International Journal of Economics and Finance; Vol. 14, No. 12; 2022
ISSN 1916-971X E-ISSN 1916-9728
Published by Canadian Center of Science and Education

Economic Impact of Energy Efficiency Policies: A Scenario Analysis

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Received: September 21, 2022 Accepted: October 13, 2022 Online Published: October 15, 2022

doi:10.5539/ijef.v14n12p1 URL: https://doi.org/10.5539/ijef.v14n12p1

Abstract

The number of countries that have pledged to uphold the 2050 decarbonization targets is constantly growing, and many have established strategies and planned related investments for the coming years. The economic impact of decarbonization and energy efficiency policies has become a major topic of discussion in the global effort to mitigate climate change and contain the temperature rise to less than 2 degrees. Previous literature has identified the risks and opportunities of decarbonization policies, especially concerning the rebound effects and the situation that may arise if, due to persistent biases and the costs of fulfilling climate policies, industries were to transfer production to countries where laxer emission constraints are in force. At the core of the 2030 Agenda for Sustainable Development is the Sustainable Development Goals, which are a global call for action regardless of countries' level of economic development. With Goal 12 on sustainable production and consumption and Goal 14 on climate change mitigation in mind, we provide an economic impact analysis of decarbonization and energy efficiency policies. We compare two scenarios based on the Italian context. The reference scenario is a simulation that shows the development of energy-efficient technologies if the targets set in the national energy strategy were to be met without additional binding targets being added. The policy scenario sees energy efficiency as the principal driver of decarbonization in the presence of a national emissions constraint lasting until 2030, as envisaged by the European Commission. The results confirm that certain risks and opportunities arise from effective policymaking. The effects of decarbonization and energy efficiency policies in the reference scenario would increase final demand by approximately €278.34 billion and the policy scenario would increase it by approximately €380.36 billion by 2030.

Keywords: decarbonization, energy policy, energy efficiency, Agenda 2030, SDG 12, SDG 13, sustainable development, economic impact, sustainable growth

1. Introduction

The 2030 Agenda for Sustainable Development, which was adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), an urgent call to action by all developed and developing countries acting in a global partnership. Among the 17 SDGs, Goal 12 on sustainable production and consumption and Goal 13 on the need to take urgent action to fight climate change play a prominent role in designing decarbonization and energy efficiency policies.

The economic impact of decarbonization and energy efficiency policies has become a major topic of discussion in the global effort to mitigate climate change and contain the temperature rise to less than 2 degrees (Le Treut et al., 2021). Following global climate-change mitigation agreements, governments around the world have increased their commitment to supporting energy efficiency investments using a plethora of policy tolls, subsidies, incentives, regulatory measures and ambitious energy-saving targets (Di Foggia, 2018). Understanding how specific policy instruments can be designed to minimize the trade-offs among different outcomes is important in moving toward a sustainable transition (Peñasco et al., 2021).

The implementation of energy-efficient investment projects at the industrial level has become a common mission not only for environmental purposes but also for ensuring sustained economic competitiveness and productivity. Although supporting the green transition requires remarkable public financial resources, a less energy-dependent economy paves the way for a new perspective on industrialization; as such, the role of government spending is paramount (Caglar & Ulug, 2022).

Accordingly, evaluating public policy through the quantification of economic impact must be an integral part of efficiency policy design. Investment aimed at achieving greater energy efficiency represents an opportunity for economic growth, and thus analyzing the macroeconomic impact of energy efficiency policies is relevant (Nieto et al., 2020). We deem it appropriate to analyze the socioeconomic impact of energy efficiency policies at the national level as we believe that a policy impact analysis must evaluate the implications for economic development and social wellbeing. With this in mind, we estimate various aspects of the economic impact of energy efficiency policy scenarios over a ten-year period. Based on the information provided by the national statistical institute and the business union, we use two complementary models to simulate the macroeconomic impact of such interventions: the input–output model, which allows for an investigation of the sectorial differentiation and spillover effects of energy efficiency policy scenarios (Leontief, 2008), and a more general economic model. The general economic model allows us to assess the impact of energy efficiency policies on economy-wide measures of performance such as gross domestic product, employment, and international trade, whereas the input–output model allows us to focus on the industry level by exploiting information on the sector distribution of such interventions and by measuring the interlinkages between industries.

We primarily focus on the role of industry under the assumption that efficiency enables firms to improve their competitiveness which in turn benefits public finance and the environment while improving social wellbeing owing to additional tax revenues and job creation via cleaner and more efficient production.

We compare two scenarios. The reference scenario is a simulation that shows the development of the technologies under consideration if the targets set in the National Energy Strategy were to be met without additional binding targets being added. The policy scenario sees energy efficiency as the principal driver of decarbonization in the presence of a constraint on national emissions lasting until 2030, as envisaged by the European Commission.

Assuming that appropriate policy measures and incentives are implemented to support demand and technological innovation, the effects on the economy could be significant: final demand would increase by €380.36 billion, implying increases in the value of Italian industrial production by €713.65 billion, employment by 3.98 million full-time employees (FTEs), and value added by €237.85 billion.

Through a detailed analysis, we also assess the contribution of each sector in which interventions are made to the overall economic impact. The sector that contributes the least to overall energy efficiency is the industrial sector, given the outsized efforts made by industry in recent years. More specifically, from the energy scenario proposed by the National Agency for New Technologies, Energy and Sustainable Economic Development, we can associate the increase in energy efficiency in the sector with a cumulative investment demand of €23.88 billion.

In addition, we estimate the effects on the state budget from the incentive mechanisms embedded in the implementation of the various investments. The effects on the state budget are significant.

Considering the net effect on the state budget in terms of reduced energy bills and carbon emissions, which from our estimates is €48.38 billion, and that on the energy system, which we estimate to be €26.37 billion, the increase in demand—if captured entirely by domestic production—results in an overall positive impact on the economy of approximately €74.75 billion over the 2021-2030 period.

Although Italy has already invested heavily in energy efficiency over the past twenty years, there is still a high potential for benefits in terms of increased employment, private investment, and energy saved given the multiplier effect as well as other social and environmental benefits.

The rest of this study is organized as follows. Section two contains background information and a description of the methodology used to conduct our scenario analysis. Section three contains the results of the input–output and general economic equilibrium analyses, including the effects on international trade. Section four contains the discussion. The final section concludes.

2. Background and Methods

In light of climate change and environmental degradation, urgent action on a global scale is required to decarbonize the energy sector (Hassan et al., 2022) and make industrial sectors more energy efficient (Stede, 2017). Despite the urgency of policies and actions aimed at promoting decarbonization and energy efficiency, the literature lacks economic impact analysis studies that seek to understand the benefits and costs of public policies. Specifically, there is a need for more macroeconomic analyses based on theory and modeling (Rezai et al., 2013). The existing macroeconomic models that are often used to analyze the potential impacts of climate policy need to be improved such that they better capture the dynamics and challenges of the transition period (Fragkos & Fragkiadakis, 2022).

Since energy efficiency policies affect many aspects of the economy, a consistent methodology is required for such an analysis. In this respect, general equilibrium models have gained popularity among energy modelers (e.g., Bhattacharyya, 1996; Goulder et al., 2016). A recent study, for example, aimed to model the macroeconomic effects of autonomous energy efficiency improvement, given that assessing the macroeconomic effects of energy productivity improvement is important to achieving energy savings (Liu et al., 2019). Although such models can include many variables and hypotheses that may lead to different results, they are particularly useful in analyzing alternative scenarios, including different decarbonization paths (Nasirov et al., 2020). In addition to general equilibrium models, the economic impact of efficiency policies can be estimated through the analysis of input–output tables, which is an impact assessment method that captures the direct and indirect consequences of an impulse on the various sectors of an economy (van Leeuwen et al., 2005).

Input-output analysis is frequently used to model how government investment promotes economic development and employment (Yang et al., 2022) and can also be extended to environmental policy analysis (Hanson & Laitner, 2009). Nevertheless, there is little evidence on how input-output studies in the environmental context contribute to political decision-making and policy formulation (Vercalsteren et al., 2020). Previous literature has consistently underscored the effectiveness of input–output analysis in identifying first-best solutions when different climate policies are considered (Nguyen et al., 2019), and special attention is given to modern approaches to the analysis and forecasting of economic development by using a cross-sectoral approach (Shirov, 2018).

It is worth noting that the input–output framework allows us to evaluate how alternative measures modify production and consumption prices, income, and intermediate uses (Llop & Pié, 2008). Based on the above consideration, it is a suitable method for our analysis. We estimate the economic effects and implications for measure of competitiveness at the national level (e.g., gross domestic product, value added, and employment) as well as at the international level (e.g., sectoral competitiveness and trade). The economic impact analysis was conducted through the following steps.

The first phase was data collection using data provided by trade associations and the companies part of the Italian association representing manufacturing and service companies that provided estimates of their investments associated with achieving energy policy goals.

The second phase consisted of analyzing and utilizing the results regarding investments in energy technologies for 2021-2030 in two scenarios. The reference scenario is based on the achievement of the targets in the National Energy Strategy (i.e., a 21 percent reduction in emissions from the levels recorded in 2005, a 24 percent reduction in projected final consumption, and a 21 percent increase in the proportion of renewables in final consumption) assuming that no additional binding targets are added over time. The policy scenario is a projection that sees energy efficiency as the driver of decarbonization as envisioned by the European Commission and therefore evaluates certain policies that support energy efficiency.

The third step was the economic impact assessment. In the vector of final demand constructed based on input–output tables, the increase in investment in energy-efficient technologies subject to incentives was imputed to obtain an estimate of the economic effects of this increase in demand.

We evaluated the impact of certain significant economic variables (e.g., the value of production, employment, and value added) and focused on the following sectors: residential, tertiary, industrial, transportation, and electrical.

The impact analysis was performed using 63-sector input–output national account tables. The input–output tables provide a systematic description of Italy's interindustry relations and economic structure and make it possible to assess, through parameters that express the degree of sectoral interdependence, how a change in demand for any good in each sector spreads to the entire economy.

More specifically, input–output tables constitute the basis for many different types of economic analysis because they are especially conducive to integrating technical information given the way with which they capture physical relationships, which allows analysts to make estimations about economic impacts under different conditions (Beccarello & Di Foggia, 2018; Suh, 2009). An input–output table can be expressed as a sum of rows or columns. In Equation 1, x is the total output, A is the matrix of technical coefficients, B is the matrix of allocation coefficients, D is the final demand and v is the primary input.

$$X=aX+D \text{ and } x=xB=v \tag{1}$$

Such tables can be interpreted as a system of equations. The sum of the columns of the matrix of technical coefficients is a measurement of the backward linkages a_{ij}, while the sum of the rows of matrix of allocation coefficients is a measurement of the forward linkages b_{ij} and $A= Zx^{-1}$, where Z represents a n x n matrix of intermediate inputs and A represents a n x n matrix of technical coefficients ($A=[a_{ij}]$). Technical coefficients are formalized as $a_{ij}=z_{ij}/x_j$, where z_{ij} is the intermediate output of sector i to sector j.

Therefore, a_{ij} summarizes the output of industry i required to produce a unit of output of industry j. Similarly, b_{ij} corresponds to the allocation coefficients that identify the share of the output of industry i sold to industry j from the total production of industry i. Likewise, $B = x^{-1}Z$ is the n x n matrix of allocation coefficients that corresponds to $B=[b_{ij}]$, from which Equation 2 is derived.

$$b_{ij}=Z_{ij}/x_i=a_{ij}(X_j/X_i) \quad (2)$$

Accordingly, the Leontief matrix, which is widely used in economic impact assessment, can be formalized in Equation 3.

$$L = (I-A)^{-1} \quad (3)$$

To evaluate the economic equilibrium, we use data obtained from the *TIMES-Italia* model of the Italian energy system, which is a technical-economic model based on a methodology developed by a group of energy technology systems analysts at the International Energy Agency. The model uses the methodologies developed for the International Energy Agency's international agreement for technological cooperation and is a techno-economic model. Supply and demand are balanced with the quantity and price vectors that maximize the total net surplus to producers and consumers. The equilibria can be disrupted at will, and the market can be distorted by introducing additional political, behavioral, environmental, technological, and financial constraints.

Therefore, this model is particularly suitable for forecasting long-term environmental energy scenarios and evaluating the effects of economic and environmental policies. On this basis, we used it in both the reference and policy scenarios. The scenarios are thus the same as those used in the input–output analysis. For this reason, the results of the two methodologies can be used to define a range of potential macroeconomic impacts of the energy scenarios. In this joint-use approach between the two models, primary and final energy consumption are control variables (i.e., the output of the general economic equilibrium model). The decarbonization target is introduced in the policy scenario of the CGE model as a reduction in total emissions and energy consumption rather than in terms of increased investment in energy-efficient technologies, as in the previous assessment. Finally, it is important to note that decarbonization targets are also modeled for countries other than Italy. By placing Italy in the international context, the impacts of moving the decarbonization target to 2030 can be assessed on the following variables: gross domestic product, sectoral value added, sectoral employment, import and export balance, and trade balance.

3. Results

In this section, we present the results of our analysis from the input–output and general equilibrium perspectives. Increased investments in efficient technology and innovation produce substantial growth in gross domestic product, which positively affects the employment balance. Implementing the planned investments in the sectors we considered would increase final demand by approximately €278.34 billion by 2030 in the reference scenario. This would increase Italian industrial production by €514.62 billion, increase employment by approximately 2.59 million FTEs, and result in a €163.01 billion increase in value added.

Assuming that appropriate policy measures are implemented to support demand and appropriate incentives are in place to boost technological innovation, the effects on the Italian economy would be much more significant and increase final demand by €380.36 billion (implying an increase in the value of Italian industrial production by €713.65 billion), employment by 3.98 million FTEs, and value added by €237.85 billion by 2030. The increase attributable to additional investments in energy-efficient technologies would be approximately €101.5 billion, with increases over the baseline scenario of nearly €198.79 billion in terms of output, €1.38 million in terms of employment and approximately €74.89 million in value added. Table 1 summarizes the economic impact.

Table 1. Overall impact on the Italian economy

	Unit	Base	Reference scenario	Policy scenario
Industrial production	€ million	2,192,701	514,623.2	713,652.1
Intermediate use import	€ million	218,792	87,391.5	106,708.7
Employment	th FTE	17,335.5	2,597.7	3,982.3
Value added	€ million	1,014,600	163,010.4	237,855.1
Investments	€ million		278,354.3	380,363.9

Source: Authors' calculations.

* The overall total does not coincide with the sum of the estimated increases for individual projects because the overall assessment was made by simultaneously imputing the annual demand increase from 2020 to 2030 in all affected sectors, which accentuated the direct and indirect economic effects compared to those from the sum of the individual cases. A more detailed analysis allows us to assess the contribution of each sector to the overall economic impact, as shown in Table 2.

Table 2. Sectoral contribution to the impact on the national economy

Sector	Increased demand	Production million	Employment thousands of FTEs	Value added million
Residential	155,591.8	303,125.2	1,943.2	104,901.3
Tertiary	55,015.1	100,214.8	571.2	32,360.3
Industry	23,888.9	46,708.9	246.4	14,777.7
Transportation	98,146.3	195,916	1,032.5	54,560.1
Electric	47,722.5	79,499.07	224.42	24,001.67
Cumulative total	380,363.9	713,651.82	3,982.3	237,855.03

Note. The overall total does not coincide with the sum of the estimated increases for individual projects because the overall assessment was made by simultaneously imputing the annual demand increase from 2020 to 2030 in all relevant sectors, which accentuated the direct and indirect economic effects compared to those resulting from the sum of individual sectoral interventions.

Taking only the policy scenario as a reference, the largest intervention is assumed to be in the residential sector, (€155.59 billion), which alone accounts for about half of the expected increases in both types of industrial output (€303.12 billion), value-added (€104.9 billion), and employment given the 1.94 million added FTEs. The sector that is expected to contribute the least to energy efficiency is the industrial sector. Given the notable efforts made in recent years by Italian industrial companies, the energy scenario proposed by the National Agency for New Technologies, Energy and Sustainable Economic Development has associated a total investment of €23.88 billion with the increase in energy efficiency in the sector.

The effects on the state budget resulting from the incentive mechanisms included in the various investments were also added to complement the analyses. Their consequences on the state budget are significant, particularly regarding both the direct and indirect tax revenue streams. Regarding direct taxes, we record an increase in tax revenues from manufacturing companies that produce energy-efficient goods and technologies as well as from the individuals who work for these companies to contrast a decrease in those paid by energy companies, which see a reduction in their revenues. From Table 3, it is possible to observe the same regarding indirect taxes. At the same time, there is an increase in VAT revenue related to the assumed increase in demand as well as a significant reduction in VAT revenue and excise taxes paid on energy saved.

Table 3. Overall effects on the Italian economy

Ambit	Item	Unit	Value
Effects on the public budget	Regional taxes	€ million	138,581.10
	VAT	€ million	62,778.10
	Subsidies	€ million	-152,974.50
	Total	€ million	48,384.70
Effects on the energy system	Energy savings	toe million	60.06
	Avoided carbon emissions	Tons million	235.90
Economic impact on the energy system	Energy savings (1)	€ million	18,466
	Avoided carbon emissions (2)	€ million	7903.70
	Total	€ million	26,369.70
Total Impact		€ million	74,754.40

(1) Calculated assuming a value of €71/barrel, (2) Calculated assuming a value of €20.5/ton of CO2.

Considering the net effects on the state budget, which we estimate to be €48.38 billion, and those on the energy system, in which reduced energy costs and emissions amount to €26.37 billion, we estimate that the increase in demand—if captured entirely by domestic production—results in an overall positive economic impact of approximately €74.75 billion over the 2021-2030 period.

After observing the impacts on the national gross domestic product, employment, and the state budget under the assumption that domestic production meets the assumed increase in demand, the macroeconomic impacts of decarbonizing energy policies in a globally competitive environment are observed for the same period and calculated as the difference between the baseline and policy scenarios considering the current composition of the global market.

We now present the simulation results. The inclusion of transnational relations resulted in a lower gross domestic product growth rate in both the baseline and policy scenarios than in the previous assessment. In addition, our model does not consider possible changes in global trade policies resulting from decarbonization and the promotion of energy-efficient technologies. In other words, as previously discussed, current trade policies are kept unchanged in the model without introducing any tariff adjustments, even though the decarbonization process proposed in global and European intergovernmental agreements could lead to reduced international competitiveness and the "carbon leakage" phenomenon.

Should prudent policies to support domestic industries be implemented, Italy could reap more benefits from environmental reform and achieve more robust increases in its gross domestic product, value added and employment. Value added is positive in eight sectors out of the 13 considered in both the baseline and policy scenarios. An analysis of policy impacts shows that value added grows most robustly in the steel, transportation, nonmetallic minerals, and textiles sectors. We observe pronounced growth in the construction sector, which can also be interpreted in connection with the energy upgrades that are currently taking place in Italy.

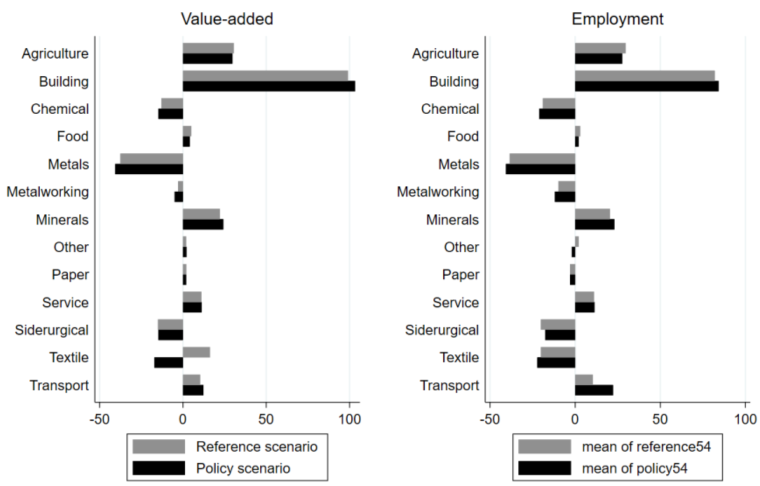

Figure 1. Impact on value added and employment

The baseline scenario shows an increase employment in the agriculture, nonmetallic minerals, food, construction, transportation, and services sectors. Compared to the reference scenario, the policy scenario shows sectoral employment growth consistent with the trend already observed for value added. In the policy scenario, the trend shown in the reference scenario is accentuated in almost all sectors: employment increases more in those sectors in which it was expected to grow (i.e., nonmetallic minerals, construction and transport) and decreases further in those in which it was expected to decline (i.e., chemical and petrochemicals, nonferrous metals, textiles and engineering). Exceptions are the agriculture and steel sectors, while the food, paper and services sectors show identical changes in the two scenarios. Considering the effects on international trade, the model kept current trade policies unchanged and thus did not assume any protectionist interventions, as recent geopolitical developments might foreshadow. Comparative advantages thus determine trade flows, and the different intensities of decarbonization goals, particularly those between the EU and emerging economies, may impair international competitiveness and give rise to carbon leakage.

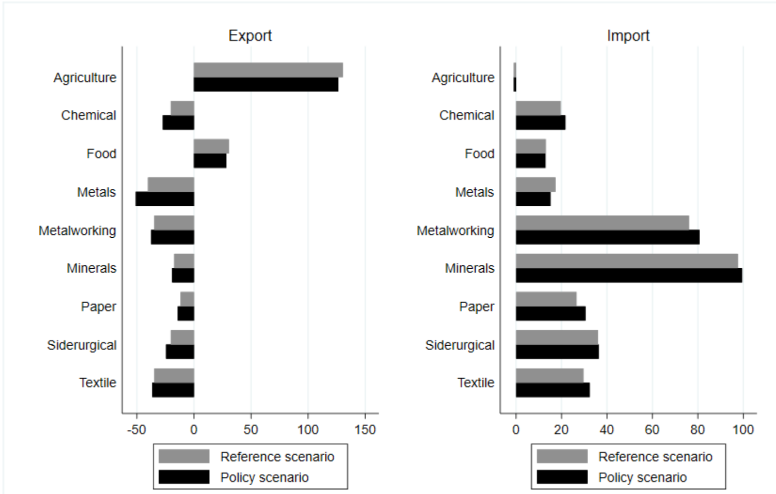

Figure 2. Impact on exports and imports

We believe it is necessary to assume that the model used in this study is unsuitable for providing a detailed representation of different energy-efficient technologies. In the reference scenario, it shows that the negative trend in Italian exports is exacerbated by the new policies, and Italian exports contract in all sectors except food.

This trend confirms the possibility that decarbonization targets are accompanied by carbon leakage, thus leading to less environmentally virtuous countries gaining a competitive advantage. The policy scenario shows a decrease in exports in all sectors except textiles and engineering.

The competitive advantage from lower environmental targets could also be reflected in the international rankings of exporting countries. Italy's top five export sectors are engineering, services, chemicals and petrochemicals, textiles, and food.

The import trend in the reference scenario appears to be increasing in all key sectors except agriculture. In the policy scenario, a further increase in imports in some sectors is evident when compared to the reference scenario. With regard to energy imports, a deeper reduction in demand for coal and oil emerges in the reference scenario, but not for natural gas. The containment target modeled in the policy scenario amplifies this decline. However, it does not translate into an improvement in the energy dependence indicator, as the observable decrease in primary consumption in 2030 induced by emissions containment and energy efficiency is greater than the decrease in imports of energy products due to a contraction in domestic energy production.

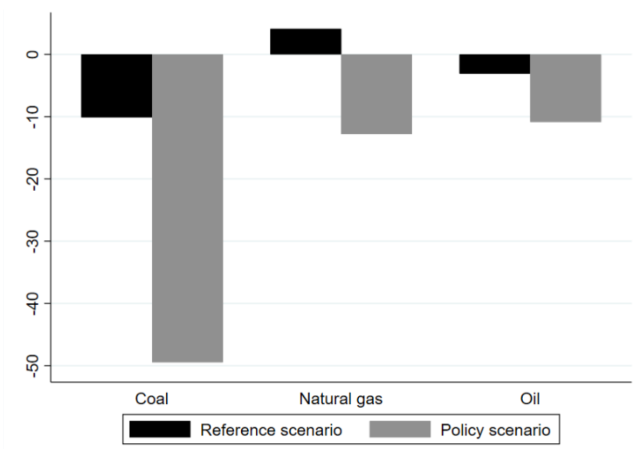

Figure 3. Impacts on imports of energy products

A complete view of the impacts on international trade can be provided by examining the trade balance, the trend of which is shown in Figure 4. The balance is negative in the baseline and policy scenarios throughout the period under consideration.

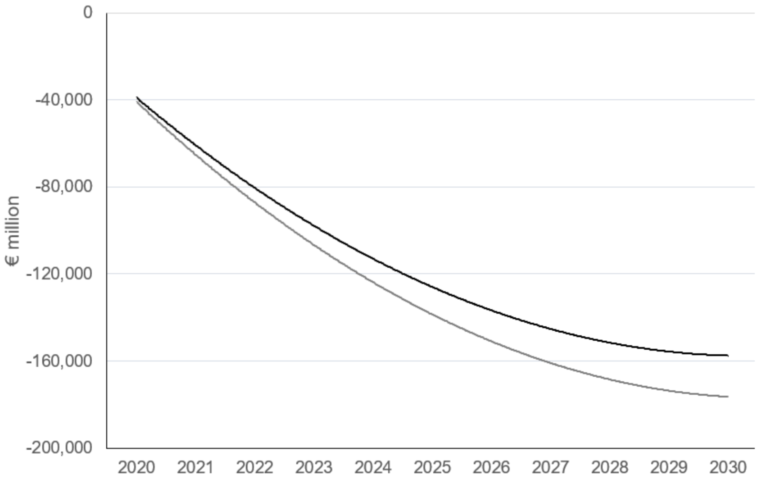

Figure 4. Impacts on the trade balance

The worsening of the overall balance induced by the policy scenario can be detailed at the sectoral level and shows a larger decrease in the textile, paper, nonmetallic mineral production, and engineering sectors. Trade balance trends confirm once again that despite energy efficiency measures, decarbonization goals may expose the Italian industrial sector to losses in competitiveness and result in the carbon leakage phenomenon.

Finally, we report some effects on industrial growth. The more widespread use of energy-efficient technologies is necessary to achieve the environmental sustainability goals and meet emissions reduction commitments.

Increased efficiency enables businesses to improve their balance sheets and households to strengthen their spending power through lower energy bills. Such energy cost savings would make Italian companies more competitive in international markets in the medium term. Investments that achieve greater energy efficiency would also represent a growth opportunity for the country's broader economy.

At the international level, however, it is necessary to consider how Italy's competitive position is affected by the decarbonization targets adopted by other countries, particularly those of emerging economies, as well as the different costs of reducing emissions.

The competitiveness gains associated with energy efficiency described above may in practice be insufficient to offset lower decarbonization targets and/or costs in other economies, thus leading to a reduction in Italy's comparative advantages and the carbon leakage phenomenon. In this study, we focus on energy efficiency and consider investments to reduce energy consumption in the following sectors: residential, tertiary, industrial, transportation, and electricity. In addition, we present an assessment of general economic equilibria to consider the effects of the Italian decarbonization goals on its international competitiveness.

The input–output and general economic equilibrium approaches are similar in their intent to assess the macroeconomic spillovers of the 2030 decarbonization targets from the perspective of a cost-benefit analysis and increase the penetration of energy-efficient technologies. In this study, we begin by evaluating an energy scenario, which, when combined with data for economic spillovers, can be used to derive useful industrial policy insights by identifying the areas in which incentivizing improved consumption efficiency and the use of new technologies on a large scale is most appropriate.

The results derived from the input–output and the general economic equilibrium approaches, which include the implications of international trade, consider a range of potential outcomes for the Italian economy with respect to the decarbonization goals adopted at the European level and the opportunities guaranteed by efficient technologies.

4. Discussion

Because the European Green Deal aims at European climate neutrality by 2050 (Wolf et al., 2021), to achieve such challenging environmental goals, public policies must be set such that they support investments in industry. This is important since, without incentives, investments in energy efficiency affect the cost of production and, therefore, the final prices of the goods produced, at least in the short term. In contrast, supporting efficiency will bring significant benefits in the economic, social, and environmental dimensions (Vasylieva et al., 2019).

Decarbonization policies create competitiveness concerns for energy-intensive industries, whose products are traded internationally and face uneven greenhouse gas constraints.

Widely speaking, biased policy designs may lead to carbon leakage, which occurs when emissions outside a country increase as a direct result of a policy to cap emissions in that country (Paroussos et al., 2015; Verde, 2020). This means that the country's decarbonization policy is less effective and more costly in terms of containing emission levels, which has become a legitimate concern for policymakers (Flachsland et al., 2020; Gillingham & Palmery, 2014). It follows that energy efficiency policies must be well designed to limit the risk of losses in competitiveness due to the relocation of energy-intensive industries to countries with more favorable climate policies.

The capacity of a sector to retain earnings and market share can be used to measure its competitiveness. An industry's competitiveness is impacted by cost increases in various ways, including increased competition from more cost-efficient competitors in domestic and international markets and reduced profits limiting its ability to expand and develop. Provided that energy efficiency has become a lever for transforming industrial processes, which will ensure that demand for energy-efficient products increases (Di Foggia, 2021), it seems clear that competition from less environmentally sensitive countries could cause a loss of competitiveness for industries in countries with higher environmental targets, which make investments in more energy-efficient technologies and production processes to lower their environmental impact.

The two scenarios represent the possible paths, according to the assumptions considered, within which the evolution of the Italian economy can proceed. Both show a positive trend, as gross domestic product is expected to sustainably grow in both scenarios. However, appropriate policies must be adopted to support industry and incentivize investments in energy efficiency so that socioeconomic and environmental benefits are generated in such a way that avoids turning the efforts of the most virtuous countries into possible losses in competitiveness resulting from the potential free-riding behaviors of competing countries.

This is consistent with previous literature, which underscores how energy and emissions policies should better reflect consumption characteristics to increase the potential to reduce energy consumption and emissions (Supasa et al., 2017). Our approach also has some limitations, especially concerning our use of an input–output analysis. Although the advantages of using input–output tables are well known, they contain limitations that constrain their use or at least risk distorting estimates to a small degree in the medium to long run. The use of input–output models should be understood in context of a comparative static analysis with all other considerations being equal. In addition, the parameters related to sectoral interdependence refer to a single year.

Thus, the underlying assumption in the impact analyses is that this degree of integration is constant throughout the period under review (i.e., the technological and structural changes that may occur are not duly considered). However, structural changes occur very slowly in industrial systems in industrialized countries. That said, our results can serve both policymakers and scholars. Policymakers can obtain insights regarding the possible impact of energy efficiency policies from a reliable case study; Italy is recognized as having one of the most energy-efficient industrial bases and as an economy in which energy efficiency measures and regulations have a long tradition. Similarly, scholars may find it useful to compare our results with those of similar studies and use them as a basis for additional research on the economic impacts and potential outcomes of energy efficiency policies.

5. Conclusion

The need to investigate the economic impacts of decarbonization and energy efficiency policies along with their link with the SDGs is the motivation for this study. In line with the United Nations 2030 Agenda, we believe that proper development of the green economy must be accompanied by creating opportunities for business development, new markets, investments in clean technologies, and social wellbeing by creating job opportunities and a healthier environment. Our economic impact analysis of energy efficiency policies is particularly useful in providing policymakers with information regarding the socioeconomic consequences of their decisions. It seems clear that there are potential positive economic, social and environmental impacts from decarbonization policies if such policies are designed to limit or avoid carbon leakage that has become a prominent problem in Europe. Such policies shall take into consideration how to incentivize energy intensive industries to invest in energy efficiency project by supporting such industries via well-design carbon emission reduction support. We assessed the effects of decarbonization and energy efficiency policies through an economic model based on Italy and considered two scenarios. The baseline scenario increases final demand by approximately €278.34 billion, industrial production by €514.62 billion, value added by €163.01 billion, and employment by 2.59 million FTEs. The policy scenario increases final demand by approximately €380.36 billion, industrial output by €713.65

billion, value added by €237.85 billion, and employment by 3.98 million FTEs. The impact of the growth of investment in process innovation was also particularly significant in this analysis. The increase attributable to investment in energy-efficient technologies is approximately €101.5 billion, with increases of nearly €198.79 billion in industrial output, approximately €74.89 million in value-added, and 1.38 million FTEs.

We also estimated the effects on the state budget from the incentive mechanisms assumed in implementing the various investments. The effects on the state budget are significant, particularly those concerning tax revenue streams. Considering that the net effects on the state budget amount to €48.38 billion and those on the energy system (in terms of reduced energy costs and emissions) amount to €26.37 billion, we estimated that the increase in demand, if met by domestic production, would result in an overall economic impact of approximately €74.75 billion. Therefore, energy efficiency policies offer high potential benefits with a 1.5 multiplier in terms of increased employment, private investment, energy saved, and environmental benefits.

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