Bocconi

THE HIDDEN COST OF UNCOORDINATED EUROPEAN GREEN SUBSIDIES

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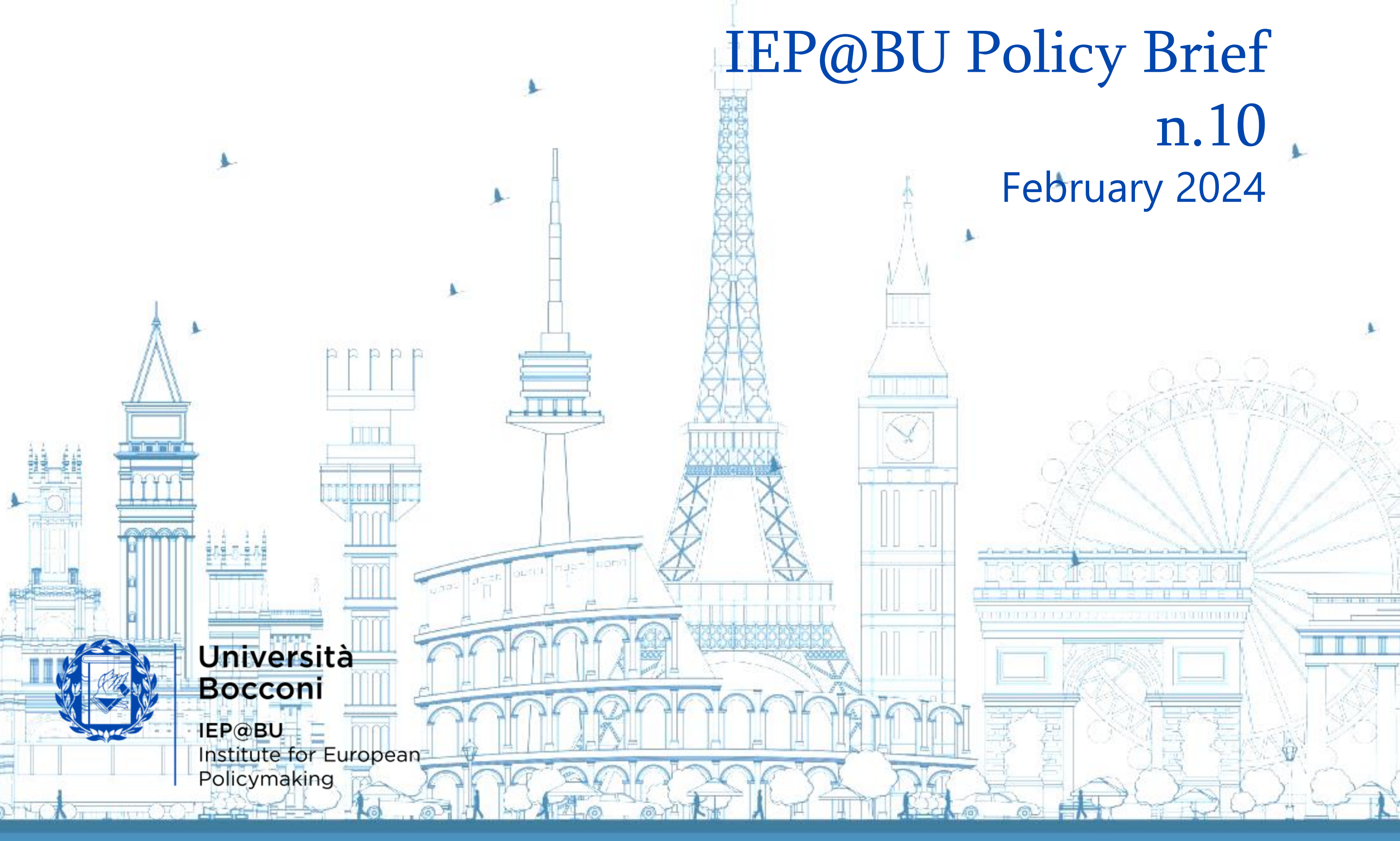

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Abstract*

This policy brief highlights that while the green subsidies provided by the Inflation Reduction Act of the United States are homogeneous across beneficiaries, the subsidies associated with the Green Deal industrial plan are highly fragmented across European member States. We quantify the extent of resource misallocation due to this subsidy dispersion by using the model of Hsieh and Klenow (2009), calibrated on the EU electricity-producing industry. We compare both the actual allocation of subsidies, and a policy of subsidies coordinated at the EU level, to a hypothetical frictionless benchmark with no subsidies. We find that moving to coordinated subsidies can increase productivity by more than 30% with respect to the uncoordinated scenario, substantially reduce the productivity gap with the United States, and generate gains worth up to 6% of the EU value-added in the industries considered. Policy recommendations include greater EU-level coordination to minimize misallocation and enhance productivity.

Executive Summary

- During the last years, although with a different timing, both the European Union (EU) and the United States (US) have committed to reduce greenhouse gas emissions to net-zero levels, that is balancing the amount of emitted greenhouse gases with the amount removed from the atmosphere.
- The key instruments designed to achieve this goal are the Inflation Reduction Act (IRA) in the US, and the Green Deal (GD) initiative in Europe, with an associated industrial plan. Despite sharing similar goals, however, the IRA and the GD are very different initiatives, both in terms of policy instruments and institutional articulation.
- The IRA mainly consists of green subsidies provided through a homogeneous federal tax credit. By contrast, the GD is based on multiple policy instruments—most notably State-aids—and it foresees different levels of intervention (supra-national, national and regional). The inherent complexity is amplified by the fact that member States have already uncoordinated subsidies schemes in place.
- Subsidies are able to address market failures, but they also distort price signals if they are not optimally set, generating inefficiency through resource misallocation. This policy brief abstracts from the environmental impact of the subsidies and focuses on the productivity implications of subsidy dispersion across producers.

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* We thank IEP fellows for valuable comments.

- We quantify the extent of resource misallocation due to subsidy dispersion by using the model of Hsieh and Klenow (2009), calibrated on the EU electricity-producing industry in Germany, France, Italy and Spain. In particular, we compare two scenarios: the actual uncoordinated allocation of subsidies over the period considered, and a policy of subsidies coordinated at the EU level. To avoid bias in the comparison, we analyze the two scenarios in terms of difference with respect to a hypothetical frictionless benchmark with no subsidies.
- We find that, with respect to the uncoordinated scenario, moving to coordinated subsidies can increase productivity by roughly 30%. The latter implies that the reform would yield 20 additional euros of value added per hour worked, which translates into 7.86 billion of additional euros accruing to workers in the power sector of Germany, France, Italy and Spain. These gains are worth 2.3% of the power sector gross output and 6.7% of its added value. In terms of productivity gap w.r.t to the US, the subsidy reform would entail productivity gains reducing the EU-US difference from the current 5.4% (at average 2018 exchange rates) to 0.9%, thus closing 83% of the productivity gap. Extending these calculations to the whole industry and energy sectors in the four countries considered, the reform would generate additional income worth around 78 billion euros, or 6.4% of the total value added generated.
- We suggest policy recommendations which would foster a greater EU-level coordination of national existing subsidies so as to minimize misallocation and enhance productivity. Coordination can be implemented by the EU Commission e.g. by leveraging more on Important Projects of Common European Interests. At the same time, a more general provision could be introduced for a ’Single Market of State aids’, based on art. 122 of the Treaty, e.g. through a mechanism of governance consistent with the new EU fiscal governance framework and based on plans of investment and reforms commonly agreed between the EC and the member States, similar to the ones of the Recovery and Resilience Facility.

The transatlantic quest for carbon-neutrality

During the last five years both the European Union (EU) and the United States (US) have committed to reduce greenhouse gas emissions to net-zero levels, ultimately aiming to balance the amount of emitted greenhouse gases with the amount removed from the atmosphere.

The EU’s central policy instrument for reaching this goal is the European Green Deal, introduced in 2019. The Green Deal outlines a comprehensive framework to transform the EU into a more sustainable and climate-neutral economy by 2050, with an intermediate ’fit for 55’ goal of cutting emissions by 55% (compared to 1990 levels) by 2030.

Under the Green Deal umbrella the European Commission has progressively introduced a number of key legislative initiatives within the EU Single Market, among which several regulations aimed at promoting renewable energy sources and enhancing energy efficiency across various sectors, including transport, industry, buildings, and agriculture. The EU is also working on a tighter implementation of

carbon pricing mechanisms, such as the EU Emissions Trading System, subject to progressively stricter quotas and extended to transport industries (shipping and aviation).

In the United States under the Trump administration the pursuit of carbon neutrality has lacked a nationwide commitment until the US, under the Biden administration, rejoined the Paris Agreement in early 2021, and thus also committed to carbon neutrality by 2050. The latter spurred a number of initiatives and policies in the country, starting with the Infrastructure Investment and Jobs Act passed in November 2021, a $1.2 trillion plan aimed at improving US physical infrastructure, with a part dedicated to the construction of a national network of electric vehicle chargers, as well as investment in power infrastructure and clean energy transmission. In August 2022 the Inflation Reduction Act (IRA) was passed, supporting a number of policies aimed at reaching zero-carbon electricity production by 2035, a 52% emissions reduction in 2030 from 2005 levels, and carbon neutrality by 2050. The law mobilizes some $360 billion on climate action, according to initial Congressional Budget Office estimates, and it has created a lot of hype in the European Union in light of the potential protectionist nature of some of its provision (Kleimann et al., 2023).

As a result in February 2023 the EU has promoted a Green Deal industrial plan, with the aim of increasing support to the technological development, manufacturing production and installation of net-zero products within the EU, implicitly responding to the competitive challenge posed by the US IRA. The IRA and the Green Deal industrial plan, however, although sharing similar goals end up in being very different initiatives, both in terms of policy instruments and institutional articulation.

In what follows, we provide a brief comparison between the two initiatives, and then set out to explore the potential pitfalls of the EU plan. By so doing, we join the current debate on the risks associated to a subsidy-based approach (McWilliams et al., 2024) that, we argue, are not limited to increasing the cost of key inputs (e.g. solar panels)—but they include lower aggregate productivity arising from subsidy heterogeneity and the misallocation of resources it entails.

US IRA vs EU Green Deal industrial plan

The US IRA mainly consists of three types of green subsidies, essentially provided in the form of a federal tax credit. These are: i) a consumption tax credit for electric vehicles; ii) production and investment tax credits for renewable energy production (electricity and hydrogen), and iii) a tax credit for Carbon Capture and Storage.

The provision of these subsidies is relatively straightforward because they are: a) implemented through a set of policies that apply uniformly across the US to all beneficiaries; b) directly applicable by the beneficiary once the consumption/investment decision is undertaken. Moreover, as a federal policy, the

IRA can be financed through public borrowing on the market[1].

On the contrary, the European Green Deal industrial plan is a much more complex piece of legislation based on multiple policy instruments. In particular, the plan articulates a "Net-Zero Industry Act", which identifies key technologies and products (among which batteries, heat pumps, solar, electrolysers, windmills) to boost in terms of internal production, and for which it will be required to manage dependency risk. In parallel, the EU has launched a "Critical Raw Materials Act", which aims to make the EU more self-reliant in mining, processing and recycling a list of 34 critical metals and minerals, by accelerating and financing national programs for exploring EU internal geological resources, as well as limiting the sourcing of critical minerals from third countries by 2030. Finally, a reform of the EU electricity market design is also ongoing.

In addition to these legislative instruments, the Green Deal industrial plan also allows for some financial instruments, in the form of a revised temporary State-aids framework and the general block exemption regulation, as well as the introduction of some form of flexibility in the use of existing structural funds by the Member States, with the possibility of a different earmarking towards 'green' goals[2].

The EU plan thus foresees different levels of intervention (supra-national, national and regional), with an inherent complexity amplified by the fact that MSs have already uncoordinated subsidies schemes in place[3]. The same evolution of the EU fiscal rules as defined by the EcoFin Council in a political agreement of December 2023[4] seems to rule out insofar the possibility of carving out national investment expenditures related to the green transition from the computation of the new nominal expenditure rule. At the same time, the tense debate ongoing within the European Council on the extension of the EU multiannual financial framework does not seem to bode well for the creation of an EU 'federal' fiscal capacity able to fund green-related expenditures.

As a result, missing a common funding mechanism as well as a 'golden rule' exempting green investments at the EU level, the financing of the Green Deal industrial plan is not straightforward, as funding in the end is mostly done by individual MSs under the temporary State-aid exemption. The latter creates three sources of heterogeneity. First, heterogeneity in fiscal capacity, as some member States are relatively less constrained on fiscal policy (mostly Germany, and to a lesser extent France) and thus are able to spend

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[1] Estimates of the fiscal cost of the IRA differ greatly, as well as evaluations on the actual degree of protectionism implied in its provisions. We abstract here from an in-depth analysis, and we refer to Gros et al. (2023) for a detailed discussion

[2] In the EU, the lion share of support measures is paid by individual MSs through State aid. Although Article 107 TFEU generally prohibits State aid to minimize distortions, it exceptionally justifies it when "necessary for a well-functioning and equitable economy". As a general rule, and when compatible with the Single Market, Member States must comply with a formal procedure in which they give prior notification to the EU, which reviews and eventually approves the aid. Derogations are possible under a general Block Exemption provision for specific industries, or under specific schemes authorized by the Commission – in particular the Temporary State aid Crisis and Transition Framework, and the Important Projects of Common European Interest. The Green Deal modifies and exploits such frameworks to speed up and simplify aid granting.

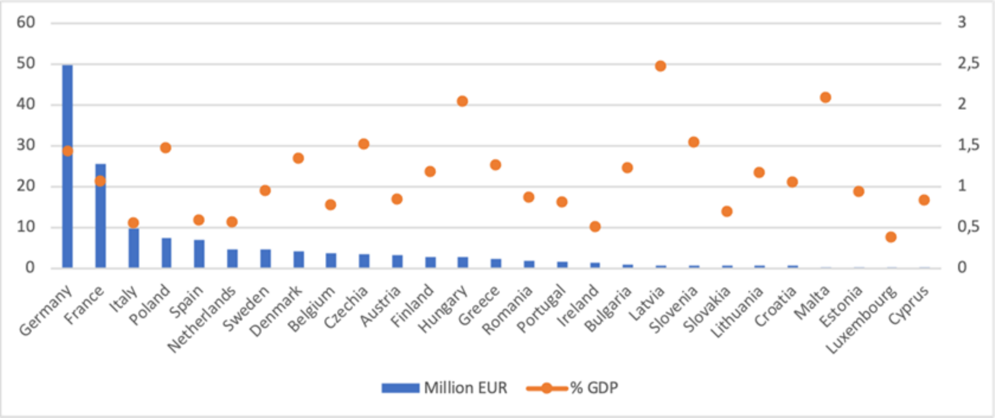
[3] See Kleimann et al. (2023) for a review of the existing EU-level and national support schemes.

[4] See the related press release of December, 21.

more then other EU countries. Second, heterogeneity in the funded initiatives, as State aid expenditures often tend to follow short-term political goals, rather then a long-term industrial strategy (Friederiszick et al., 2006). And third, even if State aid subsidies contribute to gross fixed capital formation, the latter is often not integrated at the European level, with many overlaps or limited inter-operability across systems.

Figure 1 presents a snapshot of such heterogeneity by showing the average sums actually used for State aid by MSs between 2010 and 2021[5]. The figure shows that over the last ten years there has been substantial dispersion across countries.

Figure 1: State Aid heterogeneity (average 2010-2021).



Notes: this figure shows total State aid disbursement in constant prices across member states, averaged between 2010 and 2021. Total State aid includes grants and tax exemptions, equity participation, soft loans and tax deferrals, repayable advances and guarantees.

Source:
https://webgate.ec.europa.eu/comp/redisstat/databrowser/view/AID_SCB_INST/default/table?lang=en&category=AID_SCB_INST.

Following the pandemic, in 2020 and 2021 more than half of total State aid has been used as a “remedy a serious disturbance in the economy of a Member State” (European Commission, 2022). In previous years, State aid has been used to accelerate the rollout of renewable energy production and storage, but also to subsidize the production of key inputs for the decarbonization of industry, such as batteries, solar panels, wind turbines, heat-pumps, electrolyzers, and instruments for carbon capture usage and storage. As a result, the subsidies did not just target specific sectors such as electricity production, but they have been extended to the industrial sector as a whole.

As a result, despite the efforts to design a coordinated EU response to the IRA[6], these differences within levels of governance and across countries are likely to entail a potentially significant cost in terms of

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[5] This might differ from sums *approved*, which might be larger.

[6] See the EC communication “EUROPEAN ECONOMIC SECURITY STRATEGY” (June 2023).

overall efficiency for the EU Single Market. In the remaining part of the policy brief we set out to quantify this point.

The costs of uncoordinated policies

The economic rationale behind the idea of providing green subsidies, which to different extents are at the core of both the US IRA and the EU Green Deal, is the typical market failure associated to the idea of 'externalities'. Individual producers do not fully internalize the returns accruing to the general community from developing and adopting clean technologies and thus, if acting along standard market incentives, would generate a suboptimal investment into the green transition. Subsidies are thus introduced in order to address this market failures. However, the flip side is that they distort price signals if they differ from the wedge between the private and social value of the investment, and so they might generate allocative inefficiency.

To that extent, a standard principle of efficient resource allocation is that the marginal product of inputs should be equalized across producers (Restuccia et al., 2008; Hsieh and Klenow, 2009). The intuition is that dispersion in marginal product implies the existence of unexploited opportunities due to a sub-optimal allocation of resources. The extent of misallocation can be summarized by the 'wedge' between different producers' marginal product.

To see this through a simple example, suppose that there are two producers, A and B. Producer A pays 800 Euro for each unit of additional capital. Then optimality for A requires that capital should be adjusted up until the point every additional unit of capital produces exactly 800 Euro of additional revenue.[7] Now suppose that B receives subsidies, resulting in the cost of each unit of additional capital being 500 rather than 800 Euro. Then optimality for B requires that capital is adjusted up until the point each additional unit increases revenue by 500 Euro. In this situation, optimality holds at the level of the individual producers, but in the aggregate there is misallocation, since one could transfer some units of capital from B to A, where they are more valuable. The wedge between A and B summarizes the extent of misallocation, which in the example is equal to 800/500–1 = .6. Notice that absent subsidies, the cost of capital would have been the same for the two producers, resulting in a zero wedge.[8] The larger the wedge, the more the opportunities missed, and the lower the aggregate productivity.

On the other hand, clearly, a lack of subsidies would imply a free market equilibrium which would be efficient from an individual producer point of view, but with a sub-optimal aggregate investment into the green transition. The presence of externalities, in other words, generates a policy dilemma between

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[7] The marginal product changes with the quantity of inputs used because of decreasing returns to scale in production, a standard assumption in economics theory.

[8] Clearly, the wedge can be negative. What matters here is its absolute value.

a socially desirable outcome (a significant investment in the green transition), and the unavoidable misallocation emerging through the use of subsidies. The optimal policy objective is thus not to make away with subsidies, but rather to allocate them in a way that minimizes misallocation. Hence the reason for preferring "horizontal" subsidies applied uniformly, as those are typically less distortive than targeted support (see a formalization in Model Appendix A).

To that extent, the US IRA tends to apply federal subsidies to the domestic industry in a quite uniform way, thus creating a constant wedge between the marginal cost and the marginal product of inputs. As a result, the extent of resource misallocation in the US should be lower, and so the impact on aggregate productivity.

On the contrary, under the current setup of the EU Green Deal industrial plan, subsidies are provided independently by MSs, being therefore heterogeneous in size, modalities, and industries covered. The latter result in a heterogenous wedge which generates dispersion in marginal products, and hence an implied 'shadow-cost' translated into a lower aggregate productivity for the EU economy.

An application to the electricity sector

In order to gauge the extent to which the provision of uncoordinated subsidies at the national level might lead to a sub-optimal productivity outcome at the EU level, we build an empirical application based on the electricity sector.[9] This is a key market in the green transition and it is highly subsidised, which makes it a natural candidate to look for misallocation.

Model Appendix A shows that the productivity loss due to misallocation can be measured from country-level data on subsidies and nominal wages. Given some data constraints, which are discussed in Data Appendix B, we focus on the largest EU economies (Germany, France, Italy and Spain) between 2015 and 2017.

The model distinguishes between output and investment subsidies. The first type of subsidy increases the sale price of the output. In the electricity sector, these are known as *Feed-in tariffs*, and constitute almost 80% of all EU subsidies to the renewable sector. Information on Feed-in tariffs is available through official statistics.

Instead than increasing the value of output, investment subsidies reduce the cost of investment. To retrieve country-specific subsidy rates, we have divided the nominal amounts in tax expenditure and grants to the energy sector (also available through official statistics) by the total investment in that sector.

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[9] Specifically, in the official classification of industries of the EU, it is NACE rev. 2 "35.1 — Electric power generation, transmission and distribution".

Between 2015 and 2017, subsidies exhibited a substantial amount of heterogeneity across the countries considered. Appendix Table B1 shows that Feed-in tariffs ranged between 0 and 0.19 USD/kWh (average 0.08), while investment subsidies between 1.5% and 4% of investment (average 2.6%).

A key parameter of our calibration is the elasticity of substitution across the varieties of electricity produced in each country. Given that the results are very sensitive to this parameter, which is hard to robustly estimate with the data at hand, we present results for different values of elasticity traditionally used in the literature.[10]

Our quantitative exercise is carried out in three steps: 1) deriving a sufficient statistic able to measure misallocation in the EU under the actual heterogeneous subsidies; 2) calculate the associated TFP loss relative to a frictionless benchmark (no subsidies), and 3) compare it with the TFP loss that would have occurred if subsidies were homogeneously decided at the EU level. Importantly, we thus compare both the current scenario with heterogenous subsidies and the one with homogeneous subsidies, with respect to the hypothetical frictionless benchmark with no subsidies. The latter allows us to compare the two scenarios as a difference with respect to a common benchmark, thus minimizing errors due to unobserved common variables. Appendices A and B presents the formal details of these calculations, as well as a description of our data sources.

Results

The main results are presented in Figure 2. For different values of the elasticity of substitution $\sigma = \{3,6,10\}$, the figure displays the TFP loss under the actual heterogeneous allocation vs. the frictionless benchmark, and the situation in which subsidies are constant across countries and equal to their sample-average.

Relative to the frictionless benchmark, we find that the actual heterogeneous allocation generates TFP losses of 3%, 6% and 10% under different elasticities (blue bar in Figure).

Strikingly, when we compare this scenario to the one in which we impose homogeneous subsidies, the TFP losses relative to the frictionless benchmark (red bar in Figure 2) are reduced to roughly 1%, 2% and 4%, respectively. This implies that TFP could increase by almost 1/3 thanks to homogenization.

To put this number in perspective, we calculate the gains that would occur to the power sector of Germany, France, Italy and Spain combined (85% of Euro area output) following the subsidy reform[11].

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[10] As electricity is a commodity, the elasticity of substitution should be relatively high. However, market power and other frictions affect the parameter. In Appendix B.3, we provide a tentative measurement.

[11] Ideally we would focus on the electricity sector, but data limitations force us to consider the broader "Electricity, gas, steam and air conditioning supply", which is sector "D" in ISIC rev. 4. classification. The data are taken from the OECD STAN dataset, where the most recent data points refer to 2018.

We proxy TFP with nominal value added per hour worked at current prices, which allows us to express the results in Euro terms.

Assuming a value for the elasticity of substitution equal to 10[12], the results above imply that the reform would entail 20 additional euros of value added per hour worked, which translates into 7860 million of additional euros accruing to European workers in the power sector. These gains are worth 2.3% of the power sector gross output and 6.7% of its added value[13].

OECD data allows us to perform an international comparison with the US. Specifically, we find that in the four European countries, the power sector is 5.4% less productive than in the US at average 2018 exchange rate.[14] However, the subsidy reform would entail productivity gains which would reduce the difference to 0.9%, closing 83% of the productivity gap.[15]

The empirical application presented above focuses on the electricity sector, but the idea that subsidy homogenization would reduce misallocation and increase productivity is broader. If we extend the calculations above to the whole industry and energy sectors,[16] we find that the reform would generate additional income worth 2.1% of GDP and 6.4% of value added;[17] it would also reduce the productivity gap with the US by 35%.[18]

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[12] Appendix B.3 shows that consistent with the idea that energy is a homogeneous good, the estimated elasticity of substitution is even larger than 10.

[13] The details of the calculations are as follows. According to OECD data, current value added per hour in 2018 for the four countries is 298 euros. Given the results presented above, this implies that value added per hour in the frictionless benchmark would be 298/(1-.1) = 331. Under homogeneous subsides, value added per hour would then be 331*(1-.04) = 318. Thus, the reform would increase European productivity in the power sector by (318/298 - 1) = .067. OECD data tells us that in 2018, total hours worked in the power sector of the four countries are 393 million. Therefore, (318 - 298 =) 20 additional euros of value added per hour worked correspond to (393*20) 7860 million of additional euros accruing to European workers. In the same year, gross output in the power sector of the four countries is 335877 million euros and value added is 117177 million euros. Thus, the reform would generate additional resources worth 7860/335877 = .023 of gross output and 7860/117177 = .067 of value added.

[14] Specifically, US value added in the power sector is 279388 USD, which converted at the average USD/EUR exchange in 2018 (1,1811) gives us 329985 EUR million. In the same year, total hours worked in the US power sector are 1047, which results in value added per hour worked 329985/1047 = 315. So the productivity gap is 298/315 - 1 = -.054.

[15] The reform would increase value added per hour worked to 318. Thus, the post-reform gap would be 318/315 - 1 = -.009. This implies that reform would reduce the gap by 4.5 pp or 0.9/5.4 - 1 = -.83.

[16] Specifically, we consider ISIC rev. 4 industries B to E.

[17] The details of the calculations are as follows. According to OECD data, current value added per hour in 2018 for the four countries is 101 euros. Given the results presented above, this implies that value added per hour in the frictionless benchmark would be 101/(1-.1)=112. Under homogeneous subsides, value added per hour would then be 112*(1-.04) =107.5. Thus, the reform would increase European productivity by (107.5/ 101 - 1) 0.064. In 2018, total hours worked in Europe were 12143 million. So, (107.5 - 101 =) 6.5 additional euros of value added per hour correspond to (12143*6.5) 78929.5 million of additional euros accruing to European workers. In the same year, European industry and energy gross output is 3828386 million euros and value added is 1231951 million euros. So the reform would generate additional resources worth 78929.5/3828386 = 2.1% of EU gross output, and 78929.5/1231951 = 6.4% of the value added generated

[18] The pre-reform gap is 101/119-1=-.15 at average 2018 exchange rate. The reform would increase value added per hour worked to 107.5. Thus, the post-reform gap would be 107.5/119 - 1 = -.097. This implies that reform would reduce the gap by 9.7/15 - 1 = -.35

We conclude that policy coordination at the EU level would help internalizing the effects of misallocation from cross-country dispersion in subsidy provision, and that this can have a significant impact on aggregate EU productivity.

Coordinated policy to minimize misallocation: an example

We conclude the policy brief with a concrete example of how coordinated EU policy might curb misallocation in the electricity sector.

Appendix A.4 shows that we can further decompose the effect of subsidies on misallocation to shed light on the drivers of TFP dispersion. In particular, we can calculate how much of the total TFP dispersion can be attributed to cross-country variation in a (somehow unavoidable) "structural component"—most notably wages—, the role of subsidies, and the covariance between the two.[19]

The results are presented in Figure 3. Wage dispersion across countries accounts for 40%, subsidy dispersion for 20%, and the remaining variation to the covariance between wages and subsidies. The latter component is interesting, because ex-ante it might contribute to increase or decrease the overall misallocation. Specifically, Appendix A.5 shows how to decompose the covariance term further, and examines the relationship between the structural component and each type of subsidy, as well as that between the subsidies.

In our model, the covariance between wages and Feed-in tariffs, and wages and investment subsidies, enter the expression for misallocation (μ), with a negative sign.[20] This implies that a positive cross-country correlation between wages and Feed-in tariffs, or wages and investment subsidies, tend to decrease misallocation and increase aggregate productivity. Instead, the covariance between Feed-in tariffs and investment subsidies enters the expression for μ with a positive sign. Therefore, a positive correlation between the two types of instruments contributes to increase overall misallocation and reduce productivity.

Table 1 summarizes how the four countries in our sample relate to the productivity-enhancing correlations between nominal wages (W), Feed-in tariffs (FIT) and investment subsidies (IS) discussed above (i.e. +, +, –).[21] Green indicates that the country contributes to reduce overall misallocation, while red indicates that it increases misallocation (i.e. deviations from the productivity-enhancing correlations: +, +, –).

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[19] If one allows for more cross-country differences, these would contribute to increase or decrease further the dispersion of the structural component.

[20] The sign is reversed for investment subsidies, that are defined as one minus the subsidy rate.

[21] To determine the signs of the correlation, we compute the sample average value of nominal wages, Feedin tariffs and investment subsidies. If a country has a value larger than the average, we assign a "+", while if it is below, we assign a "-". More disaggregated data—at the firm level for instance—would allow to compute actual within-country correlations.

Our approach can lead to quite clear-cut policy prescriptions. For instance, only countries with high nominal wages should pay large subsidies. The intuition is that high wages increase the marginal cost of generating electricity, thus providing a rationale for supporting producers. At the same time, countries should use either output *or* investment subsidies (which entails a negative correlation between the two), but not both.[22]

Table 1 presents a simple example. Two of the four countries examined—Spain and Italy, drive a negative sample correlation between wages, and output and input subsides. Thus, one might envision a coordinated EU policy inducing such countries to re-distribute resources, thus generating a positive correlation between wages and one of the two types of subsidies. This would also result in a negative correlation between the two instruments, thus "fixing" the sign of the last column of Table 1.

By construction, even "virtuous" countries such as Germany and France in Table 1 cannot have a contemporaneous positive (negative) correlation between wages, Feed-in tariffs and investment subsidies, and also a negative (positive) correlation between Feed-in tariffs and investment subsidies. However, Appendix A.5 shows that the relative strength of the different correlations in affecting productivity depends on the model parameters.[23] Thus, one can devise "second best" policies in which, depending on structural characteristics, countries can select the least distortive option consistent with subsidy provision.

Policy conclusions

Clearly, the exercise presented in this Policy Brief is based on several simplifying assumptions, and a rather small sample of countries (albeit the largest ones) due to data constraints. Nonetheless, the magnitude of the effects we uncover suggests that subsidy dispersion might generate substantial productivity losses, and that a more sophisticated and comprehensive analysis along these lines is a promising direction for further research.

Looking at the policy implications of our findings, there is a broad consensus within the European institutions that the main pillar of the forthcoming Green Deal industrial plan should be the EU Single Market. The latter, if efficiently designed and implemented, is a tool of competitive advantage; and a source of global political power, if strategically leveraged.

However, as we have previously shown, the EU is paying a very high cost (in terms of missed

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[22] Why this is the case can be understood by inspecting the expression for μ in Appendix A.2. The variation of the last term in the variance operator is reduced when output and investment subsides are negatively correlated.

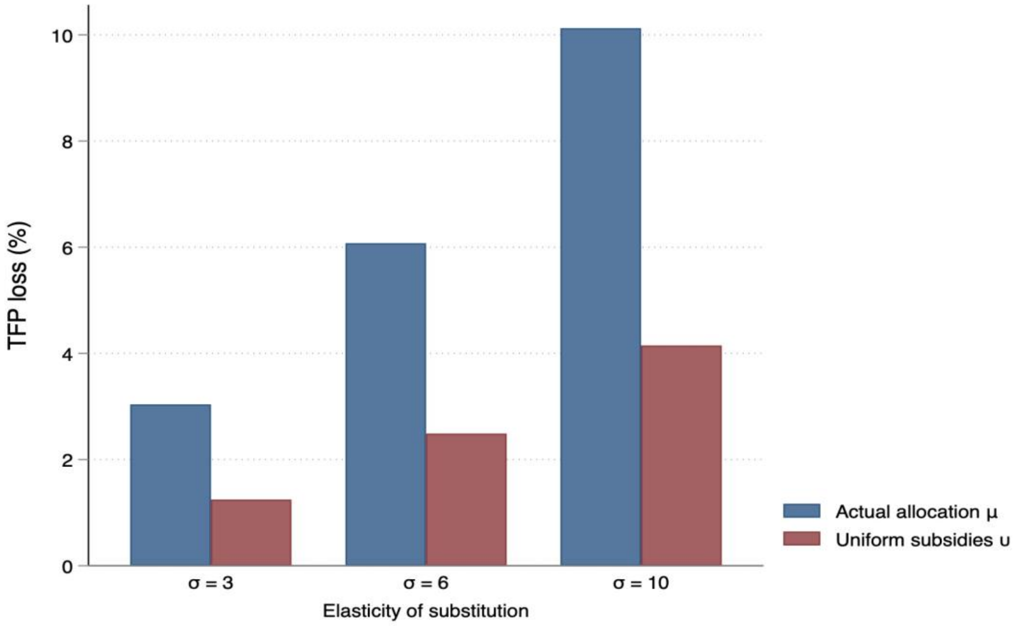
[23] In the example presented in this policy brief, the relative strength is determined by the elasticity of electricity generation to changes in the capital stock. A more sophisticated model would provide additional country-specific structural dimensions affecting these relationships.

productivity) for the lack of a proper Single Market mechanism in terms of industrial policies. Still, adding a ’common’ layer of coordination to existing national policies is not beyond the competence of the EU.

The latter in fact could be achieved leveraging on art. 122 of the Treaty, through a mechanism of governance similar to the one of the Recovery and Resilience Facility. The reform of the Stability and Growth Pact, once approved, already foresees the possibility for countries to present specific Reform and Investment plans agreed with the European Commission in order to adjust the growth of nominal expenditure over a seven-year horizon (from an initial four-year horizon). As such, it is in principle possible for the Commission to stir the ‘ex-ante national’ proposed reform and investment plans into ‘ex-post European’ support measures, efficiently coordinated at the EU Single Market level across different areas, thus implementing in this way a ‘common’ industrial policy (using art. 122 as a juridical basis).

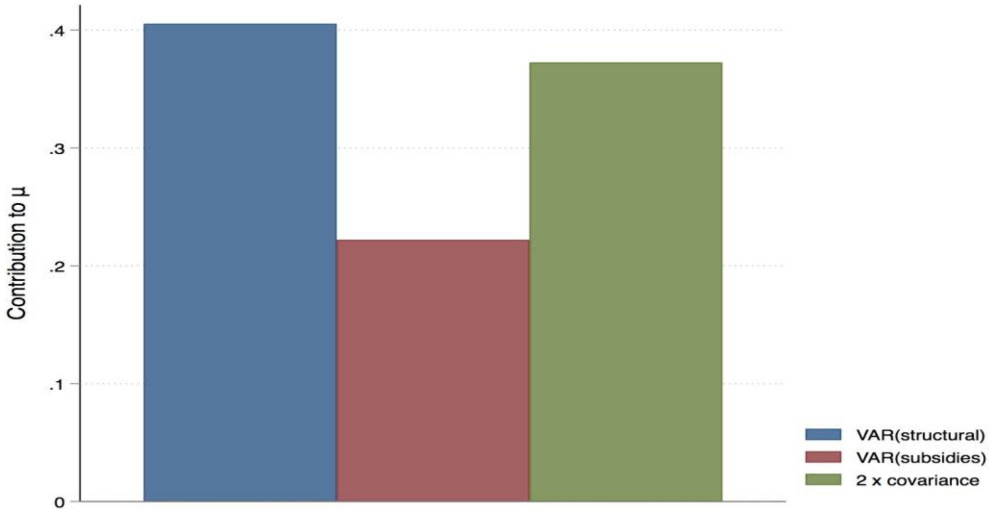
A first group of initiatives coordinated within the new fiscal policy framework could stem from the current list of Important Projects of Common European Interest, which could be further expanded through appropriate negotiations with the Member States within the framework of the Country Specific Recommendations.
By coordinating otherwise national support measure through a ‘Single Market of State aids and Industrial policy’ would lead to significant aggregate productivity gains for the EU.

Figure 2: TFP loss relative to frictionless benchmark.



Notes: this figure shows the predicted percentage loss in EU Total Factor Productivity (TFP) due to: i) actual heterogeneous output and investment subsidies (μ in the model) relative to a frictionless benchmark with no subsidies (blue bar), and ii) country-invariant (sample average) output and investment subsidies (υ in the model) relative to the frictionless benchmark (red bar). The calculations are based on the model in Hsieh and Klenow (2009). Feed-in tariffs data are from the OECD; investment subsidy and nominal wage data are from Eurostat.

Figure 3: Drivers of TFP dispersion.



Notes: this figure shows the shares of EU TFP loss due to subsidies explained by the cross-country variation in nominal wages (the structural component), subsidies and the covariance between the two. The calculations are based on the model in Hsieh and Klenow (2009). Feed-in tariffs data are from the OECD; investment subsidy and nominal wage data are from Eurostat.

Table 1: Which countries contribute to increase misallocation?

Correlation:	(W,FIT)	(W,IS)	(FIT,IS)
Spain	−	−	+
Italy	−	−	+
Germany	+	+	+
France	−	+	−

Notes: this table presents the signs of the estimated correlations between nominal wages (W), Feed-in tariffs (FIT) and investment subsidies (IS) in the sample. To determine the country-specific sign of the correlations, we compute the sample average value of nominal wages, Feed-in tariffs and investment subsidies. If a country has a value larger than the average, we assign a "+", while if it is below, we assign a "-".

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Appendix

A) Model Appendix

We consider the EU production bundle:

$$Y^{EU} = \left(\sum_{i=1}^{27} Y_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

where $\sigma > 1$ and the country-specific output Y_i is produced by a representative monopolistically competitive firm.

The production function of country i is given by

$$Y_i = A_i K_i^{\alpha_i} L_i^{1-\alpha_i}$$

and country i's profits are given by

$$\Pi_i = (1+\tau_i^Y) P_i A_i K_i^{\alpha_i} L_i^{1-\alpha_i} - w_i L_i - (1-\tau_i^K) R_i K_i$$

where τ_i^Y a production subsidy and τ_i^K an investment subsidy.

We use the framework of Hsieh and Klenow (2009) to express aggregate EU total factor productivity as

$$\log TFP = \frac{1}{\sigma-1} \log \left(\sum_{i=1}^{27} A_i^{\sigma-1} \right) - \frac{\sigma}{2} VAR(\log TFPR_i)$$

where country i revenue total factor productivity

$$TFPR_i \equiv P_i A_i = \left(\frac{R_i}{\alpha_i} \right)^{\alpha_i} \left(\frac{w_i}{1-\alpha_i} \right)^{1-\alpha_i} \frac{(1-\tau_i^K)^{\alpha_i}}{(1+\tau_i^Y)}$$

We further assume that there is a common rental rate of capital $R_i = R$ and all countries have identical technology $\alpha_i = \alpha$.

A.1) Frictionless benchmark

In the frictionless benchmark there are no subsidies $\tau_i^Y = 0$, $\tau_i^K = 0$ and no labor market frictions, which implies $w_i = w$. In turn, this implies that $VAR(\log TFPR) = 0$ and therefore

$$\log TFP^* = \frac{1}{\sigma - 1} \log \left(\sum_{i=1}^{27} A_i^{\sigma-1} \right)$$

where the star indicates the competitive benchmark.

A.2) Actual allocation with varying subsidies

Log-TFP under the actual allocation with subsidy dispersion is given by

$$\log TFP = \frac{1}{\sigma - 1} \log \left(\sum_{i=1}^{27} A_i^{\sigma-1} \right)$$

$$-\frac{\sigma}{2} VAR \left[\log \left[\left(\frac{R}{\alpha} \right)^{\alpha} \left(\frac{w_i}{1-\alpha} \right)^{1-\alpha} \right] + \log \left[\frac{(1 - {\tau_i}^K)^{\alpha}}{(1 + {\tau_i}^Y)} \right] \right]$$

Here we are making the key assumption that productivity A_i is exogenous and identical under the actual scenario and the frictionless benchmark.

The TFP discount relative to frictionless benchmark is:

$$\mu \equiv \log TFP^* - \log TFP$$

$$= \frac{\sigma}{2} VAR \left[\log \left[\left(\frac{R}{\alpha} \right)^{\alpha} \left(\frac{w_i}{1-\alpha} \right)^{1-\alpha} \right] + \log \left[\frac{(1 - {\tau_i}^K)^{\alpha}}{(1 + {\tau_i}^Y)} \right] \right]$$

A.3) Allocation with constant subsidies

Now we consider the last scenario, with uniform (EU-coordinated) subsidy provision. Here we have

$$\tau_i^K = \overline{\tau^K}$$

$$\tau_i^Y = \overline{\tau^Y}$$

$$\log \overline{TFP} = \frac{1}{\sigma - 1} \log \left(\sum_{i=1}^{27} A_i^{\sigma-1} \right)$$

$$-\frac{\sigma}{2} VAR\left[\log \left[\left(\frac{R}{\alpha}\right)^{\alpha} \left(\frac{w_i}{1-\alpha}\right)^{1-\alpha} \right] + \log \left[\frac{(1-\bar{\tau}^K)^{\alpha}}{(1+\bar{\tau}^Y)} \right] \right]$$

Here we are making the strong assumption that the there is the same equilibrium wages under actual and uniform subsidy provision scenarios.

In this case, the TFP discount relative to frictionless benchmark

$$\upsilon \equiv \log TFP^* - \log \overline{TFP}$$

$$= \frac{\sigma}{2} VAR\left[\log \left[\left(\frac{R}{\alpha}\right)^{\alpha} \left(\frac{w_i}{1-\alpha}\right)^{1-\alpha} \right] \right]$$

A.4) Unpacking the covariance term

$$\mu \equiv \log TFP^* - \log TFP$$

$$= \frac{\sigma}{2} VAR\left[\underbrace{\log \left[\left(\frac{R}{\alpha}\right)^{\alpha} \left(\frac{w_i}{1-\alpha}\right)^{1-\alpha} \right]}_{\equiv \Sigma_i \text{ structural}} + \underbrace{\log \left[\frac{(1-\tau_i{}^K)^{\alpha}}{(1+\tau_i{}^Y)} \right]}_{\equiv S_i \text{ subsidies}} \right]$$

$$= \frac{\sigma}{2} \left[VAR(\Sigma_i) + VAR(S_i) + 2COV(\Sigma_i, S_i) \right] \qquad \text{(A1)}$$

A.5) Unpacking the covariance terms further

$$T_i^Y \equiv \log(1 + \tau_i^Y)$$
$$T_i^K \equiv \log(1 - \tau_i^K)$$

$$\mu = \frac{\sigma}{2} \Bigg[VAR(\Sigma_i) + \alpha^2 VAR(T_i^K) + VAR(T_i^Y)$$

$$-2\underbrace{COV(\Sigma_i, T_i^Y)}_{-.003784} + 2\alpha \underbrace{COV(\Sigma_i, T_i^K)}_{-.000886} - 2\alpha \underbrace{COV(T_i^K, T_i^Y)}_{.000385} \Bigg] \qquad \text{(A2)}$$

B) Data Appendix

B.1) Feed-in tariffs

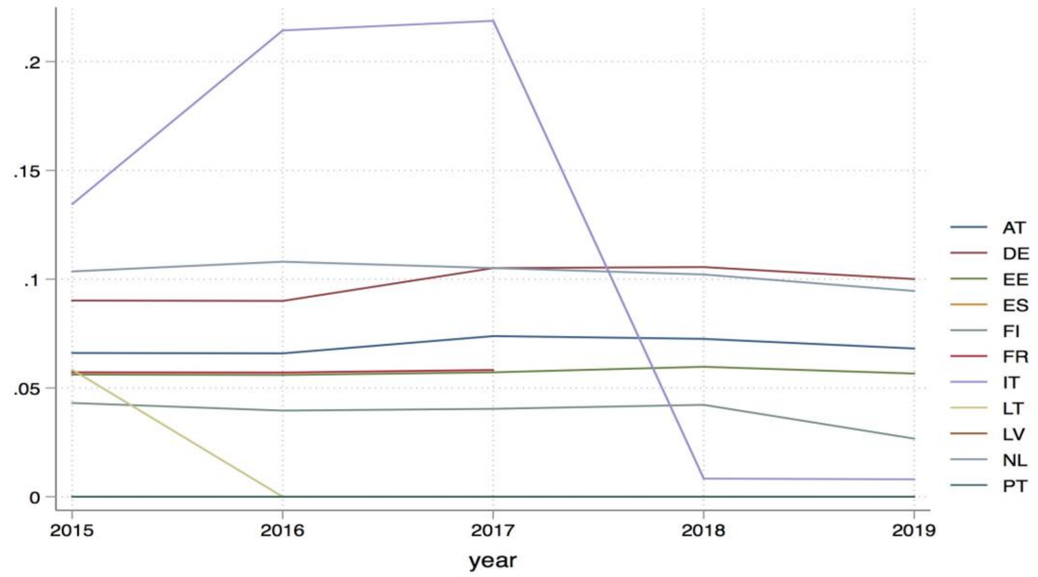
We retrieve Feed-in tariffs rates (USD/kWh) comparable across countries and years (Source: OECD) as a proxy of production subsidy τ_i^Y. These are shown in Figure B1. We notice that France has no data after 2017, and that Italy experiences a large reform.

Since we want to have the four largest economies in the sample, which account for more than 75% of total subsidies paid in the renewable industry (Figure B4), we restrict the sample to Germany, France, Italy and Spain, between 2015 and 2017.

B.2) Investment subsidies

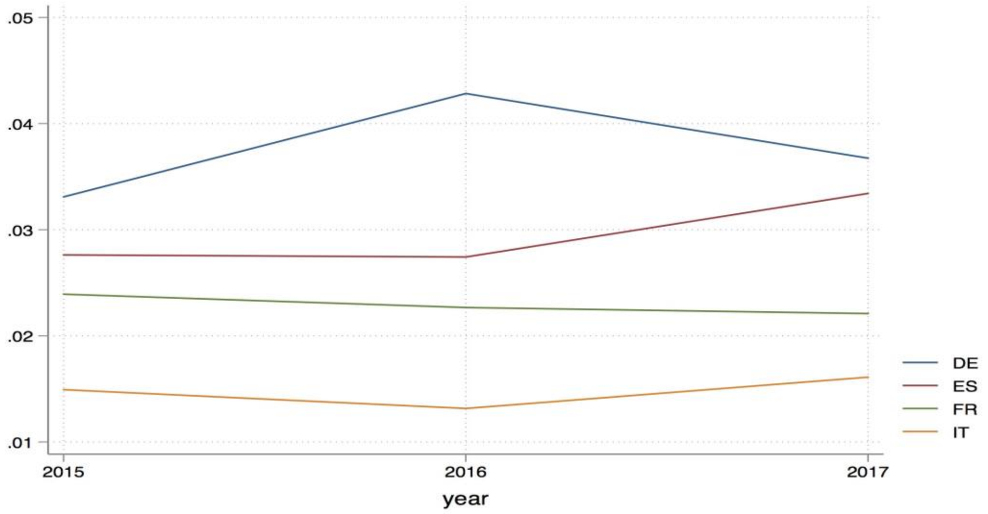
We retrieve EUR millions spent in tax expenditure + grants in “Energy sector” (Source: Eurostat) and assume that the sum is not used for *production* tax credit, which is fully managed through Feed-in tariffs rates. Finally, we divide it by EUR millions investment (GFCF) in electricity sector (Source: Eurostat) as a proxy of investment subsidy τ_i^K. The data are shown in Figure B2.

Figure B1: Feed- in tariffs τ_i^Y.



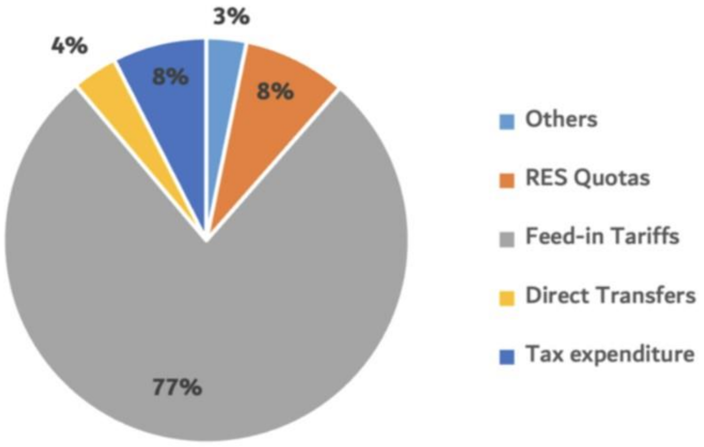
Notes: this figure shows the time evolution of Feed-in tariffs rates in several EU countries for which data are available. The data are taken from the OECD: https://www.oecd.org/environment/indicators-modelling-outlooks/policy-instruments-for-environment-database/.

Figure B2: Investment subsidy τiK.



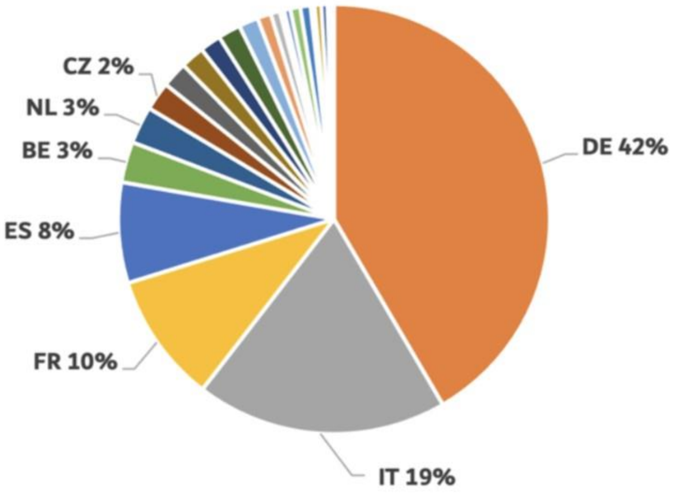
Notes: this figure shows the time evolution of investment subsidy rates in the largest EU countries for which data are available. The data are taken from Eurostat: https://op.europa.eu/en/publication-detail/-/publication/34a55767-55a1-11ed-92ed-01aa75ed71a1.

Figure B3: EU27 RES by financial instruments (2020).



Source: Gros et al. (2023)

Figure B4: EU27 RES by member state (2020).



Source: Gros et al. (2023)

B.3) Wages and missing parameters

Nominal Wages w_i are obtained by dividing EUR paid in wages and salaries by number of full time-equivalents in electricity sector (Source: Eurostat).

Before calculating our key quantities μ and υ, we set $\alpha = 0.35$ and $R = 1.04$. We also need to assign a value for σ. For manufacturing, Hsieh and Klenow (2009) set $\sigma = 3$. For electricity, which is a homogeneous good, σ is likely to be much larger. A simple regression of the form

$$\log\left[\frac{\text{Turnover}_{it}}{\text{Deflator}_{it}}\right] = \sigma \log\left[\text{Deflator}_{it}\right] + year\, FE + \varepsilon_{it}$$

Table B1: Summary statistics

	(1) N	(2) mean	(3) sd	(4) min	(5) max
w_i	4	0.0525	0.00731	0.0447	0.0604
R	4	1.040	0	1.040	1.040
τ_{iY}	4	0.0855	0.0794	0	0.189
τ_{iK}	4	0.0262	0.00970	0.0147	0.0376
α	4	0.350	0	0.350	0.350

Notes: this table presents the summary statistics of the variables used in the analysis.