing aggregation of results for sub-groups to a higher level of aggregation in a consistent manner); (iii) high degree of adaptability (e.g., time-series analysis, cross-country comparisons, etc.); (iv) ease of use (due to its relative simple formulae); and (v) ease in result interpretation (by eliminating the unexplained residuals, the complexity in result explanation is reduced).

The decomposition analysis separates and quantifies the impacts of the individual factors ('effects') of changes in economic activity, structure, and energy intensities on the final energy consumption (Ang 2015; 2005) in each sector and sub-sector/end-use of Italy from 1995 to 2015. The three main factors resulting from the decomposition analysis are: (i) activity, that is, the basic human or economic actions that drive energy use in a particular sector (e.g., the value-added output in the industrial or service sectors); (ii) structure, which reflects the mix of activities within a sector that can affect how energy is used (e.g., the share of production represented by each sub-sector of industry); and (iii) intensity, which represents the energy use per unit of specific activity (e.g., the ratio between the energy consumption and the floor area in the residential sector for space heating). To make full use of the time-series data and to investigate year-to-year changes, chaining decomposition (i.e., from 1995 to 1996, from 1996 to 1997, from 1997 to 1998, and so on) is preferred to non-chaining decomposition (from 1995 to 2015 - 'period-wise').

Table 2 illustrates the data employed in the decomposition analysis. For each sector and/or sub-sector/end-use an indicator for 'activity', 'structure', and 'intensity' is constructed[2].

Table 2: Data and indicators included in the LMDI-I analysis.

Sector	Sub-sector/End-use	Activity	Structure	Intensity
Industry	Chemical	Gross value added	Share of value added	Energy/value added
	Primary metals			
	Non-metallic minerals			
	Paper, pulp and printing			
	Food			
	Textile and leather			
	Machinery			
	Mining			
	Construction			
	Other industries			
Transport	**Passenger transport**			
	Cars	Passenger kilometre	Share of passenger-kilometres	Energy/passenger-kilometre
	Buses		Share of passenger-kilometres	Energy/passenger-kilometre
	Rail transport of passenger		Share of passenger-kilometres	Energy/passenger-kilometre
	Domestic air transport		Share of passenger-kilometres	Energy/passenger-kilometre
	Freight transport			
	Trucks & light vehicles	Tonne kilometre	Share of tonne-kilometres	Energy/tonne-kilometre
	Rail transport of goods		Share of tonne-kilometres	Energy/tonne-kilometre
	Waterways goods traffic		Share of tonne-kilometres	Energy/tonne-kilometre
Residential	Space heating climate corrected	Number of Households	Floor area/number of households	Energy/floor area
	Water heating		Occupied dwellings/number of households	Energy/occupied dwelling
	Cooking		Occupied dwellings/number of households	Energy/occupied dwelling
	Air cooling		Floor area/number of households	Energy/floor area
	Large appliances		Appliance stock/number of households	Energy/appliance unit
Services	Services	Gross value added	Share of value added	Energy/value added
Agriculture	Agriculture	Gross value added	Share of value added	Energy/value added

[2] Motorcycles and small appliances are excluded from the analysis due to a lack of data about the passenger kilometre for motorcycles and the stock of small appliances.

With regard to the industrial, services, and agricultural sector, the choice of the gross added value as activity indicator has been driven by the lack of physical activity measures (e.g., consumption per tonne of manufactured products), which are directly linked to the energy used and are not influenced by changes in price (Trotta 2020).

Assuming that V is an aggregate composed of n factors $(x_1, x_2, \dots, x_n)$ and that from period 0 to T the aggregate changes from V^0 to V^T, the objective is to derive the contributions of the n factors to the change in the aggregate, which can be expressed as:

$$\Delta V_{tot} = V^t - V^0 = \Delta V_{x_1} + \Delta V_{x_2} + \ldots + \Delta V_{x_n} \tag{1}$$

$$\Delta V_{x_k} = \sum L\,(V_i^t, V_i^0)\ \ln\,(\frac{x_{k,i}^T}{x_{k,i}^0})$$

where $L(a, b) = (a - b)/(\ln a - \ln b)$ is the logarithmic mean of a and b, and $L(a,a) = a$

The IDA identity can be given by:

$$E = \sum_i E_i = \sum_i Q\,\frac{Q_i}{Q}\,\frac{E_i}{Q_i} = \sum_i Q\,S_i I_i \tag{2}$$

where E is the total energy consumption, Q is the overall activity level, E_i is the energy consumption of sector i, Q_i is the activity level of sector i, S_i is the structure (activity share) of sector i, and I_i is the energy intensity of sector i.

The three explanatory effects in the additive form are calculated as follows:

Activity effect: $$\Delta E_{act} = \sum_i L(E_i^T, E_i^0) \ln(\frac{Q^t}{Q^0}) \quad (3)$$

Structure effect: $$\Delta E_{str} = \sum_i L(E_i^T, E_i^0) \ln(\frac{S_i^t}{S_i^0}) \quad (4)$$

Intensity effect: $$\Delta E_{int} = \sum_i L(E_i^T, E_i^0) \ln(\frac{I_i^t}{I_0^t}) \quad (5)$$

The difference between the total energy consumption in *T* and the total energy consumption in 0 is equal to the sum of the three effects (no residual):

$$\mathrm{E^t - E^0 = \Delta E_{tot} = \Delta E_{act} + \Delta E_{str} + \Delta E_{int}} \quad (6)$$

where $\mathrm{\Delta E_{act}}$, $\mathrm{\Delta E_{str}}$, $\mathrm{\Delta E_{int}}$ denote the absolute changes in final energy consumption between T and 0, due to changes in activity effect, structure effect and intensity effect, respectively.

To analyze the drivers of energy consumption changes in more detail, for the industrial, freight transport, passenger transport, and residential sector, the LMDI-I analysis is conducted at sub-sector/end-use level. The aggregate industrial, freight transport, passenger transport, and residential final energy consumption changes is given by the sum of changes in their sub-sectors or end-uses[3]:

[3] The decomposition is perfect and there is no residual at the aggregate (single-step procedure) and subcategory (step-by-step procedure) levels.

$$\sum_k \Delta E^k_{tot} = \sum_k \Delta E^k_{act} + \sum_k \Delta E^k_{str} + \sum_k \Delta E^k_{int} \tag{7}$$

where k indicates the twelve sub-sectors of the industrial sector (chemical, primary metals, non-metallic minerals, wood, paper, pulp and printing, food, textile and leather, machinery, transport equipment, mining, construction, other industries), the four sub-sectors of the passenger transport sector (cars, buses, rail transport of passenger, domestic air transport), the three sub-sectors of the freight transport sector (trucks and light vehicles, rail transport of goods, waterway goods traffic), and the five end-uses of the residential sector (space heating, water heating, cooking, air cooling, large appliances).

The isolated energy intensity changes in each sector (e.g., industry, transport, and services) and sub-sector/end-use (e.g., chemical industry, rail transport, and water heating) are used as a proxy for energy efficiency improvements. By building up from the disaggregated data and incorporating changes in other explanatory factors, the isolated measures of intensity more closely approximate changes in the underlying efficiency of energy use (Goh and Ang 2018; Xu and Ang 2014). These *ex post* estimates of energy savings account for potential rebound effects and others behavioral responses or implementation challenges that can reduce the expected energy savings from energy efficiency improvements. It should be recognized that, in addition to the above discussed limitations of using monetary instead of physical output data when forming an efficiency metric within the underlying dataset, inaccuracies may be caused by productivity and intra-sector structural changes (for a further discussion on this point see Norman 2017).

To better capture the impact of energy efficiency policies on energy consumption, the period of analysis from 1995 to 2015 is broken down in two period sub-periods (1995-2005 and 2006-2015), where the second sub-period (2006-2015) includes most of the energy efficiency policies implemented in Italy due to the stimulus from the EU to increase energy efficiency and establish a common framework for mutually reinforcing mechanisms (e.g., the Energy End-Use Efficiency and Energy Services Directive 2006/32/EC, the Energy Performance of Buildings Directive 2010/30/EU and 2010/31/EU, the Energy Efficiency Directive 2012/27/EU).

Subsequently, to track the progress towards the mandatory energy saving (Section 3.2) and the national indicative energy efficiency targets (Section 3.3) set for 2020, the calculated energy savings with LMDI-I are compared to the saving estimates reported by the Italian government to the EC and the overall and sectoral targets to be achieved by 2020. By doing so, it is possible to provide a better indication of the actual contribution of energy savings driven by energy efficiency improvements towards the national energy targets and to what extent these savings deviate from values deemed *ex-ante* reported by the Italian government.

3. Results and Discussion

3.1 Drivers of changes in final energy consumption

Table 3 illustrates the contribution of the ‘activity effect’, the ‘structure effect’, and the ‘intensity effect’ to the variation in final energy consumption by all types of end-users, and by each end-use sector in Italy over the period 1995–2015, using the LMDI-I decomposition approach. The year-to-year variations in the final energy consumption (Mtoe) by sector and sub-sectors/end-use from 1995 to 2015 due to the ‘activity effect’, the ‘structure effect’, and the ‘intensity effect’ are shown in the Appendix (Table 4, Table 5, and Table 6, respectively).

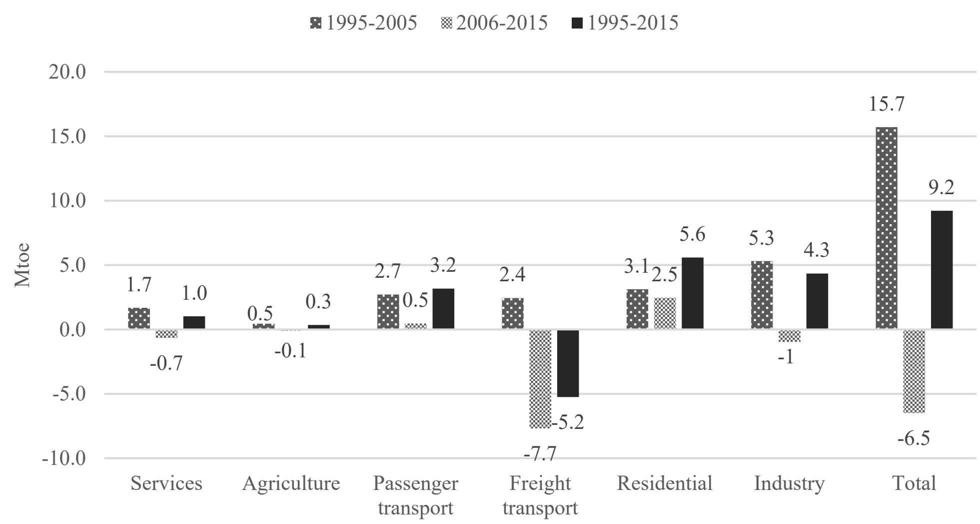
Table 3. Drivers of changes in the final energy consumption of Italy from 1995 to 2015.

Sector	E^0 1995	Activity ΔE_{act}	Structure ΔE_{str}	Intensity ΔE_{int}	E^t 2015	Variation $E^t - E^0$
Total	108.71	9.22	-8.78	-0.04	109.1	0.39
Industry	35.62	4.34	-5.79	-8.67	25.5	-10.12
Chemical	6.65	0.72	-0.88	-3.19	3.29	-3.36
Primary metals	8.34	0.91	-1.2	-2.7	5.34	-3
Non-metallic minerals	6.93	0.88	-1.19	-1.66	4.97	-1.96
Paper, pulp and printing	2.4	0.29	-0.43	0.11	2.37	-0.03
Food	2.78	0.36	-0.54	0.1	2.71	-0.07
Textile and leather	2.46	0.33	-0.3	-1.38	1.11	-1.35
Machinery	4.01	0.54	-0.79	-0.01	3.76	-0.25
Mining	0.15	0.02	-0.03	-0.03	0.11	-0.04
Construction	0.2	0.02	-0.04	0.18	0.35	0.15
Other industries	1.69	0.27	-0.38	-0.09	1.49	-0.2
Residential	24.5	5.58	-4.33	5.67	31.43	6.93
Space heating	17.35	4.13	-4.63	6.85	23.70	6.35
Water heating	3.92	0.73	-0.07	-0.82	3.76	-0.16
Cooking	1.46	0.33	-0.03	0.25	2.02	0.56
Air cooling	0.03	0.02	-0.02	0.12	0.15	0.12
Large appliances	1.75	0.37	0.42	-0.73	1.81	0.06
Passenger transport	24.62	3.17	0.05	-7.53	20.31	-4.31
Cars	22.62	2.92	-0.52	-6.89	18.12	-4.5
Buses	1.2	0.15	0.05	-0.2	1.19	-0.01
Rail passenger transport	0.34	0.04	0.01	-0.1	0.3	-0.04
Domestic air transport	0.46	0.07	0.51	-0.35	0.7	0.24
Freight transport	10.5	-5.24	0.46	7.52	13.24	2.74
Trucks and light vehicles	10.02	-4.76	-0.43	7.32	12.15	2.13
Rail goods transport	0.25	-0.05	0.03	-0.07	0.16	-0.09
Inland waterways transport	0.23	-0.43	0.86	0.27	0.93	0.7
Services	10.22	1.02	0.94	3.74	15.92	5.7
Agriculture	3.25	0.35	-0.13	-0.77	2.7	-0.55

From 1995 to 2015, the final energy consumption of Italy remained almost stable; when compared to the year 1995, the industrial sector reduced its energy consumption by 28.4%, the passenger transport by 17.5%, and the agricultural sector by 16.9% in 2015, while the residential, services, and freight transport sector increased their consumption by 28.3%, 55.8%, and 26.1%, respectively.

The decomposition results show that an increase of 9.22 Mtoe in the final energy consumption caused by activity effects has been almost totally offset by structural changes (-8.78 Mtoe); on the other hand, the contribution of energy intensity improvements to reducing energy consumption has been marginal (-0.04 Mtoe). Nonetheless, the underlying drivers of changes in energy consumption vary significantly according to sector and sub-sector/end-use or the period under consideration. More specifically, with the exception of the freight transport sector, all the sectors registered an increase in energy consumption due to activity effects. However, while the activity effects contributed to a total increase of 15.7 Mtoe from 1995 to 2005, the activity effects driven by the freight transport sector led to a reduction of 6.5 Mtoe from 2006 to 2015 (Figure 1).

Figure 1. Variation in the final energy consumption of Italy by sector among three different periods (1995-2005, 2006-2015, and 1995-2015) due to the 'activity effect'.



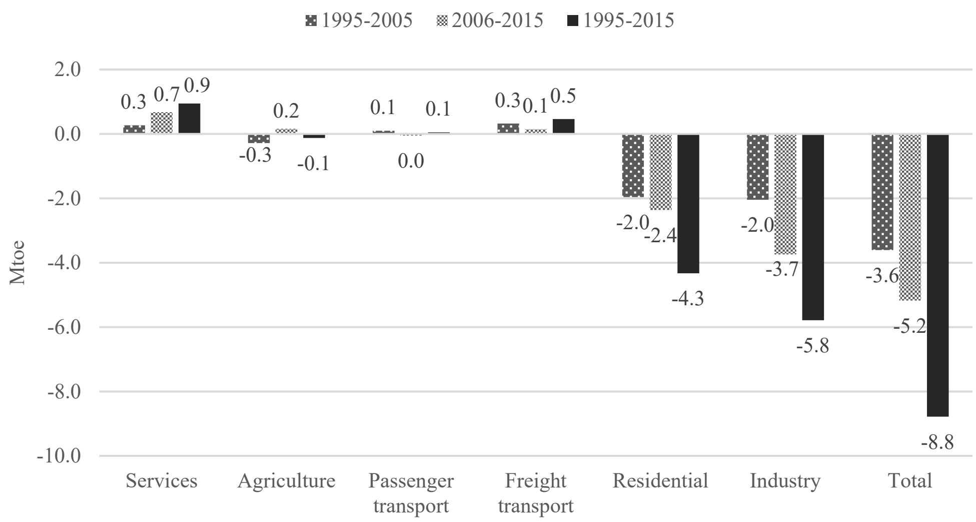
This result can be attributed to the increase in fuel price in Italy that is among the highest in the EU (Directorate-General for Energy, European Commission 2018), and especially the competition of Eastern European truckers, who have a significant lower remuneration and reduced social insurance contributions[4]. As a result, according to the Centro Ricerche

[4] The EU is currently discussing a range of measures to ensure a fair competition between Eastern and Western European countries, and to help to improve drivers' employment conditions. http://www.europarl.europa.eu/RegData/etudes/BRIE/2017/614596/EPRS_BRI(2017)614596_EN.pdf

Continental Autocarro's analysis, which is based on data from the Italian National Institute of Statistics[5], from 2006 to 2015 the road freight transport dropped by 38.1%; the goods transported in 2006 were 24.9 tonnes per person, but were 15.4 tonnes per person in 2015. Compared to the period from 1995-2005, the period of 2006-2015 registered reductions of energy consumption due to activity effects also in the industry, agriculture, services, and passenger transport sector; major reductions were registered in the years 2008-2009 (Appendix, Table 4), reflecting the economic recession of 2008.

Mixed results emerge with regard to the structural effects (Figure 2). From 1995 to 2015, the changes in the share of production represented by each sub-sector of industry and the changes in the share of floor area/stock of dwelling occupied by households led to significant energy savings (10.1 Mtoe). As shown in Figure 3, the declining trend in energy consumption caused by structural changes in the industry and residential sector was more pronounced between 2006-2015 than 1995-2005.

Figure 2. Variation in the final energy consumption of Italy by sector among three different periods (1995-2005, 2006-2015, and 1995-2015) due to the 'structure effect'.



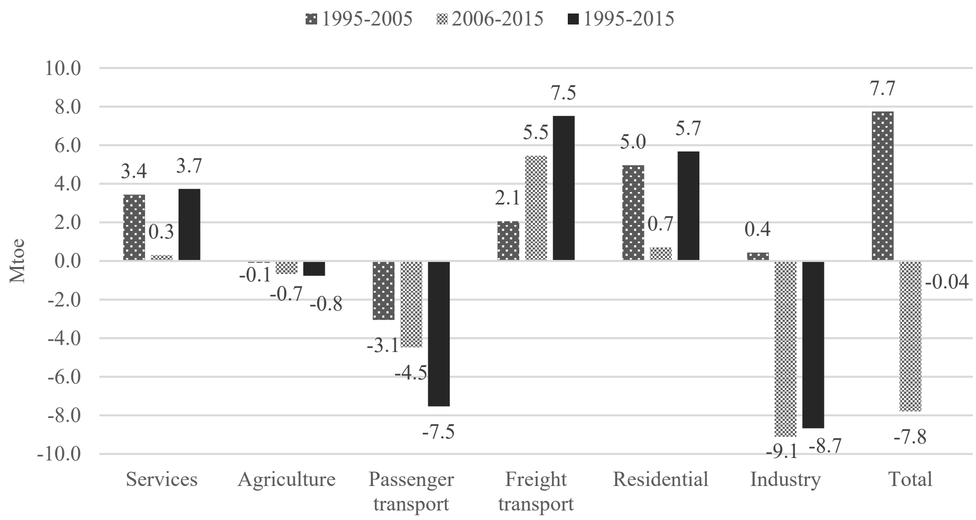
[5] http://www.contitruck.it/2018/02/21/2006-2015-il-trasporto-merci-su-strada-in-italia-e-calato-del-381-2/

On the other hand, an increase of approximately 1 Mtoe from 1995 to 2015 in the services sector due to structural effects can be attributed to the growth of the services value added to the economy by 4.6%. With regard to the freight transport sector, the changes in the shares of tonne-kilometres by roads that saved 0.43 Mtoe were counterbalanced by changes in the shares of tonne-kilometres by waterways, which increased energy consumption by 0.86 Mtoe (Appendix, Table 5).

The energy intensity improvements driven by the industrial (-8.67 Mtoe), the passenger transport (-7.53 Mtoe), and (in minor part) the agricultural sector (-0.77) have been counterbalanced by energy intensity increases of the freight transport (7.52 Mtoe), residential (5.67 Mtoe), and services sector (3.74 Mtoe). In all categories, without the energy intensity improvements that occurred between 1995 and 2015, the energy consumption in 2015 would have been almost the same. However, without the energy intensity improvements that occurred between 2006 and 2015, the energy consumption in 2015 would have been 7.1% higher.

Although it is not possible to indicate mechanical causalities between energy intensity improvements and specific policy interventions, the highest energy reductions due to energy intensity improvements were achieved during the period from 2006-2015 when the most important pieces of legislation in the energy efficiency domain were implemented – e.g., Legislative Decree 192/05, Thermal Account, White Certificates, and tax deductions (for further discussion on this point, please see Section 3.2 and Section 3.3). This is particularly evident for the industrial sector: from 1995 to 2005, energy intensity increased energy consumption by 0.4 Mtoe, while energy intensity reduced energy consumption by 9.1 Mtoe from 2006 to 2015 (Figure 3).

Figure 3. Variation in the final energy consumption of Italy by sector among three different periods (1995-2005, 2006-2015, and 1995-2015) due to the 'intensity effect'.



Alongside the industrial sector, compared to the period from 1995-2005, the services, agriculture, passenger transport, and residential sectors reduced their energy intensity during the period from 2006-2015, although in the case of the services and residential sector the energy intensity reductions did not lead to energy savings[6].

Between 2006 and 2015, the freight transport sector represented an exception to these positive energy intensity trends, and the increase in energy intensity resulted in 5.5 Mtoe of energy consumption. One possible explanation of this result can be found in the obsolescence of heavy/medium and light trucks. According to the latest European Automobile Manufacturers Association (2017) report, in 2015, the average age of heavy and medium vehicles used for transporting goods in Italy was 13.2 years, well above the EU average (11.7) and the average age of trucks used by major European Member States such as Germany (8.0), France (7.5), and

[6] Compared to the study of Economidou (2017) reporting savings of 9.5 Mtoe over the period 2005-2015, in this study, the results indicate that (from 2005 to 2015) energy intensity reduced energy consumption by 6.7 Mtoe (Appendix, Table 6).

the United Kingdom (8.8); similarly, the average age of light vehicles used for transporting goods in Italy was 11.9, above the EU average (10.7) and the light vehicles fleet used in Germany (7.3), France (8.3), and the United Kingdom (8.5). Along with the vehicle intensities of trucks by age and size, the overall energy intensity of truck freight can also be determined by the relative utilization of each kind of vehicle, speed limits, fuel choices, road conditions, driving behaviors, and loading levels (Ruzzenenti and Basosi 2017). The lower (and reduced) energy intensity in the rail transportation of goods, for example, can partially be attributed to the overall larger loads of the trains compared to those of the trucks (Schipper et al. 1997).

3.2 Progress towards the mandatory energy-saving target

Pursuant to Article 7 of the Energy Efficiency Directive (EED) 2012/27/EU, the minimum cumulative end-use energy-saving target to be achieved over the period from 2014-2020 is based on 1.5% annual savings averaged to the final energy sales – with the exclusion of the transport energy consumption – over the three-year period from 2010-2012. In accordance with Article 7(2) of the EED, Italy made use of two exemptions, the 'early actions'[7] and the 'progressive phasing in of the energy savings' (1% for 2014 and 2015; 1.25% for 2016 and 2017; and 1.5% for 2018, 2019, and 2020), which reduced the original target by 25%. As a result, the minimum cumulative end-use energy saving target to be achieved in Italy over the period 2014-2020 is equal to 25.5 Mtoe (Ministry of Economic Development, Directorate-General for the electricity market, renewable energy, energy efficiency and nuclear energy 2014).

[7] Energy savings resulting from individual actions newly implemented since 31 December 2008 that continue to have an impact in 2020 and that can be measured and verified.

To deliver the energy-saving target, Italy relies on three policy measures: the White Certificates, the Thermal Account, and the tax deductions (Ministry of Economic Development, Directorate-General for the electricity market, renewable energy, energy efficiency and nuclear energy 2014). The White Certificates represent a financial and tradable instrument attesting to the achievement of end-use energy savings through energy efficiency improvement initiatives and projects mostly in industry but also in the residential and services sectors. The White Certificate scheme was enacted in 2005 and was imposed on electricity and gas distributors (DSOs) with more than 100,000 users connected to their grid (from 2008, the obligated parties' threshold was 50,000 users). Each year, these parties are required to deliver a number of certificates proportionate to the energy they distribute. From 2014 to 2020, the White Certificate scheme is expected to deliver 16 Mtoe of final energy savings (0.5 Mtoe in 2014, 1.1 Mtoe in 2015, 1.8 Mtoe in 2016, 2.1 Mtoe in 2017, 2.7 Mtoe in 2018, 3.5 Mtoe in 2019, and 4.3 Mtoe in 2020), corresponding to 62.7% of the mandatory energy-saving target.

The Thermal Account (Legislative Decree No 28/2011) is an incentive scheme for projects of energy efficiency improvements and the generation of small-scale renewable thermal energy in buildings that was enacted in July 2013. The scheme is addressed to both public administrations and non-industrial private parties (i.e., individuals, apartment block owners, housing cooperatives, and parties with business or agricultural income). It covers up to 65% of the total expense incurred by the eligible beneficiaries and is paid out in annual instalments for a period from 2 to 5 years according to the actions implemented. From 2014 to 2020, the Thermal Account is expected to save 5.88 Mtoe of final energy (0.21 Mtoe in 2014, 0.42 Mtoe in 2015, 0.63 Mtoe in 2016, 0.84 Mtoe in 2017, 1.05 Mtoe in 2018, 1.26 Mtoe in 2019, and 1.47 Mtoe in 2020), corresponding to 23% of the mandatory energy-saving target.

Lastly, tax deductions for building-based energy upgrades were introduced in Italy by the Budget Law 2007 and are still in force. They are mainly targeted at the residential sector and offer the possibility of deducting from IRPEF (personal income tax) and IRES (corporate income tax) for actions needed to improve the energy efficiency of existing buildings. The tax deduction rate varies from 50 to 85% depending on the type of intervention. From 2014 to 2020, the tax deduction scheme is expected to save 3.92 Mtoe of final energy (0.14 Mtoe in 2014, 0.28 Mtoe in 2015, 0.42 Mtoe in 2016, 0.56 Mtoe in 2017, 0.7 Mtoe in 2018, 0.84 Mtoe in 2019, and 0.98 Mtoe in 2020), corresponding to 15.3% of the mandatory energy-saving target.

The sum of the expected savings by policy measure (the White Certificates, the Thermal Account, and the tax deductions) is 27 Mtoe, which is slightly above the minimum cumulative end-use energy saving target (25.5 Mtoe). As explained in the methodology reported to the EC (Ministry of Economic Development, Directorate-General for the electricity market, renewable energy, energy efficiency and nuclear energy 2014), the savings of each action benefitting from the tax deduction scheme and the Thermal Account are calculated against expected savings based on the preliminary savings calculation afforded by similar technologies applied in equivalent contexts. With regard to the White Certificates, the savings are calculated for three types of projects: standard, analytical, and with *ex post* calculation. Standardised evaluation is performed with reference to technical data sheets that preliminarily set out the specific saving of the single reference physical unit. For the analytical projects, the savings achieved are obtained analytically by means of standardised methodological sheets; in this case, the algorithm is fed by few parameters characterising the operating and energy-consumption status of the equipment covered by the action. However, in the standardised method, the saving certified the first year is maintained over time, and in the analytical method, the saving must be recalculated each year using the parameter values submitted by the applicant. In the case of complex projects, for which no pre-set methodologies are available, all parameters are measured by means of an ad hoc measurement programme.

According to the 2018 annual report on energy efficiency (Ministry of Economic Development, Directorate-General for the electricity market, renewable energy, energy efficiency and nuclear energy 2018), Italy is perfectly on track to meet the cumulative end-use energy-saving target. Although the specific contribution of each policy measure to final energy savings is slightly different from the expected savings (the White Certificates and tax deductions delivered more savings than expected, while the Thermal Account produced less), the overall sum of the reported savings of the three policy measures is equal to the cumulative end-use energy-saving target for the years 2014-2015.

In line with a Finnish study (Trotta 2020), the estimates of the LMDI-I analysis are lower than what was reported by the government to the EC. For the years 2014-2015 the Italian government reported final energy savings of 2.646 Mtoe, while the LMDI-I analysis indicates savings for 1.952 Mtoe, which correspond to approximately 30.2% less than the estimates provided by the Italian government. Unlike the estimates reported by Italian government and the 'progressive phasing-in' requirement of Article 7, the results of the LMDI-I analysis show that the final energy savings driven by energy efficiency improvements have not been incremental and have been subject to significant fluctuations in the period (and sectors) under consideration. Table 7 compares the energy savings reported by policy measure in the annual report on energy efficiency (2018) over the years 2014-2015 with the energy savings by end-use sectors calculated with LMDI-I.

Table 7. Comparison of mandatory savings (Mtoe) reported in the annual report on energy efficiency and the LMDI-I estimates (2014-2015).

Annual report on energy efficiency 2018 (Mtoe)				**LMDI-I analysis (Mtoe)**			
Policy measure	**2014**	**2015**	**Total 2014-2015**	**End-use sector**	**2014**	**2015**	**Total 2014-2015**
White certificates	-0.872	-0.859	-1.731	Industry	-0.265	-0.337	-0.602
Thermal account	-0.003	-0.008	-0.011	Services	-1.315	0.611	-0.704
Tax deductions	-0.306	-0.597	-0.903	Residential	-1.392	0.935	-0.457
				Passenger transport	0.190	-1.718	-1.528
				Freight transport	1.402	0.076	1.478
				(Transport)	(1.592)	(-1.642)	(-0.05)
				Agriculture	-0.101	-0.038	-0.139
Total	-1.181	-1.465	-2.646	Total[8]	-1.481	-0.471	-1.952

In 2014, energy efficiency improvements delivered 1.481 Mtoe of final energy savings (LMDI-I), which is slightly above what was reported by the Italian government (1.181 Mtoe). Major final energy savings were achieved in the residential and services sectors. Conversely, in 2015, the energy savings calculated with the LMDI-I are significantly lower than the savings of the year 2014 and what was claimed by the Italian government. This is mainly because energy efficiency improvements did not continue to deliver savings in the services and residential sectors. On the other hand, most of the energy savings achieved in 2015 were driven by the passenger transport sector and offset inefficiencies in the freight transport sector. Overall, the services sector contributed to 36% of the final energy savings achieved during the period 2014-2015, followed by the industrial sector (30.8%), the residential sector (23.4%), the agricultural sector (7.1%), and the transport (both passenger and freight) sector (2.6%). During 2014-2015, only 13.1% of the 2020 mandatory energy-saving target was achieved.

[8] By excluding the end-use sectors not directly targeted by energy efficiency policies (passenger and freight transport sectors) from the comparison of mandatory savings reported in the annual report on energy efficiency and the LMDI-I estimates, the overall results do not change in any significant way.

3.3 Progress towards the indicative energy efficiency target

In accordance with Article 3 of the EED transposed by the Legislative Decree No. 102 of 2014, the indicative energy efficiency target set for 2020 is equal to 15.5 Mtoe of final energy savings and 20.05 Mtoe of primary energy savings (Italy's Third National Energy Efficiency Action Plan 2014).

The indicative energy efficiency target is the sum of the individual estimations of energy savings at the sectoral level induced by existing and planned policies and measures from 2011 to 2020. In addition to the White Certificates, Thermal Account, and tax deductions (see Section 3.2), other energy savings are expected from the Legislative Decree 192/05 (which involve the insulation of building envelopes, the replacement of doors and windows, screening elements, and more), and other measures such as replacement of large domestic appliances, high-speed transportation, and emission performance standards for new passenger cars (Regulation (EC) No. 443/2009) and new light commercial vehicles (Regulation (EU) No. 510/2011) - Italy's Fourth National Energy Efficiency Action Plan 2017.

A reduction in final energy consumption of approximately 29% is predicted compared to the PRIMES 2007 'business as usual' (BAU) scenario that simulates a market equilibrium solution for energy supply and demand in 2020 under the assumption that no measure supporting energy efficiency is implemented over the period 2011-2020 (Italy's Fourth National Energy Efficiency Action Plan, 2017). The contribution of each sector to the achievement of the energy efficiency target for 2020 has been determined as follow (Ministry of Economic Development, Directorate-General for the electricity market, renewable energy, energy efficiency and nuclear energy 2018): the transport sector is expected to be the largest contributor to the target, representing 35.5% of the final energy savings in 2020, followed by the industrial sector (32.9%), the residential sector (23.7%) and the service sector (7.9%).

From 2011 to 2015 the final energy savings due to energy efficiency improvements claimed by the Italian government were 5.01 Mtoe, corresponding to 32.3% of the target set for 2020. Almost half of these savings were achieved in the residential sector (44.7%), 31.3% in the industrial sector, 21% in the transport sector, and only 3% in the service sector (The Italian National Energy Efficiency Agency 2016).

However, as in the case of the mandatory energy savings during 2014-2015, the results reported by the Italian government to track the progress towards the indicative energy efficiency target for the period 2011-2015 significantly deviate from the LMDI-I estimates of energy savings (Table 8).

Table 8. Comparison of progress towards the 2020 energy efficiency target reported in the energy efficiency annual report and the LMDI-I estimates (2011-2015).

Italy's energy efficiency annual report (Mtoe)										LMDI-I analysis 2011-2015 (Mtoe)			
End-use sector	White certificates	Tax deductions	Thermal account	Legislative Decree 192/05	Measures transport sector	Other measures	Total 2011-2015	Expected for 2020	Achieved target (%)	End-use sector	Total 2011-2015	Expected for 2020	Achieved target (%)
Industry	-1.468	-0.025	-	-0.076	-	-	-1.57	-5.1	30.8%	Industry	-3.109	-5.1	61%
Services	-0.101	-0.013	-0.0008	-0.036	-	-	-0.15	-1.23	12.2%	Services	-1.468	-1.23	119.3%
Residential	-0.417	-1.066	-	-0.685	-	-0.0019	-2.24	-3.67	61.1%	Residential	-0.776	-3.67	21.1%
Transport	-	-	-	-	-1.01	-0.038	-1.05	-5.5	19.1%	Transport	3.43	-5.5	-62.4%
										(Passenger transport)	(-1.451)	-	-
										(Freight transport)	(4.881)	-	-
										Agriculture	-0.314	-	-
Total	-2.04	-1.104	-0.0008	-0.797	-1.01	-0.057	-5.01	-15.5	32.3%	Total	-2.24	-15.5	14.5%

The results of the LMDI-I analysis show that from 2011 to 2015, the final energy savings driven by energy efficiency improvements were 2.24 Mtoe, corresponding to 14.5% of the indicative energy efficiency target set for 2020, which is less than half than what was reported by the Italian government. Major savings came from the industrial sector (3.109 Mtoe) and the services sector (1.468 Mtoe), while the residential sector contributed marginally (0.776 Mtoe). Mixed results emerge with regard to the transport sector: the final energy savings in the passenger transport sector (-1.451 Mtoe) have been cancelled out by energy intensity increases of the freight transport that led to higher energy consumption (4.881 Mtoe). In light of the expected major contribution of the transport sector to reducing energy consumption, this result is particularly worrisome. During the period from 2011-2015, the transport sector is the only sector in which energy intensity increased energy consumption due to the inefficiencies in the freight vehicles fleet in use.

When the energy savings estimated with the LMDI-I are compared with the expected energy savings for each sector, the results indicate that the services sector has already surpassed its target, the industrial sector is well on track, the residential sector achieved 21.1% of the expected savings, and the transport sector is very far from meeting its target.

4. Conclusions

Measuring progress on energy efficiency, its contribution to reducing energy consumption, and the impact and effectiveness of energy efficiency policies, is complex, especially in large-scale process. At the national level in EU Member States, the indicative energy efficiency and the minimum cumulative end-use energy-saving targets are measured against model-based scenarios and *ex ante* engineering estimates, respectively, which might provide inaccurate indications of the actual energy savings delivered by energy efficiency. This is because the former is assessed as reduction in final energy consumption exclusively induced by existing and planned policy measures - without accounting for the other factors (activity and structural changes) influencing the variation in final energy consumption - and the latter is assessed as *ex ante* engineering estimates of expected energy savings induced by specific policy measures, thus missing rebound effects and other behavioral adjustments or implementation challenges that lead to less energy savings than would be expected.

To the best of the author's knowledge, this is the first study that identifies and quantifies the factors influencing the variation in the final energy consumption of Italy over a long time period (from 1995 to 2015), and that track the progress towards the 2020 energy targets by employing decomposition analysis (LMDI-I) and using disaggregated data. In particular, the decomposition analysis shows to what extent the variation in final energy consumption has been driven by changes in the economic activity, structure, and energy intensity of different sectors and sub-sectors/end-uses. The isolated measures of energy intensity are then used to track the progress towards the Italian indicative energy efficiency and mandatory energy-saving targets set for 2020 and compared to the estimates reported by the Italian government. The decomposition results show that an increase in final energy consumption from 1995 to 2015 caused by activity effects has been almost totally offset by structural changes, and that the contribution of energy efficiency improvements to reducing energy consumption has been minimal. However, during the period from 2006-2015, coinciding with the implementation of most of the energy efficiency policies in Italy, the improvements in energy efficiency have been the main driver of final energy savings. Without the energy efficiency improvements that occurred during 2006–2015, the final energy consumption in 2015 would have been 7.1% higher. At the sectoral level, the industrial and passenger transport sectors registered significant energy intensity reductions during 2006-2015; on the other hand, the energy intensity in the residential and services sectors increased energy consumption from 2006 to

2015, although at a slower pace compared to the period from 1995-2005. The energy intensity increases in the truck freight sector have been the main inhibitor to the reduction of energy consumption during the period under investigation.

The progress towards the 2020 national indicative energy efficiency target and the mandatory energy-saving target reported by the Italian government to the EC appear to be overestimated. Specifically, with regard to the mandatory energy-saving target, the Italian government reported incremental energy savings of 2.64 Mtoe for the period 2014-2015, while the LMDI-I analysis indicates non-incremental energy savings of 1.95 Mtoe. Concerning the national indicative energy efficiency target, the Italian government reported saving estimates of 5.01 Mtoe for 2011-2015, while the LMDI-I analysis indicates energy savings of 2.24 Mtoe. Significant differences exist also with respect to the contribution of each sector to the final energy savings: compared to the saving estimates reported by the Italian government, the LMDI-I analysis indicates higher energy savings in the industrial and services sectors, but lower estimates in the residential sector. In contrast with the energy savings (1.05 Mtoe) of the transport sector (both passenger and freight transport) reported by the Italian government, the LMDI-I analysis indicate increased energy consumption (3.43 Mtoe) in the transport sector driven by energy intensity in the freight truck vehicles.

While energy efficiency improvement actions targeting heavy/medium and light trucks such as vehicle efficiency standards, fuel tax, training and information on eco-driving, modality shift, and mobility reduction measures appears to be common sense, they are limited by the current scope of the Article 7 of the EED and its extended scope (2021-2030) under the new Energy Efficiency Directive (European Commission 2016b). As confirmed by recent studies analysing the implementation of the Article 7 in EU Member States (Rosenow and Fawcett 2016; Forster et al. 2015), the possibility to (partially or fully) exclude the energy consumption of the transport sector from the baseline used for target setting undermines the willingness of policy-makers to intensify efforts aimed at improving the energy efficiency in the transport sector.

In addition, the decomposition results indicate opposite energy efficiency trends among the passenger and freight transport sector; and within the freight transport sector, the truck freight vehicles registered significant energy intensity increases, while the energy intensity in the rail freight decreased. Therefore, accounting for differences between the passenger and freight transport sector and their sub-sectors can provide more reliable information.

A strong political commitment is also needed in the residential sector, which accounted for the lion's share of final energy consumption in Italy in 2015, driven by the residential space heating usage. Although during 2006-2015 the energy intensity of space heating was lower than the period from 1995-2005, these relative improvements were not sufficient in delivering energy savings. The tax deduction scheme and more stringent energy efficiency requirements for buildings alone will unlikely be able to keep up with future energy demand and socio-demographic trends such as increased number of single-person households, elderly households, and even improved thermal comfort standards, which are expected to increase total residential space heating demand (Trotta 2018a; Trotta 2018b; Laureti and Secondi 2012; Lindén et al. 2006; Liao and Chang 2002).

Italy, as well as other EU Member States, should reconsider the way the energy savings and the progress towards the energy targets are estimated. An ideal *ex post* evaluation would compare the energy use of participants with the energy use of a counterfactual scenario. However, this method is only accurate in the very unlikely case there are no other factors influencing participants between the 'before' and 'after' energy use measurements (Wade and Eyre 2015). In addition, these large-scale experiments are prevented by data availability, regulatory, institutional, design, and scope constraints that make their use complicated, expensive, and time-consuming (Vine et al. 2014).

Therefore, in order to assess the progress towards the energy targets and the energy savings delivered by energy efficiency policies, an *ex post* LMDI-I analysis of the final energy consumption at sectoral and sub-sectors/end-uses level could be a good compromise between the virtual impossibility to perform large-scale experimental evaluations and the engineering estimates of deemed savings. Instead of estimating the expected energy savings as a direct consequence of a specific policy measure, the energy savings are (i) assessed at the sectoral and sub-sectors/end-uses level to which energy efficiency policies are targeted; (ii) disentangled from some factors influencing the variation in energy consumption, such as activity and structural changes; and (iii) integrated with e.g., rebound effects, free-ridership, implementation challenges, and other factors having an influence on energy efficiency interventions – without accounting for their relative contribution.

This broader perspective, which has recently been applied at the EU level to track progress towards the 32.5% energy efficiency target set for 2030 (Trotta 2019), more fully addresses the complexity of the challenges involved in estimating final energy savings (and their progress) at national level and integrates economic, engineering, and policy insights.

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Declaration of interest statement

The author declares that there is no conflict of interest.

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Appendix

Table 4. Variation in final energy consumption (Mtoe) by sector and sub-sector/end use from 1995 to 2015 due to 'activity effect'.

ACTIVITY EFFECT																						
	1995	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*Total*
TOTAL	*t=0*	1.43	1.46	2.61	0.31	4.66	0.98	0.92	-0.73	3.27	0.79	1.87	1.49	-0.89	-4.91	1.44	-2.85	-4.57	0.53	0.03	1.37	9.22
INDUSTRY	*t=0*	0.46	0.57	0.51	0.55	1.46	0.65	0.13	0.02	0.63	0.33	0.75	0.59	-0.31	-1.84	0.52	0.18	-0.72	-0.41	0.06	0.23	4.34
Chemical	*t=0*	0.08	0.10	0.09	0.09	0.24	0.10	0.02	0.00	0.09	0.05	0.10	0.08	-0.04	-0.26	0.07	0.02	-0.10	-0.06	0.01	0.03	0.72
Primary metals	*t=0*	0.10	0.13	0.11	0.11	0.29	0.14	0.03	0.00	0.13	0.07	0.16	0.13	-0.06	-0.36	0.10	0.04	-0.17	-0.09	0.01	0.05	0.91
Non-metallic minerals	*t=0*	0.09	0.11	0.10	0.11	0.30	0.13	0.03	0.00	0.14	0.07	0.16	0.13	-0.07	-0.40	0.10	0.03	-0.14	-0.08	0.01	0.04	0.88
Paper, pulp and printing	*t=0*	0.03	0.04	0.04	0.04	0.10	0.04	0.01	0.00	0.04	0.02	0.05	0.04	-0.02	-0.14	0.04	0.01	-0.06	-0.03	0.00	0.02	0.29
Food	*t=0*	0.04	0.05	0.04	0.05	0.13	0.06	0.01	0.00	0.06	0.03	0.06	0.05	-0.03	-0.18	0.05	0.02	-0.07	-0.04	0.01	0.02	0.36
Textile and leather	*t=0*	0.03	0.04	0.03	0.04	0.10	0.05	0.01	0.00	0.04	0.02	0.04	0.03	-0.02	-0.09	0.02	0.01	-0.03	-0.02	0.00	0.01	0.33
Machinery	*t=0*	0.05	0.07	0.06	0.07	0.19	0.09	0.02	0.00	0.08	0.04	0.10	0.08	-0.04	-0.26	0.07	0.02	-0.10	-0.06	0.01	0.03	0.54
Mining	*t=0*	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	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Construction	*t=0*	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	-0.01	0.00	0.00	-0.01	-0.01	0.00	0.00	0.02
Other industries	*t=0*	0.02	0.03	0.03	0.03	0.10	0.05	0.01	0.00	0.04	0.02	0.05	0.04	-0.02	-0.14	0.04	0.01	-0.04	-0.02	0.00	0.01	0.27
TRANSPORT	*t=0*	0.53	0.41	1.66	-0.72	2.50	-0.06	0.20	-1.26	1.90	-0.02	0.47	0.13	-0.85	-2.19	0.27	-3.25	-3.96	1.33	-0.11	0.94	-2.07
Passenger transport	*t=0*	0.52	0.40	0.70	0.15	1.99	-0.11	-0.14	0.03	0.22	-1.04	2.10	0.62	-0.82	-0.77	-0.25	-0.83	-2.36	1.15	0.65	0.97	3.17
Cars	*t=0*	0.47	0.36	0.65	0.14	1.83	-0.10	-0.13	0.02	0.20	-0.95	1.91	0.56	-0.74	-0.70	-0.22	-0.74	-2.11	1.02	0.58	0.87	2.92
Buses	*t=0*	0.02	0.02	0.03	0.01	0.09	-0.01	-0.01	0.00	0.01	-0.05	0.10	0.03	-0.04	-0.04	-0.01	-0.05	-0.14	0.07	0.04	0.06	0.15
Rail transport of passenger	*t=0*	0.01	0.01	0.01	0.00	0.02	0.00	0.00	0.00	0.00	-0.01	0.03	0.01	-0.01	-0.01	0.00	-0.01	-0.03	0.02	0.01	0.01	0.04
Domestic air transport	*t=0*	0.01	0.01	0.01	0.00	0.05	0.00	0.00	0.00	0.01	-0.03	0.06	0.02	-0.03	-0.02	-0.01	-0.03	-0.08	0.04	0.02	0.03	0.07
Freight transport	*t=0*	0.02	0.01	0.96	-0.87	0.51	0.05	0.34	-1.28	1.68	1.02	-1.62	-0.49	-0.03	-1.42	0.52	-2.42	-1.60	0.18	-0.76	-0.04	-5.24
Trucks & light vehicles	*t=0*	0.01	0.01	0.88	-0.78	0.45	0.04	0.30	-1.14	1.50	0.91	-1.46	-0.44	-0.03	-1.28	0.47	-2.19	-1.46	0.16	-0.69	-0.03	-4.76
Rail transport of goods	*t=0*	0.00	0.00	0.02	-0.02	0.01	0.00	0.01	-0.02	0.02	0.01	-0.02	-0.01	0.00	-0.02	0.01	-0.03	-0.02	0.00	-0.01	0.00	-0.05
Waterway goods traffic	*t=0*	0.00	0.00	0.05	-0.06	0.05	0.00	0.03	-0.12	0.16	0.09	-0.14	-0.04	0.00	-0.13	0.04	-0.20	-0.12	0.01	-0.06	0.00	-0.43
RESIDENTIAL	*t=0*	0.26	0.26	0.25	0.26	0.14	0.12	0.54	0.50	0.46	0.32	0.29	0.47	0.44	0.30	0.29	0.11	0.59	-0.10	0.03	0.05	5.58
Space heating	*t=0*	0.19	0.19	0.18	0.19	0.10	0.09	0.40	0.37	0.34	0.24	0.21	0.36	0.34	0.22	0.22	0.08	0.43	-0.08	0.02	0.03	4.13
Water heating	*t=0*	0.04	0.04	0.04	0.04	0.02	0.02	0.07	0.07	0.06	0.04	0.04	0.06	0.05	0.03	0.04	0.01	0.07	-0.01	0.00	0.01	0.73
Cooking	*t=0*	0.02	0.02	0.01	0.02	0.01	0.01	0.03	0.03	0.03	0.02	0.02	0.03	0.03	0.02	0.02	0.01	0.04	-0.01	0.00	0.00	0.33
Air cooling	*t=0*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Large appliances	*t=0*	0.02	0.02	0.02	0.02	0.01	0.01	0.04	0.03	0.03	0.02	0.02	0.03	0.03	0.02	0.02	0.01	0.04	-0.01	0.00	0.00	0.37
SERVICES	*t=0*	0.13	0.17	0.15	0.17	0.45	0.21	0.04	0.01	0.22	0.12	0.31	0.25	-0.14	-1.00	0.30	0.10	-0.41	-0.25	0.04	0.14	1.02
AGRICULTURE	*t=0*	0.04	0.05	0.04	0.05	0.12	0.05	0.01	0.00	0.05	0.03	0.06	0.05	-0.03	-0.18	0.05	0.02	-0.07	-0.04	0.01	0.02	0.35

Table 5. Variation in final energy consumption (Mtoe) by sector and sub-sector/end use from 1995 to 2015 due to 'structure effect'.

STRUCTURE EFFECT																						
	1995	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*Total*
TOTAL	*t=0*	-0.35	-0.62	-0.13	-0.39	-0.31	-0.64	-0.37	-0.55	0.05	-0.30	0.22	-0.33	-0.86	-2.19	0.44	-0.55	-1.30	-0.01	-0.53	-0.07	-8.78
INDUSTRY	*t=0*	-0.36	-0.59	-0.18	-0.34	-0.24	-0.43	0.13	-0.25	0.19	0.03	0.61	0.11	-0.64	-3.04	0.67	-0.27	-0.33	-0.38	-0.42	-0.04	-5.79
Chemical	*t=0*	-0.07	-0.11	-0.03	-0.06	-0.04	-0.06	0.02	-0.04	0.03	0.00	0.08	0.02	-0.09	-0.43	0.10	-0.04	-0.05	-0.06	-0.06	-0.01	-0.88
Primary metals	*t=0*	-0.08	-0.13	-0.04	-0.07	-0.05	-0.09	0.03	-0.05	0.04	0.01	0.13	0.02	-0.13	-0.59	0.13	-0.06	-0.08	-0.09	-0.09	-0.01	-1.20
Non-metallic minerals	*t=0*	-0.07	-0.11	-0.03	-0.07	-0.05	-0.09	0.03	-0.05	0.04	0.01	0.13	0.02	-0.14	-0.66	0.13	-0.05	-0.06	-0.07	-0.08	-0.01	-1.19
Paper, pulp and printing	*t=0*	-0.03	-0.04	-0.01	-0.02	-0.02	-0.03	0.01	-0.02	0.01	0.00	0.04	0.01	-0.05	-0.23	0.05	-0.02	-0.03	-0.03	-0.03	0.00	-0.43
Food	*t=0*	-0.03	-0.05	-0.01	-0.03	-0.02	-0.04	0.01	-0.02	0.02	0.00	0.05	0.01	-0.06	-0.29	0.06	-0.02	-0.03	-0.04	-0.04	0.00	-0.54
Textile and leather	*t=0*	-0.02	-0.04	-0.01	-0.02	-0.02	-0.03	0.01	-0.02	0.01	0.00	0.04	0.01	-0.03	-0.14	0.03	-0.01	-0.01	-0.02	-0.02	0.00	-0.30
Machinery	*t=0*	-0.04	-0.07	-0.02	-0.04	-0.03	-0.06	0.02	-0.03	0.03	0.00	0.08	0.01	-0.09	-0.43	0.09	-0.04	-0.04	-0.05	-0.06	-0.01	-0.79
Mining	*t=0*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	-0.03
Construction	*t=0*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.04
Other industries	*t=0*	-0.02	-0.03	-0.01	-0.02	-0.02	-0.03	0.01	-0.02	0.01	0.00	0.04	0.01	-0.04	-0.22	0.05	-0.02	-0.02	-0.02	-0.02	0.00	-0.38
TRANSPORT	*t=0*	0.10	0.04	0.14	-0.08	0.05	-0.15	0.11	0.18	-0.05	0.08	0.01	0.03	0.03	0.40	0.15	-0.20	-0.49	0.20	-0.02	-0.01	0.51
Passenger transport	*t=0*	0.02	0.08	0.14	-0.06	0.22	-0.14	-0.04	0.03	0.01	-0.16	0.12	0.12	-0.09	-0.07	0.01	-0.09	-0.31	0.11	0.05	0.09	0.05
Cars	*t=0*	-0.01	0.05	0.20	-0.11	0.29	-0.18	-0.07	-0.05	-0.04	-0.31	0.20	0.11	-0.14	-0.12	-0.06	-0.22	-0.53	0.24	0.07	0.15	-0.52
Buses	*t=0*	0.00	0.00	-0.03	0.01	-0.08	0.03	0.03	0.01	0.01	0.07	-0.08	-0.03	0.03	0.04	0.01	0.05	0.13	-0.07	-0.03	-0.06	0.05
Rail transport of passenger	*t=0*	0.00	-0.01	-0.03	0.01	-0.02	0.02	0.00	0.00	0.00	0.02	0.00	-0.01	0.01	0.00	0.00	0.01	0.03	-0.01	0.00	0.00	0.01
Domestic air transport	*t=0*	0.04	0.05	-0.01	0.02	0.02	-0.01	0.01	0.06	0.04	0.07	0.00	0.05	0.01	0.01	0.05	0.07	0.07	-0.05	0.01	0.00	0.51
Freight transport	*t=0*	0.08	-0.05	0.00	-0.01	-0.17	-0.01	0.14	0.16	-0.06	0.24	-0.11	-0.10	0.11	0.47	0.15	-0.11	-0.18	0.09	-0.07	-0.09	0.46
Trucks & light vehicles	*t=0*	0.04	-0.13	0.16	-0.05	0.02	0.04	0.09	-0.15	0.14	0.08	-0.28	-0.16	0.11	0.32	0.11	-0.36	-0.26	0.14	-0.22	-0.07	-0.43
Rail transport of goods	*t=0*	-0.01	0.02	-0.03	0.01	0.00	-0.01	-0.01	0.02	-0.02	-0.01	0.03	0.01	-0.01	-0.03	-0.01	0.04	0.02	-0.01	0.02	0.01	0.03
Waterway goods traffic	*t=0*	0.04	0.07	-0.13	0.03	-0.19	-0.05	0.06	0.29	-0.17	0.17	0.14	0.05	0.01	0.19	0.05	0.21	0.05	-0.04	0.13	-0.03	0.86
RESIDENTIAL	*t=0*	-0.13	-0.15	-0.15	-0.13	0.00	0.03	-0.45	-0.40	-0.35	-0.24	-0.23	-0.40	-0.40	-0.23	-0.22	-0.16	-0.54	0.03	-0.10	-0.11	-4.33
Space heating	*t=0*	-0.15	-0.17	-0.16	-0.15	-0.04	-0.03	-0.42	-0.40	-0.37	-0.26	-0.25	-0.41	-0.41	-0.25	-0.24	-0.18	-0.52	0.00	-0.10	-0.12	-4.63
Water heating	*t=0*	-0.01	-0.01	-0.01	-0.01	-0.01	0.01	-0.03	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	-0.07
Cooking	*t=0*	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	-0.03
Air cooling	*t=0*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
Large appliances	*t=0*	0.03	0.03	0.03	0.03	0.04	0.04	0.01	0.02	0.02	0.03	0.02	0.01	0.01	0.03	0.03	0.02	-0.01	0.02	0.00	0.01	0.42
SERVICES	*t=0*	0.04	0.07	0.02	0.03	0.05	0.07	0.00	0.04	-0.06	0.02	-0.08	-0.01	0.10	0.54	-0.12	0.04	0.06	0.06	0.09	-0.01	0.94
AGRICULTURE	*t=0*	-0.01	0.02	0.04	0.13	-0.16	-0.16	-0.15	-0.13	0.32	-0.19	-0.08	-0.05	0.06	0.13	-0.04	0.04	0.00	0.08	-0.07	0.10	-0.13

Table 6. Variation in final energy consumption (Mtoe) by sector and sub-sector/end use from 1995 to 2015 due to 'intensity effect'.

INTENSITY EFFECT																						
	1995	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*Total*
TOTAL	*t=0*	-0.15	1.16	-0.10	4.62	-2.77	0.96	0.21	5.58	-2.83	1.07	-1.56	-1.00	0.42	-1.57	-1.84	-0.86	3.68	-3.10	-1.48	-0.47	-0.04
INDUSTRY	*t=0*	-0.70	1.11	0.02	1.40	-0.01	-1.13	-0.42	2.25	-1.32	-0.76	-2.47	-1.44	-0.68	-1.69	0.28	-1.07	0.01	-1.44	-0.27	-0.34	-8.67
Chemical	*t=0*	-0.29	0.04	-0.29	0.11	-0.37	-0.81	-0.11	0.48	-0.33	-0.17	-0.43	0.40	-0.82	0.33	-0.29	-0.15	0.18	0.13	-0.34	-0.46	-3.19
Primary metals	*t=0*	-0.75	0.45	-0.35	-0.49	0.48	-0.05	-0.57	0.56	0.08	0.05	-0.32	-0.78	-0.21	-1.04	1.12	0.44	-0.01	-1.04	0.12	-0.40	-2.70
Non-metallic minerals	*t=0*	-0.11	0.16	0.16	0.69	-0.13	-0.51	0.01	0.83	0.17	0.00	-1.04	-0.18	0.31	-1.22	-0.23	-0.09	-0.24	-0.26	-0.43	0.45	-1.66
Paper, pulp and printing	*t=0*	0.07	0.09	0.04	-0.10	0.00	0.03	0.02	0.09	0.01	-0.16	-0.06	0.01	-0.20	0.24	-0.12	-0.16	0.19	-0.27	0.25	0.11	0.11
Food	*t=0*	0.03	0.02	0.17	0.46	-0.13	0.06	0.12	0.08	-0.21	-0.23	-0.27	-0.16	0.18	0.18	-0.33	-0.04	0.05	0.06	0.12	-0.05	0.10
Textile and leather	*t=0*	-0.11	0.04	0.08	0.07	0.04	-0.04	0.01	0.02	-0.22	-0.19	-0.21	-0.39	-0.21	-0.04	-0.10	-0.14	0.05	0.00	-0.01	-0.04	-1.38
Machinery	*t=0*	0.13	0.35	0.16	0.16	0.09	0.04	0.02	0.10	-0.09	-0.12	-0.17	-0.16	0.03	-0.28	0.08	-0.29	-0.09	-0.03	0.02	0.04	-0.01
Mining	*t=0*	0.01	-0.01	-0.01	0.02	0.00	0.00	0.00	0.01	0.01	0.00	0.00	-0.01	0.00	0.00	0.00	0.02	-0.04	0.00	0.01	-0.01	-0.03
Construction	*t=0*	0.00	-0.01	0.01	-0.02	0.01	-0.02	-0.02	0.03	0.01	0.00	-0.01	-0.01	0.00	0.02	0.00	0.23	-0.04	-0.01	0.00	-0.01	0.18
Other industries	*t=0*	0.31	-0.03	0.03	0.51	-0.01	0.17	0.09	0.04	-0.75	0.07	0.04	-0.18	0.23	0.12	0.15	-0.90	-0.05	0.00	0.00	0.03	-0.09
TRANSPORT	*t=0*	0.00	-0.10	-0.81	1.99	-3.18	1.18	0.32	1.30	-1.17	-0.52	-0.16	-0.05	-1.12	0.02	-1.14	3.34	2.31	-2.17	1.59	-1.64	-0.02
Passenger transport	*t=0*	-0.47	-0.29	-0.10	-0.07	-2.65	0.27	0.15	-0.22	-0.38	0.69	-2.40	-1.08	-0.03	0.63	-0.15	0.40	1.45	-1.78	0.19	-1.72	-7.53
Cars	*t=0*	-0.42	-0.21	-0.18	-0.08	-2.49	0.35	0.14	-0.24	-0.29	0.72	-2.36	-1.05	-0.02	0.68	-0.17	0.43	1.45	-1.78	0.27	-1.66	-6.89
Buses	*t=0*	-0.03	-0.03	0.04	0.01	-0.13	-0.01	0.00	0.00	-0.02	-0.01	0.00	0.00	0.02	0.01	0.02	0.01	0.01	-0.01	0.01	-0.08	-0.20
Rail transport of passenger	*t=0*	0.00	0.00	0.01	-0.04	-0.01	-0.02	0.01	0.01	-0.02	-0.01	-0.02	-0.01	-0.01	0.02	0.02	-0.01	0.01	0.00	-0.03	0.00	-0.10
Domestic air transport	*t=0*	-0.01	-0.04	0.04	0.04	-0.03	-0.05	0.00	0.01	-0.05	-0.01	-0.01	-0.03	-0.01	-0.08	-0.02	-0.03	-0.02	0.01	-0.07	0.02	-0.35
Freight transport	*t=0*	0.46	0.19	-0.71	2.06	-0.53	0.91	0.17	1.52	-0.79	-1.22	2.24	1.03	-1.09	-0.61	-0.99	2.94	0.86	-0.39	1.40	0.08	7.52
Trucks & light vehicles	*t=0*	0.14	0.24	-0.81	1.44	-0.69	0.83	0.27	1.58	-0.79	-0.92	2.25	1.09	-1.17	-0.34	-0.85	3.01	0.88	-0.42	1.50	0.08	7.32
Rail transport of goods	*t=0*	0.00	0.00	0.01	-0.03	-0.01	-0.02	0.01	0.01	-0.01	-0.01	-0.02	0.00	-0.01	0.01	0.01	-0.01	0.01	0.00	-0.01	0.00	-0.07
Waterway goods traffic	*t=0*	0.33	-0.06	0.09	0.65	0.17	0.09	-0.10	-0.07	0.01	-0.28	0.01	-0.06	0.08	-0.28	-0.15	-0.06	-0.03	0.03	-0.09	-0.01	0.27
RESIDENTIAL	*t=0*	0.36	0.46	0.41	1.08	0.64	0.50	0.25	0.63	-0.05	0.69	0.78	1.21	0.48	-0.32	-0.65	-1.67	0.85	0.50	-1.39	0.93	5.67
Space heating	*t=0*	0.41	0.60	0.39	1.03	0.73	0.48	0.39	0.39	-0.13	0.57	1.19	1.44	0.49	-0.36	-0.78	-1.43	0.86	0.54	-0.61	0.66	6.85
Water heating	*t=0*	-0.04	-0.12	0.02	0.03	-0.15	0.04	-0.16	0.18	0.02	0.08	-0.32	-0.23	-0.02	0.04	0.16	-0.14	0.02	0.01	-0.53	0.29	-0.82
Cooking	*t=0*	0.01	0.00	0.02	0.04	0.07	-0.01	0.02	0.05	0.05	0.05	-0.07	0.01	0.02	0.02	0.01	-0.04	0.03	-0.01	-0.09	0.08	0.25
Air cooling	*t=0*	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.02	0.02	0.01	0.00	0.00	0.02	0.01	0.01	-0.01	0.00	0.01	-0.03	0.01	0.12
Large appliances	*t=0*	-0.02	-0.02	-0.02	-0.02	-0.03	-0.02	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.03	-0.04	-0.05	-0.06	-0.06	-0.05	-0.13	-0.11	-0.73
SERVICES	*t=0*	0.21	-0.16	0.37	0.38	-0.29	0.19	-0.05	1.23	0.09	1.45	0.30	-0.61	1.88	0.33	-0.13	-1.38	0.54	0.08	-1.31	0.61	3.74
AGRICULTURE	*t=0*	-0.02	-0.15	-0.09	-0.23	0.08	0.22	0.10	0.17	-0.38	0.20	-0.01	-0.12	-0.13	0.09	-0.19	-0.07	-0.03	-0.08	-0.10	-0.04	-0.77