Counterfactual assessment in the design of tax reforms: model decomposition of revenue and redistribution effects

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Abstract

In this paper, we propose a methodology for the evaluation of tax reforms through the design of counterfactual scenarios using Euromod. For this purpose, we develop two theorical model decompositions to explain the differences in tax revenue collection and the redistributive impact. We provide empirical evidence by designing a tax reform in Spain based on the French personal income tax. The approach can explain the isolated causes of differences based on the contribution of the tax system design and the income distribution. This result could help determining whether policy recommendations should focus on pre-distribution or redistribution.

JEL classification: H20, H24, C60, D04, D63, J38

Keywords: tax reforms, counterfactual, evaluation, microsimulation, Euromod

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1. Introduction

The design of tax systems varies across countries, reflecting not only the underlying social preferences but also the ability to pay and the characteristics of income and wealth distribution. The practical implementation of a tax system entails different redistributive effects defined both by the design of the taxes and the distribution of taxpayers. Consequently, the same tax rate could generate different redistributive effects in two countries, or even in two periods, with different pre-tax distributions (Kambayashi and Lechevalier, 2021; Thoresen et al., 2016; Vellutini and Benítez, 2021; Verbist and Figari, 2014).

In addition, the literature on the evaluation of tax reforms has shown that the ways to capture distributional effects also vary, and they usually depend on the definition of welfare and on the way the effects of the tax policy contribution are measured among other factors (Haughton and Khandker, 2009; Immervoll et al., 2007; Lambert, 1993). Therefore, the purpose of this paper is to provide a new methodological approach to explain the reasons why some tax systems collect and redistribute more than others. This approach is based on the use of counterfactual scenarios and microsimulation techniques, trying to avoid assumptions about how and where to measure the expected effects.

Our first question is the following: which factor can define the greater tax revenue and redistributive capacity of a tax system? We can first think about the design of the taxes. If one tax structure is more progressive than another and it could collect the same or even more revenue on a given income distribution, its redistributive impact will be greater when we measure it according to its contribution to inequality reduction between gross and net income (Kakwani, 1977). Its greater "size" or average revenue collection is an a priori indication of greater redistributive potential. Therefore, if we assume that the redistributive and tax-collecting impact of a tax only depends on its design, we will have the best solution to redistribute more and collect more revenue by transferring a better designed tax regulation and imposing it on the target distribution in any country or period.

It seems obvious that the design of a tax is not the only factor influencing how income is collected and redistributed. The initial distribution related to where the tax is going to be applied (gross income) constitutes another relevant factor to be considered just because the tax revenue and redistributive power responds differently to different income structures. In this regard, this paper assumes that the distribution of a post-tax income (net income) is a consequence of both the result of the application of a tax system regulation (tax design) and the prior characteristics of the pre-tax income distribution. So far, the purpose of this paper is to separate the contribution to genuine redistribution and revenue collection of a tax design from that achieved by the induced characteristics of the initial income distribution to be taxed.

The literature has provided some methods that make redistribution indexes comparable, controlling for differences in pre-tax distributions. One method is to "transfer" tax regimes to a common regime with an identical pre-tax distribution, whereby they can be reliably compared (Dardanoni and Lambert, 2002). This method has been used recently to analyse the redistributive capacity of personal income tax at the global level on a sample of 108 countries over the period 2007–2018 (Vellutini and Benítez, 2021). Controlling for differences in pre-tax distributions, the authors isolate the intentional effect of the tax design, obtaining evidence about the non-fulfilment of the Robin Hood paradox (Lindert, 2004) in redistribution across countries, as those with higher income inequality tend to introduce more redistributive taxes. They also find that the size of personal income tax, measured by its aggregate tax rate or the ratio of income to GDP, is a harder constraint on redistribution than progressivity of tax rates in many developing and low-income countries. Lambert et al. (2020) use this same "transfer and compare" methodology in a smaller set of eight countries, and they find that Finland is the most redistributive country based on this approach.

In this regard, the literature has concluded that there is no single solution to design a personal income tax for income redistribution and revenue collection in the same way in two different countries or income distributions. This is because the final impact of the tax will depend not only on its design but also on the income distribution to which it is applied, as it is mainly derived from the wage structure of the labour market. However, despite the relevance of this factor in predicting the effect of a personal income tax reform, there is no method in the literature that allows us to intentionally isolate the impact on tax collection and redistribution of both the effect of the initial distribution and the effect of the design of the tax structure.

Therefore, the final purpose of this paper is to propose a methodology that allows us to decompose the effects of any tax regulation in terms of both tax collection and redistribution. Our approach is based on defining counterfactual scenarios using the tax-benefit microsimulation model Euromod (Sutherland and Figari, 2013) to analyse the effects of a tax reform based on the characteristics of a given tax system. By comparing those scenarios with the baseline ones, we can realistically evaluate the effects of the tax reforms by isolating both effects, namely, the one caused by the tax design (system effect) and the one caused by the pre-tax income distribution (distribution effect).

Our basic hypothesis is that tax collection and redistributive impacts of a tax system are the consequence of the interaction of at least two effects: the system effect – how the tax regulation is designed to collect and redistribute income – and the distribution effect – how effective tax collecting and redistributing income over different income distributions are. As we will prove, those effects can perfectly explain the differences in both the tax revenue collected, as will be evidenced by the decomposition of the DTR model, and the differences in the redistributive impact achieved, as will be evidenced by the decomposition of the DRI model.[2] We generate counterfactual scenarios which can be compared to baseline scenarios, the reality, using Euromod. The counterfactuals assume a hypothetical scenario, in which the tax system of one country is applied to the income distribution of the other country. Comparisons of the results in the different scenarios allow us to isolate the contribution of the two effects by applying our developed approach: the DRI and DTR models.

As we have argued, the redistributive and tax collection capacity of a tax in a country are different if applied to the income distribution of a different country. So, this approach has the potential to offer an explanation about the isolated causes of the differences. In addition, the paper provides an empirical exercise to illustrate our proposal and to show the validity and usefulness of the decomposition methods. However, the aim of this paper is not to analyse the effects of a specific tax reform

[2] DTR and DRI stand for differences in tax revenue (DTR) and differences in redistributive impact (DRI).

across countries but to contribute to the literature by developing a systematic methodology to separate the effects of the tax system from the effects of the income distribution. The empirical exercise consists of transferring part of the design of the French personal income tax (IRPP) to the structure of the Spanish income tax (IRPF). Our counterfactual scenario analysis and its results are compared to the baseline scenarios, French and Spanish regulations applied to French and Spanish distributions of income, respectively. The differences in the tax revenue collected and in the redistributive impact in the three scenarios are explained using the DTR and DRI models to analyse the decomposition. These countries have been chosen because both tax systems provide richness to the empirical analysis in terms of differences in pre-tax income distribution and tax collection but the relevance of the DTR and DRI models is that the empirical exercise could be done by choosing any other countries. Thus, this decomposition method could be applied for analysing any practical scenario.

The empirical exercise allows us to obtain certain interesting conclusions as evidence of the results and policy recommendations that we can extract by using those models. We find that Spanish IRPF is more progressive and larger than the counterfactual application of French IRPP to the Spanish income distribution. This is merely evidence that policymakers have adapted the design of the tax to the characteristics of the Spanish income distribution, while the French rules do not fit this distribution as well. However, despite the advantages of the Spanish IRPF design, the French tax collects more with a less progressive design and with a much smaller size than the Spanish one because the average income in France is three times higher than the average income in Spain, which strongly boosts its final collection with a residual cost in terms of income redistribution. This shows the importance of analysing the average effective tax rate and its progressivity to understand the impact of any reform on tax collecting and the redistributive capacity, but it also shows the importance of income pre-distribution in explaining those differences. In this sense, the economic policy recommendation for the Spanish legislator would not be related to improving the current tax design but to propose income pre-distribution policies in the labour market that would allow for increasing the country's average income. Thus, the relevance of our methodological approach is to isolate the effect of the redistributive from the tax-revenue capacity of any tax in any country.

The rest of the paper is structured as follows. Section 2 establishes the theory about the differences in the redistributive and tax-collecting capacity of two tax systems depending on the income distribution and the design of the tax. Thus, the methodological decomposition of the DTR and DRI models is exposed in this section by introducing the comparison between real scenarios and counterfactual ones. In addition to isolating the distribution and system effects, the decomposition is reformulated in terms of average effective tax rates, a key variable for explaining the redistributive and tax-collecting capacity of a tax system. In Section 3, we describe the design of the counterfactual scenarios using Euromod, which allows us to carry out the decomposition of the effects by adapting the French IRPP to the Spanish IRPF. This section enables us to evaluate the reform on the Spanish post-tax income distribution in Section 4, in which the empirical evidence is analysed using the DRI and DTR models proposed. We present the main conclusions in Section 5, where we also anticipate some future research lines.

2. Contrafactual design and decomposition models

This section decomposes the expected differences of a tax reform in terms of tax revenue and redistributive impact, considering concepts introduced earlier in terms of system effect (SE henceforth) and distribution effect (DE henceforth). As a first step, the DRI model analyses the decomposition of the DRI of countries, that is, the redistributive potential of a tax given an original income distribution and inequality and, on the other hand, the normative effect as the differential effect of the design of one tax in relation to another. In a second step, the DTR model tries to explain the differences in revenue collection between two countries based on differences in average rates and total taxable income.

2.1. Differences in the redistributive impact: The DRI model

In this section, we provide support to the previously introduced concepts using an analytical development of the inequality indices (Lambert, 1992). The aim is to explain whether the DRI observed in two countries (differences in how each country manages to reduce its inequality, understood as the change from gross to net income by applying the tax system) are due purely to the tax design (greater or lesser progressivity and greater or lesser size of tax collection) or if they also respond to how limited these tools are in terms of redistributing a certain distribution of income. The redistributive impact is conditioned by the two components already mentioned. Firstly, the same regulation generates different effects depending on the distribution where it is applied, DE. Secondly, the same pre-distribution in a country conditions the redistributive effect that alternative regulations can achieve, SE. The main aim of this paper is to isolate the so-called effects of SE and DE. Following the notation introduced,[3] DRI between two countries i and j can be explained as the difference in their Reynolds-Smolensky (*RS*) indexes:

$$DRI_{ij} = RS_{ii} - RS_{jj} = [G_i - G_{ii}] - [G_j - G_{jj}] = [G_i - G_j] - [G_{ii} - G_{jj}] \qquad [1]$$

After re-arranging its components, equation [1] indicates that the difference in the way one country redistributes its income (i -ii) with respect to another country (j - jj) depends on, first, how different the original inequalities are and, second, how different the distributions of net income in each country in terms of inequality are, that is, after the implementation of each country's tax system. However, [1] does not report the isolated SEs or DEs. How redistributive would tax *i* be on income distribution *j*? Could the redistributive impact in country *i* be improved by introducing tax system *j*? Is the lower (higher) redistributive impact of a given tax a consequence of lower (higher) revenue potential, lower (higher) progressivity, or both?

We try to answer these questions by using the DRI model and its decomposition. To do so, it is necessary to introduce counterfactual scenarios that, via comparison with real scenarios, provide information on what would happen in alternative situations. Thus, we can consider the following two hypothetical situations:

1) What would happen if country *i*'s distribution were taxed at tax *j* (scenario *ij*)?
2) What would happen in country *j* if tax system *i* were applied (scenario *ji*)?

Baseline scenarios (control, reality) involving the enforcement of a law in the same country are compared with treated scenarios (counterfactual) where the law of one

[3] The subscripts used require further explanation. If, for instance, the Gini coefficient has only one subscript, it refers to the index calculated on income in one country. If the index has two subscripts, the first refers to the income distribution where it is applied, and the second represents the tax system. So, G_{ij} indicates that the income distribution of country *i* is taxed according to the rules in country *j*.

country is artificially applied to the distribution of the other. The treatment–control comparison identifies the effects of the tax design and distribution, providing an explanation for the DRI between the two countries *i* and *j*. The comparison of the baseline/real scenarios (*ii* - *jj*) with the counterfactual scenarios (*ij* - *ji*) enables us to answer the questions raised previously.

We aim to isolate the extent to which the DE and SE effects contribute to explaining differences in the redistributive capacity of the same tax system applied in two different countries. For this purpose, the counterfactual scenario *ij* is incorporated into the analysis of the DRI of equation [1][4]:

$$DRI_{ij} = RS_{ii} - RS_{jj} = [G_i - G_{ii}] - [G_j - G_{jj}] \quad [2]$$

$$DRI_{ij} = [G_i - G_{ii}] - [G_j - G_{jj}] + [G_{ij} - G_{ij}] + [G_i - G_i]$$

$$DRI_{ij} = [G_i - G_{ii}] - [G_j - G_{jj}] + [G_i - G_{ij}] - [G_i - G_{ij}]$$

$$DRI_{ij} = RS_{ii} - RS_{jj} + RS_{ij} - RS_{ij}$$

$$DRI_{ij} = [RS_{ij} - RS_{jj}] - [RS_{ij} - RS_{ii}] \quad [2.1]$$

$$DRI_{ij} = [RS_{ij} - RS_{jj}] - [RS_{ij} - RS_{ii}] = DE_i - SE_j \quad [2.2]$$

where *Gij* indicates the net-income inequality by applying regulation *j* in country *i*, which gives rise to the counterfactual redistributive impact, RS_{ij}, once G_{ij} is subtracted from G_i (the gross-income inequality in the distribution of country *i*). Figure 1 summarises the operation scheme of the DRI model.

[4] The only change introduced in equation [2], when moving from the first to the second expression, is the addition of two zero-sum components $[G_{ij} - G_{ij}]$ and $[G_i - G_i]$. The first component enables the counterfactual scenario *ij* to be introduced into the analysis, and the second is introduced because what is sought through this scenario is not only the influence of tax *j* on country *i* (SE) but also the impact of tax *j* on the distribution *i*, which is different from its own *j* (DE).

Equation [2.2] indicates that the observed DRI between countries I and j is due to two components which can be isolated:

- *DEi* $[RS_{ij} - RS_{jj}]$: This measures the redistributive effect of tax *j* on distribution *i* with respect to the redistributive effect achieved on its own distribution *j*. So, it proxies the difference in the redistributive potential of tax *j* applied to its own distribution and to another distribution *i*. As tax j is the reference tax, the expression captures the differential impact since this tax is not treated with its own distribution *j*, but it is settled on distribution *i*, showing different initial inequality. Therefore, it constitutes a measure of the previously named DE.

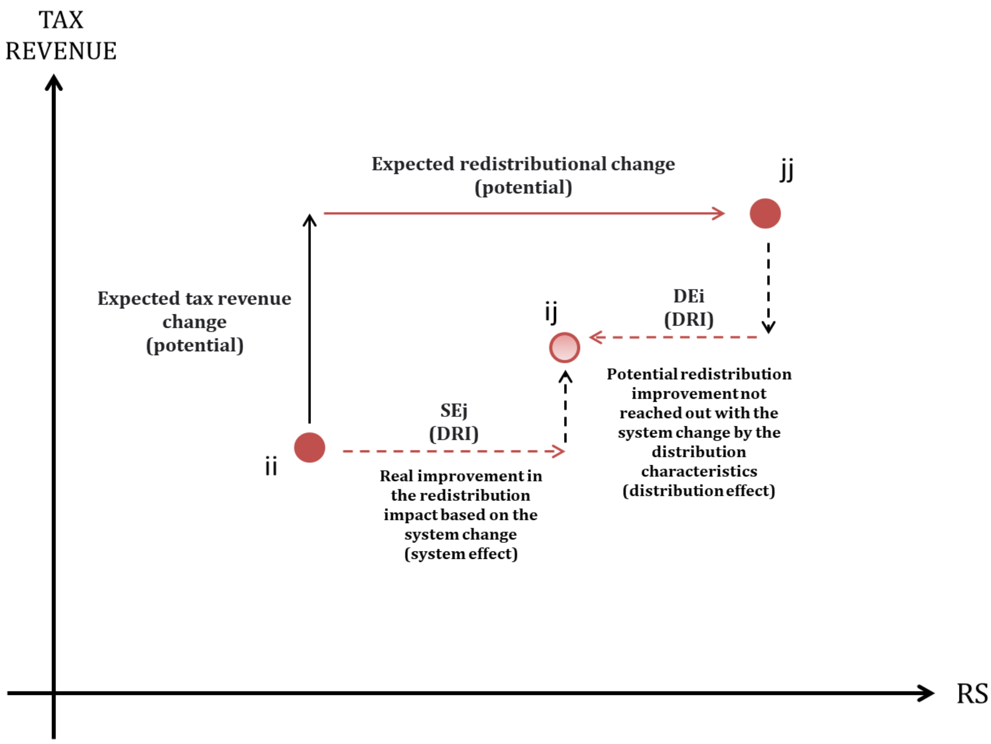
  If we denote the scenarios for Spain (country *i*) with“”" and for France (country *j*) with“”", for instance, $ED_E = RS_{EF}$- RS_{FF} indicates that the first component represents the counterfactual treatment scenario (France's regulations applied to Spain), and the second component represents the actual control scenario (France's normative applied to France). Since the way to compare the distributions is to check how they react to the application of the same tax system, the expression captures how different the Spanish distribution is compared to the French one. This introduces an alternative route to the traditional way[5] of measuring differences in distributions by calculating the redistributive effect that a tax system generates when facing two alternative distributions. Specifically, we measure the difference in the

[5] The inequality associated with a distribution can be summarised in a single value through the computation of a Gini index associated with it. In this paper, the Gini index is used as a traditional tool, but as a novelty of our analysis, the differences between two distributions are captured through the impact on them of the same tax system.

redistributive effect achieved by applying a tax in Spain that is different from the Spanish tax – in this case, the French tax – (counterfactual scenario), with respect to that which would be achieved by applying the French regulation in France (real reference scenario).

- $SE_j\,[RS_{ij} - RS_{ii}]$: It measures the difference in the redistributive capacity of tax *j* on distribution *i* compared to the redistribution attained by tax *i* on its own distribution. In this case, since distribution *i* is taken as the reference, the DRI can only be caused by a normative issue since system tax *j* is applied instead of system tax *i*. Similarly, $ESF_F = RSEF_{EF} - RSEE_{EE}$ captures the differential redistributive effect of the French regulation by comparing the redistributive capacity of the French regulation in Spain (counterfactual scenario) versus the Spanish regulation in Spain (actual reference scenario).

Figure 1. The DRI model



Source: Own elaboration

Thus, the DRI between two countries is the consequence of two isolated effects: the SE and the DE. In other words, the DRI of a tax system is the result of the non-coincidence of the initial distributions, diminished by the fact that the redistributive capacity of the tax systems *i* and *j* do not produce the same results when applied to the same distribution.

What would happen if country *j* applied the tax of country *i*? We try to answer this question by decomposing equation [1] in an analogous way to what we did with equation [2] for an alternative counterfactual scenario *ji*:

$$DRI_{ji} = RS_{jj} - RS_{ii} = [G_j - G_{jj}] - [G_i - G_{ii}]$$

$$DRI_{ji} = [G_j - G_{jj}] - [G_i - G_{ii}] + [G_{ji} - G_{ji}] + [G_j - G_j]$$

$$DRI_{ji} = [G_j - G_{jj}] - [G_i - G_{ii}] + [G_j - G_{ji}] - [G_j - G_{ji}]$$

$$DRI_{ji} = RS_{jj} - RS_{ii} + RS_{ji} - RS_{ji} \quad [3]$$

$$DRI_{ji} = [RS_{ji} - RS_{ii}] - [RS_{ji} - RS_{jj}] \quad [3.1]$$

$$DRI_{ji} = DE_j - SE_i \quad [3.2]$$

where G_{ji} measures the net-income inequality as a result of applying regulation *i* in country *j* and subtracted from the gross-income inequality in country j, G_j, it provides RS_{ji}. This corresponds to the *RS* index, the redistributive impact of the application of regulation of country *i* in country *j*.

In this case, SE_j can be interpreted as the differential impact in redistributive terms of tax *i* applied on distribution *j* (counterfactual scenario *ji*) with respect to what tax *j* achieves when applied to the same distribution (actual reference scenario *jj*). Since the reference distribution is *j*, $[RS_{ji} - RS_{jj}]$ captures what the impact of tax system *i* would be on a different distribution *j*. On the other hand, the DE_j captures the difference in the redistributive power of tax *i* when applied to the distribution of country *j* and in country *i*, $[RS_{ji} - RS_{ii}]$. It is therefore the same tax regulation applied to different income distributions and the difference in redistributive power will be due exclusively to the variation between the starting distributions.

We can see in [1] and [2.2.] or [3.2.] that the DRI (the value provide by DRI model) can be expressed in two alternative ways: one from the differences in the Gini indices between gross and net income in each country by applying their tax system, and another one from using the previous decomposition in terms of the DE and SE. It is possible to obtain an alternative expression with both equations. It allows us to conclude that the differences in net-income inequality between two countries, each applying its own tax system, is the result of three components: first, the difference in starting inequalities $[G_i - G_j]$; second, the DE; and third, the SE. The way these three components interact is as follows:

$$DRI_{ij} = RS_{ii} - RS_{jj} = [G_i - G_j] - [G_{ii} - G_{jj}]$$

$$DRI_{ij} = [RS_{ij} - RS_{jj}] - [RS_{ij} - RS_{ii}] = DE_i - SE_j$$

$$[G_i - G_j] - [G_{ii} - G_{jj}] = DE_i - SE_j$$

$$[G_{ii} - G_{jj}] = \left[[G_i - G_j] - DE_i\right] + SE_j \qquad [4]$$

Analogously, we can state:

$$[G_{jj} - G_{ii}] = \left[[G_j - G_i] - DE_j\right] + SE_i \qquad [5]$$

Thus, the difference in net inequalities can be explained by three components: the difference in initial inequality, SE and DE. The DE is incorporated by decreasing the differences in the initial inequality, while the SE increases it; equation [4] and [5] offer an explanation for the observed differences in net-income inequality between two countries *i* and *j*. Part of this observed inequality will be a direct consequence of the differences in gross-income inequality ([G_i - G_j]) inherent to the initial situation and from which we must subtract DE_i and add SE_j.

DE_i represents the potential for change, in redistributive terms, of the application of the regulation of country *j* on the income distribution of country *i*, as compared to the situation where the regulation of country *j* is applied on its own. The higher the value of DE_i the more the differences in initial inequality will be reduced, ceteris paribus, and hence, the differences in net-income inequality between the two countries will be smaller. That is: $\uparrow\uparrow ED_i \rightarrow \downarrow\downarrow\left[[G_i - G_j] - ED_i\right] \rightarrow \downarrow[G_{ii} - G_{jj}]$. The first bracket explains the part of the difference in the net-income inequality between two countries as a consequence of the interaction between the difference in the initial inequality of both countries and the potential in terms of the redistributive impact of the distribution under study, in this case country *i*.

The component related to the starting distributions and their induced effects on redistribution does not fully explain the difference in net-income inequality between country *i* and country *j*. It is necessary to introduce the SE_j component to complete the explanation. It should be noted that SE_j captures the difference in redistributive power caused by applying either regulation *j* or regulation *i* in country *i*. Thus, the greater the SE_j (the difference RS_{ij} - RS_{ii}), the greater the redistributive power of tax system *j* in distribution of country *i* compared to tax system *i* in its own distribution.

Intuitively, this would mean that, in terms of design, the tax system of country *j* has a greater potential to redistribute income than the tax system of country *i* itself. This means that the less redistributive tax system *i* is with respect to *j*, the difference in net-income inequality between the two countries will tend to grow because a more redistributive regulation, *j*, could be settled when *i* is used. So, $\uparrow\uparrow ES_j \rightarrow \uparrow\uparrow [G_{ii} - G_{jj}]$. Therefore, if the objective was to reduce the net-income inequality of country *i* with respect to what happens in country *j* (assuming that tax in country *j* has more redistributive power), the more the regulation of country *i* resembled in terms of redistributive power the regulation of *j*, the greater the reduction in the differences in net-income inequality could be. Then, the reverse would be true $\downarrow\downarrow ES_j \rightarrow \downarrow\downarrow [G_{ii} - G_{jj}]$.

Although the influence of the SE could lead to a recommendation to imitate more potentially redistributive tax designs, equation [4] or [5] show that it is necessary to consider that it is not the only element that influences the differential in net-income inequality between two countries. The initial distribution component (differences in gross-income inequality) as well as the DE play a fundamental role that can compensate for that which would be generated by SE. Therefore, it is necessary to consider the two effects jointly, which is possible through the decomposition presented here.

2.2. Differences in the impact of tax revenue: The DTR model

In this section, we decompose the DTR collection of a tax-system reform according to both its design (SE) and the collection potential of the income distribution to which it is applied (DE). The tax revenue (REC_{ii}) achievable by the tax structure in country *i* on its own income distribution *i* is the sum of the net-tax quotas (CL_{ii}) as aggregation of the amount paid by each taxpayer, defined by two elements: the average effective tax rate (tme_{ii}) and the total taxable income ($\sum_{h=1}^{HI} Y_{ih}$):

$$REC_{ii} = \sum_{i=1}^{N} CL_{ii} = \sum_{i=1}^{N} CL_{ii} \cdot \frac{\sum_{h=1}^{HI} Y_{ih}}{\sum_{h=1}^{HI} Y_{ih}} = \frac{\sum_{i=1}^{N} CL_{ii}}{\sum_{h=1}^{HI} Y_{ih}} \cdot \sum_{h=1}^{HI} Y_{ih} = tme_{ii} \cdot \sum_{h=1}^{HI} Y_{ih} \quad [6]$$

where we denote by $h = 1, \ldots, HI$ the taxpayers of country *i*.

In an analogous way, we can obtain $REC_{jj} = tme_{jj} \cdot \sum_{h=1}^{NJ} Y_{jh}$, with $h = 1, \ldots, HJ$ being the taxpayers of country *j*.

We can define the corresponding equations in the counterfactual scenarios, $REC_{ij} = tme_{ij} \cdot \sum_{h=1}^{NI} Y_{ih}$ and $REC_{ji} = tme_{ji} \cdot \sum_{h=1}^{NJ} Y_{jh}$.

Thus, REC_{ij} and REC_{ji} indicate, respectively, the revenue that would be obtained by applying the average effective tax rate of regulation *j* when applied to the income of country *i* and the revenue that would be obtained by applying the average effective tax rate of regulation *i* on income of country *j*. Using the previous expressions, the difference in tax revenue collection between the two countries *i* and *j* that apply their respective tax regulations is as follows:

$$DTR_{ij} = REC_{ii} - REC_{jj} \quad [7]$$

We use equation [7] to add and subtract the counterfactual scenario *ij* and to identify the decomposition of this difference:

$$DTR_{ij} = [REC_{ij} - REC_{jj}] - [REC_{ij} - REC_{ii}] \quad [8]$$

$$DTR_{ij} = [tme_{ij} \cdot \sum_{i=1}^{N} Y_i - tme_{jj} \cdot \sum_{j=1}^{N} Y_j] - [tme_{ij} \cdot \sum_{i=1}^{N} Y_i - tme_{ii} \cdot \sum_{i=1}^{N} Y_i]$$

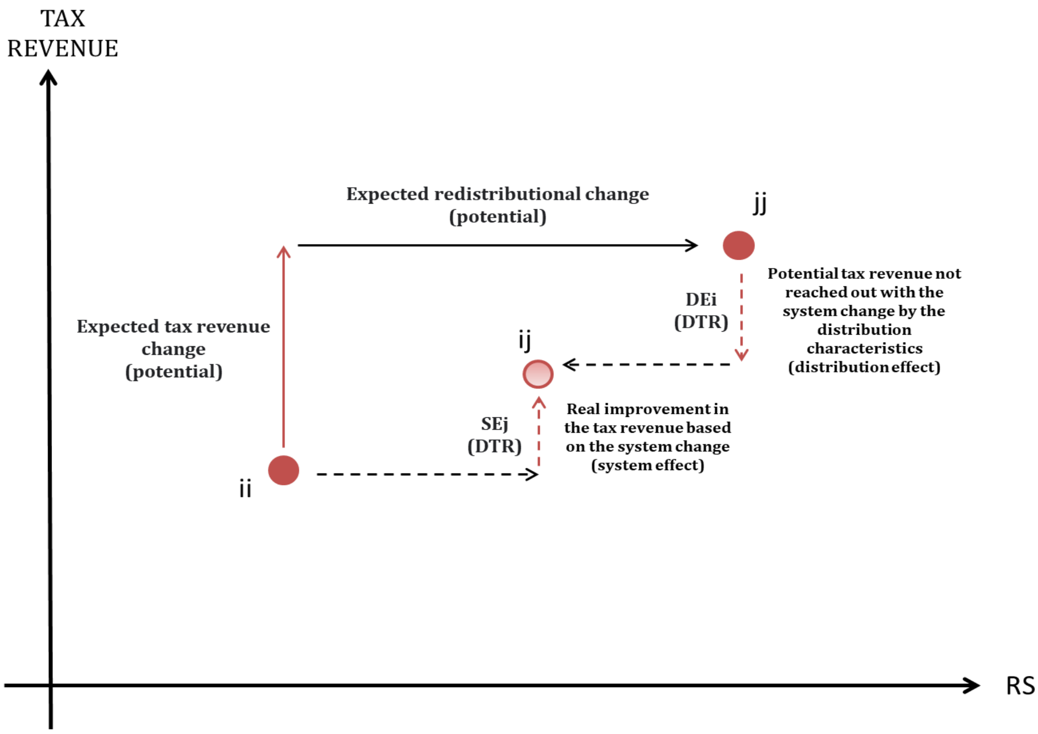
$$DTR_{ij} = \left[tme_{ij} \cdot \sum_{i=1}^{N} Y_i - tme_{jj} \cdot \sum_{j=1}^{N} Y_j\right] - \left[\left(tme_{ij} - tme_{ii}\right) \cdot \sum_{i=1}^{N} Y_i\right] \quad [8.1]$$

$$DTR_{ij} = DE_i - SE_j \quad [8.2]$$

The DTR collection can be explained by two effects according to equation [8.2]. One is because the same regulation applied to different distributions has a different collection potential (DE); the other is because the regulations themselves are different (SE) and when they are applied to the same distribution, they generate different tax revenue. Figure 2 summarises the operation scheme of the DTR model. Thus,

- *DE on tax revenue*, DE_i, indicates how much the application of the average tax rate of country *j* would raise in country *i* with respect to what the same tax variable *j* raises in country *j*. Note that the minuend represents a counterfactual scenario and the subtrahend a real scenario. Thus, the difference in tax revenue is not only because gross incomes are not equal ($\sum_{h=1}^{NI} Y_{ih} \neq \sum_{h=1}^{NJ} Y_{jh}$) but also because of the difference in how tax *j* would be collected in income distribution *i* ($tme_{ij} \neq tme_{jj}$).
- *SE on tax revenue*, SE_j, indicates how much of the DTR are because of the design of different regulations when applied to the same reference distribution. This effect is captured by the difference between the effective tax rates of the counterfactual scenario *ij* and the baseline *i* multiplied by the total taxable income in country *i* $\left[\left(tme_{ij} - tme_{ii}\right) \cdot \sum_{h=1}^{NI} Y_{ih}\right]$. In other words, the average effective tax rates tme_{ij} and tme_{ii} are different, and this generates DTR when applied even to the same income distribution, that of country *i* in this case.

Figure 2. The DTR model



Source: Own elaboration

We have evaluated the redistributive effect, and we have concluded that the whole impact can be decomposed into influences depending on the initial inequalities, the SE and the DE. It is also possible to decompose it in a convenient way through effects on revenue. We have proved that the revenue differences between the two systems are due to two perfectly isolable components. The first captures the difference between the DE on revenue, while the second subtracts the effects that the system's normative (SE) has on revenue.

2.3. The average effective tax rate as an adjustment variable for the DRI and DTR models

The previous sections have shown the influence of the distribution of income to which a tax regulation is applied and of the regulation itself as determinants of redistributive and tax-collecting capacity. In addition, we have shown in a counterfactual framework how both the revenue and redistributive differences between two alternative tax systems can be reduced to an isolated decomposition that captures two effects. Nevertheless, the effect of the distribution and the system design are not the only determinants of the differences explained by the models. The average effective tax rate resulting from the application of a tax regulation to an income distribution is also a variable that affects both the tax-collecting and distributive capacity. The objective of this section is to highlight the influence of the average effective tax rate as an adjustment variable between the two models.

A high average effective tax rate implies a high tax-collecting capacity, which will be greater the higher the total taxable income (see equation [8.1] of the DTR model). The average effective tax rate also modifies the redistributive capacity of the system as measured by the RS index. The decomposition of the index leads to the final redistributive effect:

$$RS = K \cdot \frac{tme}{1-tme} - R \quad [9]$$

We can see in equation [9] that if we disregard the usual small magnitude of the re-rank effect (R), as Lambert (1992) proved, we do not alter the relationship between progressivity and redistribution, being the redistributive capacity of a tax variable equal to the product of the Kakwani (K) progressivity index by the quotient between the average effective tax rate, and one minus the average effective tax rate. The idea underlying this relationship is that the redistributive capacity of a tax system depends both on the progressivity of its design, K, and on the magnitude of the income to which the tax is applied. In other words, a tax system designed with maximum progressivity may hardly generate any redistributive effect if the average effective tax rate is low. Similarly, a tax system with both a very high effective average tax rate and a high tax collecting capacity may hardly generate any redistribution because its contribution to progressivity is minimal.

If we recover equation [2.1] of the DRI model, or analogously [3.1], and we introduce the decomposition [9], we obtain the following:

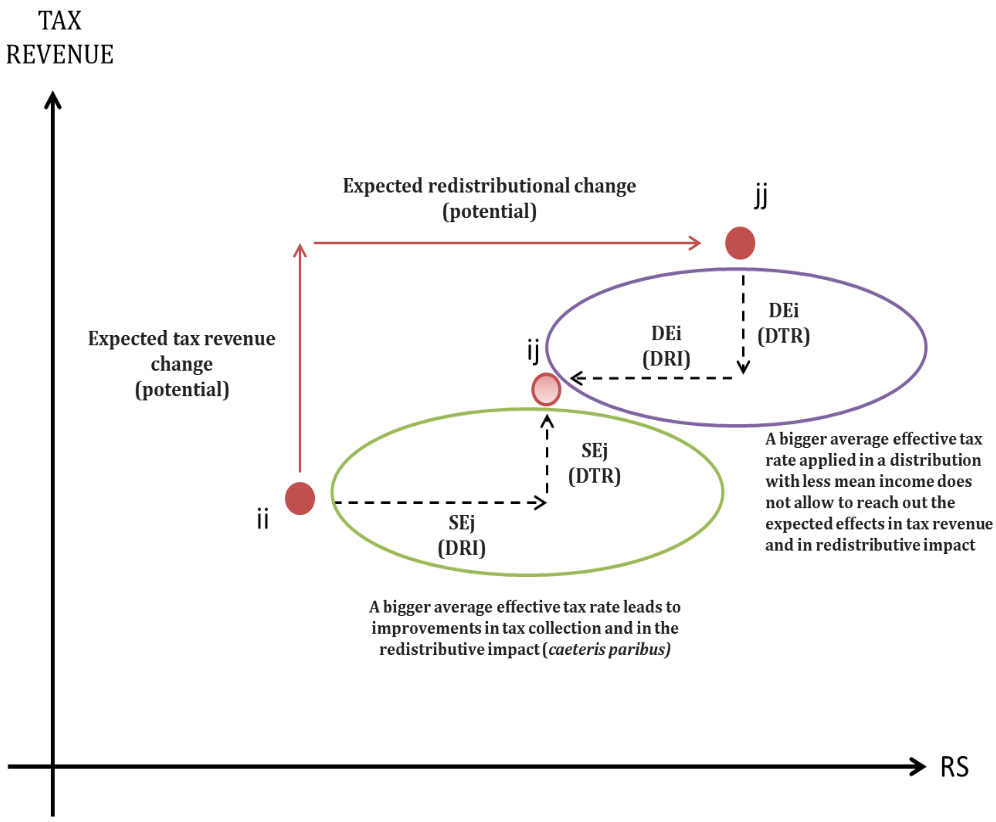
$$DRI_{ij} = [RS_{ij} - RS_{jj}] - [RS_{ij} - RS_{ii}]$$

$$DRI_{ij} = \left[K_{ij}\frac{tme_{ij}}{1-tme_{ij}} - K_{jj}\frac{tme_{jj}}{1-tme_{jj}}\right] - \left[K_{ij}\frac{tme_{ij}}{1-tme_{ij}} - K_{ii}\frac{tme_{ii}}{1-tme_{ii}}\right] \qquad [10]$$

Equation [10] will be fundamental to explain the DRI based on the interaction between the differences in the design of the tax system. We can obtain relevant information on the overall progressivity of the variable and the revenue-collecting capacity, which according to [10], we measure through the effect of the average tax rate, ($\frac{tme}{1-tme}$) in the treatment scenario (*ij*) and the control scenarios (*ii* and *jj*). Hence, the analysis of the K index provides relevant information for the analysis of the different design of regulations based on progressivity. It also depends on the distribution of the starting scenario in which the tax system is applied, while the analysis of the average tax rate effect, which is common in [8.1] and [10], will connect the conclusions from the DRI model and the DTR model. Figure 3 summarises the operation scheme of the DRI and DTR models from a joint perspective.

Since the above-described decompositions have attempted to reflect the importance of the regulation and the distribution to which it applies, we can conclude that rewriting the formulation in terms of the average tax rate has made explicit the relevance of this variable as an essential element contributing to both redistribution and tax-collecting capacity. It does so both through the income distribution to which it is applied and the progressivity inherent in the design of the normative.

Figure 3. The joint operation scheme of DRI-DTR models



Source: Own elaboration

3. Microsimulation methodology: Database and counterfactual design

In this section, we use the Euromod tax-benefit microsimulation model (Sutherland and Figari, 2013) for the empirical exercise.[6] This tool is very useful for the design of counterfactual scenarios where the normative of one country is going to be applied to the distribution of another country. This exercise requires access to the databases and regulations of each country (the database and the design of the tax-benefit system). In this paper, we make a comparison between Spain (country *i*) and

[6] EUROMOD_12.0+ version, February 2020.

France (country *j*) using the normative in force in 2018. Our main goal is to provide empirical evidence of our proposal without any intention to provide any specific tax policy recommendation between the French and the Spanish system. In this respect, we have chosen France, but we can select any country where Euromod can be implemented.

We build four output files for comparing the results:

1. Scenario *ii*: Spanish normative applied to Spanish data.
2. Scenario *ij*: French tax system applied to Spanish data.
3. Scenario *ji*: Spanish tax system applied to French data.
4. Scenario *jj*: French legislation applied to French data.

The design of the exercise assumes that scenarios labelled *ii* and *jj* are the control (factual) scenarios, which are obtained directly through the settlement of each country's normative incorporated in Euromod. The treatment (counterfactual) scenarios are represented by the subscripts *ij* and *ji* and they require the introduction of changes to run microsimulations in the tool. In fact, its introduction requires translating the regulations of one country to the income distribution of the other country.[7]

Then, the first step is to introduce the normative of each country into the model. It not only involves programming the tax design but also the entire model of monetary transfers and special contributions. In addition, the tax design not only concerns

[7] Some technical details that have arisen with the approximation of a valid counterfactual based on the French normative applied to the Spanish income have been largely solved using EUROMOD's know-how, which has been fundamental to understand the necessary parameters to validate the microsimulation of the counterfactual scenario and the meaning of the results. This validation process has been multiple, trying to use all the information potential provided by EUROMOD through the results obtained.

income tax, but it also affects other direct taxes, such as the tax on wealth as well as different country-specific contributions.

It may appear intuitively that the best option is to “switch off” everything in each country not related to the tax design to isolate the effect of the regulatory changes. However, this option is not feasible for two reasons: first because Euromod does not allow the calculations to be performed in this way and second because internal interactions of such legislation would cause incorrect simulations of important variables, such as tax revenue. If some parts of the legislation were disabled, it would be impossible to obtain the original income when income other than wages is involved, for example, retirement pensions, because the programme will try to calculate it, but it will not find this variable. Incorrect simulations could be caused by the presence of non-contributory monetary transfers, which will also generate changes in the distribution of income, both before and after taxes, as well as in tax revenue.

At the time of importing or exporting regulations for microsimulation exercises, it is important to be aware that benefits and other taxes of a country are linked to income and therefore must be preserved as intermediate variables. In the Spanish version of Euromod, for example, it is useful to use intermediate variables, such as taxable income, which not only includes income from employment or self-employment but also income from capital, private transfers, various types of pensions, unemployment benefits, sickness benefits, etc. It is also convenient to use the full amount paid in the tax, which includes variables that the programme simulates itself.

The purpose of this paper is to illustrate the theoretical development of the decomposition of regulatory and distributional effects in both revenue and redistributive terms. As has been made clear, the empirical exercise is presented simply to show how such a decomposition works. To this end, we design an accessible example where an approximation of the French (IRPP) is imported into the Spanish IRPF. The intention is to understand how the French tax interacts with the Spanish income distribution as an example of the relevance of the DTR and DRI models. This constitutes a very focused and partial change, but we do not include the complete translation of the French regulation to the Spanish context. If we attempt to do a more detailed analysis, it will require a more elaborate exercise of the tool's internal adjustment techniques. For this purpose, Table 1 compares the design of the IRPP in France with the Spanish IRPF in terms of brackets and tax rates. The design of the tax rates is similar, with five different brackets and a maximum marginal tax rate of 45 percent. However, the tax revenue presents a significant difference of 15.5 billion euros in favour of France. It is equivalent to 21.6 percent of total revenue in Spain.

Table 1. Differences in the design of the French IRPP and Spanish IRPF

	IRPP (France)			IRPF (Spain)		
	Lower limit	Upper limit	tmg	Lower limit	Upper limit	tmg
bracket 1	0.00	9,807	0%	0.00	12,450	19%
bracket 2	9,807	27,086	14%	12,450	20,200	24%
bracket 3	27,086	72,617	30%	20,200	35,200	30%
bracket 4	72,617	153,783	41%	35,200	60,000	37%
bracket 5	153,783	...	45%	60,000	...	45%
Tax Revenue	87,137,121,705.36			71,635,250,569.98		

Notes. 1. We assume that Spanish regions (Comunidades Autónomas, CC. AA.) double the national tariff, so we drop differences caused by the heterogeneity of the regional marginal tax rates.
Source: Own elaboration.

Table 2 shows the width of the income brackets subject to each marginal tax rate in Spain and France. We add to the table the average income in each country (last row), the average width of the range, and the average effective tax rate (last row) derived from the exclusive application of the rate to the taxable income brackets (31 percent in Spain and 26 percent in France). Additionally, Table 2 provides the relative differences in the upper limit of the taxable brackets with respect to average income (1/2) for France and/or (3/4) for Spain. We also included the width of the interval in Spain compared to France (6/5) as well as the absolute differences in the marginal tax rates (8/7) between Spain and France.

Table 2. Differences in the design of the French IRPP and Spanish IRPF

	IRPP (France)			IRPF (Spain)		
	Upper limit (1)	Bracket width (5)	tmg (7)	Upper limit (3)	Bracket width (6)	tmg (8)
bracket 1	9807	9807	0%	12450	12450	19%
bracket 2	27086	17278	14%	20200	7750	24%
bracket 3	72617	45530	30%	35200	15000	30%
bracket 4	153783	81165	41%	60000	24800	37%
bracket 5	...		45%	...		45%
	Mean income (eq) (2)	Average width	tme	Mean income (eq) (4)	Amplitud media	tme
	25,811.4	38,445	26%	15,731.04	15,000	31%

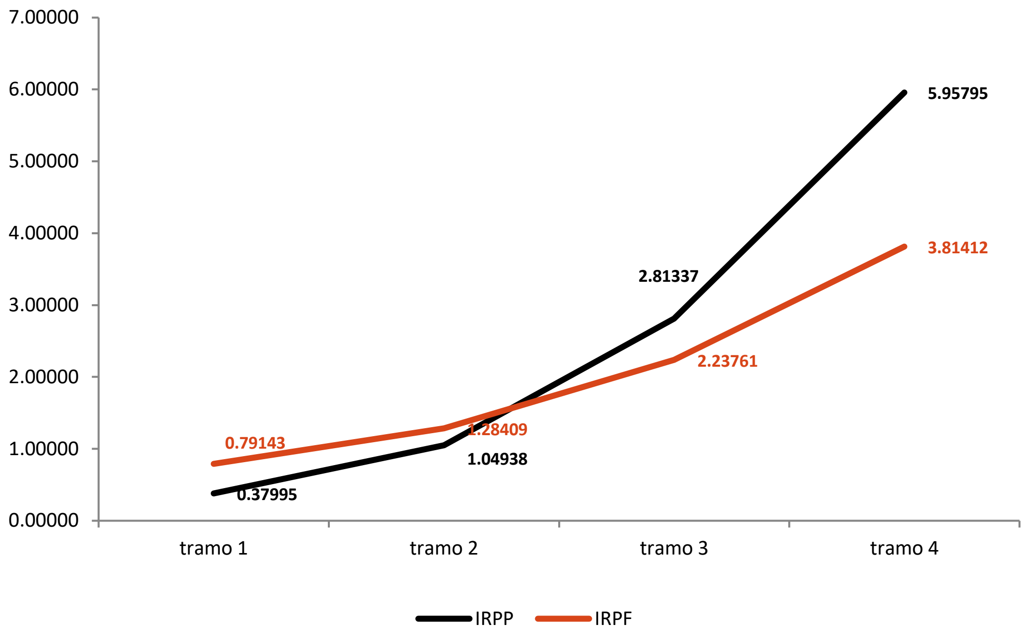
	(1)/(2)	(3)/(4)	(6)/(5)	(8)-(7)
bracket 1	0.3799	0.7914	1.2695	19%
bracket 2	1.0494	1.2841	0.4485	10%
bracket 3	2.8134	2.2376	0.3295	0%
bracket 4	5.9579	3.8141	0.3056	-4%
bracket 5				0%

Source: Own elaboration.

The tables show some key differences in the width and lower-upper limits of the brackets and in the marginal tax rates applied in both countries, which we summarise as follows:

- *Regarding the design of the tax rates*. Although the two countries have the same number of tax brackets, there is a big difference in their width. The average width of the bracket is 38,455€ in France compared to an average of 15,000€ in Spain. These differences are even more striking when comparing how much the upper limit of each bracket represents of the average income of the country. The design has several implications as can be observed in Figure 4. The first bracket of the Spanish IRPF captures almost 80 percent of the average income, while the French IRPP does not even capture 40 percent of it. In contrast, the last income bracket captures almost 6 times the average income in France, while this figure only amounts to 3.81 percent in Spain. We can infer that the French IRPP would be more progressive than the Spanish IRPF since it has wider bases capturing more progressive shares of average income. So, the French tax would increase the redistributive impact of the Spanish tax in the counterfactual scenario.

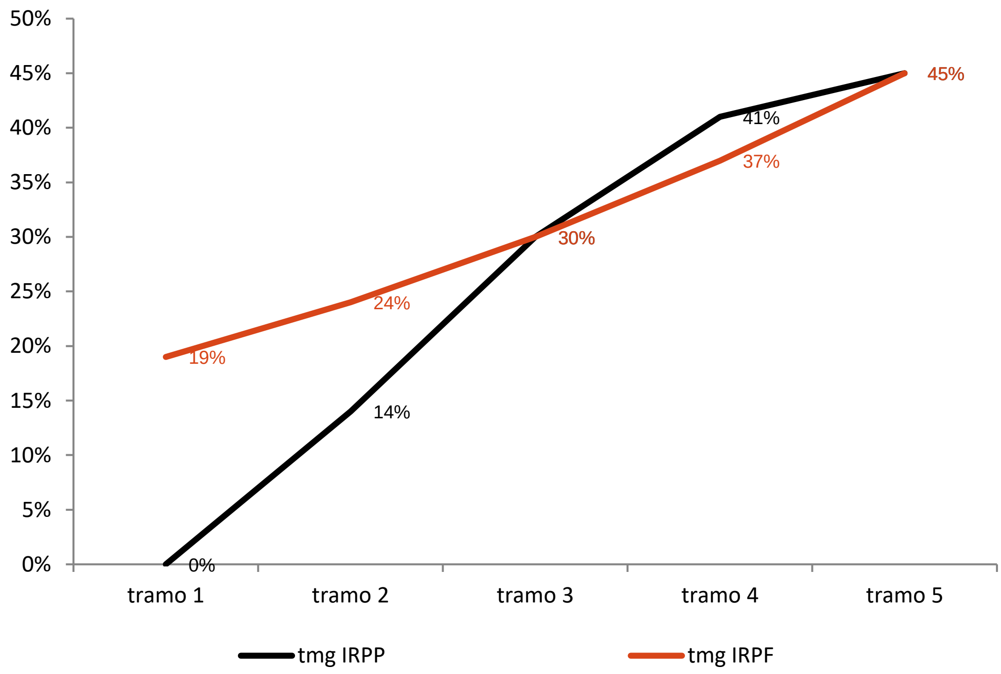
Figure 4. Share of average income in each bracket



Source: Own elaboration.

- *Regarding the size of the tax and its distribution by brackets*. Although the design of both taxes shows a progressive structure (*tme* increasing with the tax base or $tmg > tme$), there are differences in the tax pressure at the different brackets (see Figure 2). Thus, while both taxes charge the central and upper part of the distribution at the same marginal tax rate (bracket 3 at 30 percent and bracket 5 at 45 percent), the tax burden is higher in bracket 4 of the IRPP (41 vs 37 percent), while it releases bracket 1 with a marginal rate of 0 percent and tax bracket 2 at only 14 percent. The Spanish IPRF, however, places its tax burden in the first two income brackets (9 and 24 percent, respectively). These differences may enhance the progressivity of the French tax with respect to the Spanish one, but at the same time, it implies that the average French tax rate is 5 percentage points lower, 26 vs 31 percent. Thus, the redistributive effect of the tax is uncertain since it is expected to obtain a higher progressivity of the tax with a lower average tax rate (and even with lower effective tax rates) and therefore a lower tax burden, which will undoubtedly offset the effect of the possible higher progressivity on redistribution. On the other hand, it has already been proven that the French tax revenue is higher than the Spanish one, and France achieves it using a lower average tax rate. Based on this, it seems that beyond the rates and the distribution of the intervals, the differences in the distribution of gross income between France and Spain would affect potential revenue when the French design is applied to Spanish income.

Figure 5. Marginal tax rates by brackets in the IRPP and the IRPF



Source: Own elaboration.

We are now able to design changes in the Spanish IRPF to bring it closer to the French IRPP once the differences in tax systems and the distribution of the effects on income have been analysed. We can identify the role of the income distribution using the same design. We assume that the IRPF takes the marginal tax rates of the

IRPP, and we update the brackets in terms equivalent to the proportion of the average income of the country. Thus, the upper limit of the first bracket is calculated as the Spanish average income multiplied by the percentage that the French upper limit represents of its average income, that is, 0.38. This ensures that the brackets are related to the average income of the country.

We could simply transpose the same brackets as in the IRPP as an alternative to the proposed exercise. We are aware that since the average income in Spain is 61 percent of the average income in France, a high percentage of Spanish taxpayers would fall into the low brackets of the very generous French rate. We think that this alternative makes no sense without the adjustment of the income brackets. The design of the tax rates in this scenario is presented in Table 3.

Table 3. Design of the tariff for the counterfactual of applying the French tax system to the Spanish income

	Lower limit	Upper limit (1)	Width bracket	tmg	(1)/(2)
bracket 1	0.00	5976.98	5976.98	0%	0.3799
bracket 2	5976.98	16507.86	10530.88	14%	1.0494
bracket 3	16507.86	44257.22	27749.37	30%	2.8134
bracket 4	44257.22	93724.73	49467.51	41%	5.9579
bracket 5	93724.73	…		45%	
Mean income (eq) (2)	15731.04	Average width	23431.18	tme	26%

Source: Own elaboration

Our designed scenario, which we must program in the Euromod tool, takes proxies of greater average width to the tax brackets trying to match the French system. Moreover, we assign to those brackets the marginal tax rates of the French IRPP. Since the Spanish IRPF is shared 50/50 between the state and the regional governments (Autonomous Communities, CC. AA.), the programming must respond to this factor, and we must modify both the brackets and tax rates to adapt them to the schemes of the regional tax. We can use two alternative strategies. First, we can update the general tax rate to the new design with the regional parameters set to zero. Second, we can divide the marginal rates by two (see Table 3 for the national tax rate), and we can use the general scheme for all regions (except for the Basque Country and Navarre, which are not settled because they do not belong to the Common Fiscal Regime). We chose this second strategy to keep the exercise more realistic.

We must introduce a clarification to apply the previously described decompositions before proceeding with the empirical exercise. It consists of modifying only the personal income tax rate while maintaining the rest of the elements of the system. This decision, of course, affects the effective average tax rates. Hence, we must be aware that the differences between these average effective tax rates also include the effects of tax deductions and reductions of each tax in the system and not only the changes in the modified tax rates in the tariff. This affects the Spanish IRPF in scenario *ii* and the French IRPP in scenario *jj*. However, if all the IRPP regulations are transferred to the counterfactual scenario *ij*, since nominal figures would be the same, the differences between these tax rates would also capture how the system of tax deductions and reductions would act in each income distribution, *i* and *j*.

4. Results

Once we program the new tariff design, we apply it to the Spanish database, and we analyse the results of the simulation process in Table 4, which corresponds to the results of the main variables in Euromod, to analyse the policy change between both scenarios. As is shown, the counterfactual scenario causes a negative variation in tax revenue collection from direct taxes when compared to the baseline scenario of Spain. The loss amounts to about 8 billion euros (11 percent of the potential personal income tax revenue). The remaining variables do not show any variation, thus rendering the exercise valid, since the only change that has been made is the tax revenue collection and in the distribution of the post-tax income distribution and consequently over the inequality and poverty indices estimated by the programme. Thus, neither pre-tax income nor the part of the benefits transfers must be affected as can be observed.

While we can clearly explain the revenue loss because of the lower average rates and lower original income in Spain compared to France, it is interesting to note that poverty rates improve in the simulated scenario, showing a reduction with respect to those obtained by the IRPF. This effect may be a consequence of the higher disposable income because of the lower tax burden of the new system. On the other hand, the redistribution indices reveal that the Spanish IRPF achieves a larger reduction in inequality and therefore a greater redistributive impact than the IRPF designed in the counterfactual scenario based on the characteristics of the French normative.

Table 4. Result of an IRPF's tariff change

	Scenario ii	*Scenario ij*	*Difference to base*
Total market incomes	425,517.6	425,517.6	0.00
... income from (self) employment	403,531.2	403,531.2	0.00
... other sources	21,986.4	21,986.4	0.00
Government revenue through taxes and social insurance contributions	210,320.0	202,309.1	**-8,010.9**
... DRIect taxes	71,635.2	63,624.4	**-8,010.9**
... employee social insurance contributions	22,746.1	22,746.1	0.00
... self-employed social insurance contributions	8,930.3	8,930.3	0.00
... other social insurance contributions	0.00	0.00	0.00
... employer social insurance contributions (not part of disposable income)	103,125.4	103,125.4	0.00
... credited social insurance contributions (not part of disposable income)	3,883.0	3,883.0	0.00
Government expenditure on social transfers	165,223.8	165,223.8	0.00
By target group			

... unemployment benefits	19,157.2	19,157.2	0.00
... family and education benefits	5,077.6	5,077.6	0.00
... social assistance and housing benefits	3,644.6	3,644.6	0.00
... pensions, health and disability benefits	137,344.3	137,344.3	0.00
By benefit design	0	0	0
... means-tested non-pension benefits	21,419.3	21,419.3	0.00
... non-means-tested non-pension benefits	19,142.8	19,142.8	0.00
... pensions	124,661.7	124,661.7	0.00
Basic Poverty Indices	*Scenario ii*	*Scenario ij*	*Difference to base*
Population	22.08%	21.97%	-0.11pp
Children	29.66%	29.52%	-0.14pp
Working Age	22.84%	22.71%	-0.12pp
Working Age Economically Active	16.87%	16.81%	-0.06pp
Elderly	12.04%	11.98%	-0.06pp
Fixed Poverty Line	684.60	0	0
Basic Inequality Indices	*Scenario ii*	*Scenario ij*	*Difference to base*
Original Income	0.5304	0.5304	0.0000
Original Income after Taxes/SIC	0.5157	0.5161	0.0003
Original Income incl. Public Pensions after Taxes/SIC	0.3843	0.3866	0.0022
Disposable Income	0.3362	0.3390	0.0029

Source: Own elaboration based on Euromod microsimulation results

Despite having preserved the system of monetary transfers in the two scenarios, in terms of both pensions and other benefits, the Gini indexes of disposable income show a greater difference than the one obtained by the same in the after-tax income. Concretely, we expected to observe a difference of 0.0003 points while we observe a difference of 0.0022 when the pension effect is included in the calculation and of 0.0029 points when the whole benefit system is loaded. It is as though the income redistribution produced by the tax limits the redistributive impact of the transfer system. If this was true, the greater the redistributive impact with the tax, the greater the redistributive impact would be in a second phase. In this second phase, the benefit system helps to reduce net-income inequality in two different ways: through the tax itself and through the performance of the benefit-transfer system.

Finally, it is interesting to note how the expected greater progressivity obtained with the new design has not been able to offset the fall in the size of revenue, thus limiting its redistributive impact. We offer explanations for these differences in the following sections.

4.1. Decomposing the differences in tax revenue (DTR model)

We try to explain in the next paragraph the DTR collection to understand in greater depth how the different elements of the tax structure interact through the DTR model. We extract information on tax revenue and original income from the results previously obtained in the three scenarios. It allows us to obtain the average effective tax rates supported by households in the three alternative designs and their difference with the nominal average tax rates of the original tax design in Table 5.

Table 5. Average effective tax rates in the comparative scenarios

Variable EUROMOD[8]	tin_s	ils_origrepy			
X = scenario	$REC=CI_{xx}$	Y_x	Average effective tax rate	Nominal tax rate	Nominal vs average effective tax rates (change)
ii	71,329,900,640	571,308,134,595	0.124853	0.31	-59.72%
ij	63,319,008,806	571,308,134,595	0.110831	0.26	-57.37%
jj	87,137,121,705	1,414,205,856,079	0.061615	0.26	-76.30%

Source: Own elaboration.

There is a large difference between the average effective rates borne by households in the different scenarios. Whereas the system of base deductions and reductions in instalments reduces the nominal tax rate by almost 60 percent (from 31 percent to an effective average rate of 12.48 percent) in Spain, this reduction is significantly greater in France, 76.30 percent. Coupled with the lower average nominal rate of its design, this generates an average effective tax rate of 6.1 percent. However, this lower average IRPP rate in France is associated with a higher revenue than the Spanish IRPF (87.137 vs 71.330 billion euros). The explanation seems clear: taxable

[8] Tin_s always represents the income tax revenue in EUROMOD. The original income chosen is ils_origrepy, which refers to the sum of labor income and pensions or contributory benefits that are part of the taxable income.

income in France is almost three times the taxable income in Spain so that despite holding half the average effective rate, it generates larger revenue.

Therefore, the difference in tax revenue is not only due to a question of "size" in the tax legislation, but it is also due to the distribution of the original income. We report in Table 6 the differences in the tax revenue collection of the tax reform attempting to isolate both effects through the DTR model.

Table 6. DTR model: Differences in tax revenue between IRPF (scenario *ii*) and IRPP (scenario *jj*)

(1) DTR=	[REC ii	(-) REC jj]	Check
-15,807,221,064	71,329,900,640.74	87,137,121,705.36	-15,807,221,064.61

DTR=	[(tme ii	*Y i)	(-)(tmejj	*Y j)]	Check
-15,807,221,064	0.12485	571,308,134,595	0.06162	1,414,205,856,079	-15,807,221,064.61

(2) DTR=	[REC ij	(-) REC jj]	(-) [REC ij	(-) REC ii]	Check
-15,807,221,064	63,319,008,806	87,137,121,705	63,319,008,806	71,329,900,640	-15,807,221,064

DTR=	[DE i	(-) SE j]	Check
-15,807,221,064	-23,818,112,898	-8,010,891,834	-15,807,221,064

(3) DTR=	[(tmeij	*Y i)	(-)(tmejj	*Yj)]	(-)(tmeij	tme ii)	*Yi]	Check
-15,807,221,065	0.1108	571,308,134,596	0.0616	1,414,205,856,079	0.1108	0.1249	571,308,134,596	-15,807,221,065
					-0.014022016			

Source: Own elaboration.

As is shown in (1), there is a significant difference of 15 billion euros in terms of tax collection (DTR) between Spain and France. Despite Spain having higher average effective tax rates compared to France (0.125 vs 0.062 for the French IRPP), the difference of 15 billion euros in tax revenue is mainly because Spain's taxable income is almost three times smaller than France's taxable income. This difference in taxable income is the primary reason for the gap in tax revenue between the two countries. This difference in terms of tax collection can be explained by taking two facts into consideration.

First, associated with the tax design, the adjustment of the Spanish rate to the rate of the French IRPF would cause a difference in revenue of 23 billion euros when compared to the amount this design collects in France. In short, it reports a potential gap of 23billion that is compensated for because the Spanish IRPF collects more in Spain. Specifically, the Spanish IRPF raises 8 billion more than would be collected by adjusting the rate to the French model on the same distribution; this is the SE, which is favourable to the Spanish design in this case.

Second, associated with the DE, the counterfactual tax on the Spanish income (three times smaller than the French one) would generate a gap in tax collection than more of 23 billion euros despite the greater average effective tax rate achieved in the counterfactual scenario (0.111 vs 0.062). However, in the real scenario, the higher average effective tax rate of the Spanish IRPF compared to the counterfactual rate (0.125 vs 0.111) allows to compensate for the DE by 8 billion euros, thus reducing the difference in tax revenue between Spain and France to the observed deviation of 15 billion euro.

The previous analysis reveals a first conclusion: if Spain were to decide to adapt the design of its tax structure to the French system, this would result in a loss of 8 billion euros in tax revenue of the IRPF, the SE, which would be added to the 15 billion euros corresponding to the real difference, giving rise to a total differential in tax revenue collection between both countries of 23 billion euros, the DE. This loss in revenue would be due to the drop in the average effective tax rate from one scenario to the other (-0.014 points) in the Spanish income distribution that it is three times smaller than the French one.

4.2. Decomposing the differences in the redistributive impact (DRI model)

Once we have explained how the normative works in terms of revenue, this section applied the DRI model to explain the differences in its redistributive impact. We present this empirical evidence in Table 7. It provides information on how the Spanish IRPF reform adjusted to the French system runs, and we explain the reasons for the differences in net-income inequality between France and Spain using the decomposition presented in equation [10].

Table 7. Differences in the DE between the IRPF (scenario *ii*) and the IRPP (scenario *jj*)

X= Scenario \ Variable		G_x	G_{xx}	RS_{xx}
Ii		0.5304	0.5157	0.0147
Ij		0.5304	0.5161	0.0144
Jj		0.4974	0.4935	0.0039
(1) DRI=		[RS ii	(-) RS jj]	
0.0107		0.0147	0.0039	
DRI=	[RS ij	(-) RS jj]	(-) [RS ij	(-) RS ii]
0.0107	0.0144	0.0039	0.0144	0.0147
DRI=		[DE i	(-) SE j]	
0.0107		0.0104	-0.0003	
(2) RS ii=	[K ii	*tmeii / (1-tme ii)]		
0.0147	K ii	0.1427	K ii =	0.1028
RS ij=	[K ij	*tmeij / (1-tme ij)]		
0.0144	K ij	0.1246	K ij =	0.1151
RS jj =	[K jj	*tmejj / (1-tme jj)]		
0.0039	K jj	0.0657	K jj =	0.0600
(3) G ii - G jj=	[(Gi –Gj)	(-)DEi	(+) SE j]	Check
0.0223	0.0330	0.0104	-0.0003	0.0223

Source: Own elaboration.

As shown, the difference in the redistributive impact, DRI, in (1) is 0.011. It indicates that the Spanish IRPF (0.015) shows greater distributive capacity than the French IRPP (0.004). Thus, the Spanish tax results in a greater reduction in gross-income inequality than the French one (from 0.530 to 0.516 in Spain vs 0.497 to 0.493 in France). However, this result may not be an effect of the rule, but it could be due to the distribution of income, because when the starting distribution of income is more unequal, the tax shows more potential to reduce inequality independently of the tax design, the DE.

Thus, if we adjust the tax rate in Spain to the French model, the redistributive impact of the reform would be 0.014. This figure represents 98 percent of the redistributive impact achieved by the Spanish IRPF. A more unequal income distribution in Spain than in France generates a positive differential in the distributional impact of 0.010 points. We must add the difference in the greater redistributive impact of the Spanish IRPF to that proposed in the simulated scenario (0.015 vs 0.014), which implies increasing these differences to 0.011 by the design of the Spanish tax. It should be noted that the higher the DRI value is, the greater the reduction in gross-income inequality between countries and therefore the smaller the differences in net-income inequality.

We must highlight a limitation associated with the simple use of the direct results of Euromod. We calculated the concentration curve of the tax burden by differences, which ignores the possible re-ranking effect of the reform. We can assume this fact because this effect is usually very small, and it does not alter the relationship between progressivity and the revenue capacity of the system (Lambert, 1992).

A relevant question is the following: what does cause the difference in the redistributive impact between the behaviour of the Spanish IRPF and its behaviour adjusted to the French rates? We can observe in Table 7, row (2) that despite the new design conferring greater progressivity (0.115 vs 0.103) – as expected by the ex ante analysis of the tax design and as a consequence of shifting the tax burden further away from proportionality – the fall in its size (from 0.143 to 0.125) is the result of the difference between the average effective rates, which explains, together with the initial distribution of income, the loss of revenue in this scenario. It leads to compensating for the greater progressivity, thus limiting the redistributive impact of the reform.

Additionally, as equation (3) in Table 7 shows, the reduction of 32.4 percent in the difference between gross- and net-income inequality between Spain and France (from 0.033 to 0.0223 points) is explained by two factors: (i) the DE compensates for the difference in gross-income inequality by 0.0104 points (97.2 percent of the reduction) as a consequence of the greater potential of the Spanish distribution to absorb the redistributive impact of the tax, and (ii) the SE induces an additional 0.0003 point reduction in gross income inequality between the two countries (2.8 percent of the reduction) because despite its lower progressivity compared to the French tax, the Spanish tax achieves a greater redistributive impact than the French due to its higher effective average rate, adding an additional correction factor to the observed differences in gross-income inequality between the countries. Therefore, this expression allows us to identify and explain the reduction in differences between the gross- and net-income inequality of both countries.

4.3. Explaining the results by the joint DTR-DRI models

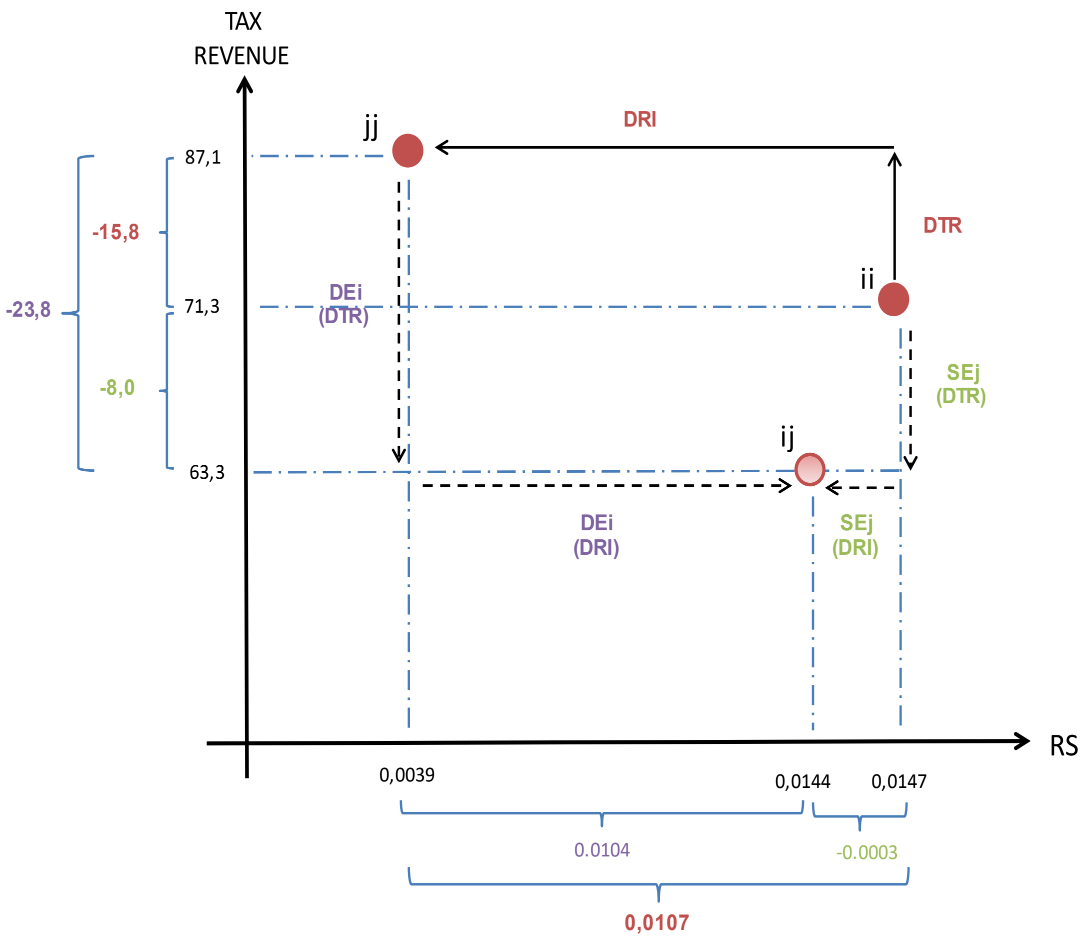
As shown in the previous sections, the average effective tax rate resulting from the application of a tax regulation to an income distribution is also a variable that affects both the tax-collecting and redistributive capacity, being an adjustment variable between the two models proposed in this paper and allowing us to analyse the results from a joint perspective.

The results of the empirical exercise from this joint perspective lead to the conclusion that if a Spanish policymaker were to decide to adapt the Spanish IRPF's normative to the French system, they should be aware that the fall in the average effective tax rate, in addition to producing a fall in tax revenue link to the smaller average taxable income in Spain, would limit the potential improvement in reducing gross-income inequality, which could induce improvement in the progressivity of the new tax design. Figure 6 summarises the results obtained in the empirical exercise from the joint perspective of the DRI and DTR models.

If we analyse the differences in the tax revenue (DTR model) by applying the French system to the Spanish distribution, the tax collection would not only lose 15 billion euros as a result of the actual difference, but it would also lose 23 billion euros (DE) because even though the French system would achieve a higher average effective tax rate in the Spanish distribution than in the French one, the Spanish average taxable income is three times lower. This additional 8 billion loss in the Spanish tax revenue collection is explained by the lower average effective tax rate of the French tax system compared to the average effective tax rate of the Spanish tax system (SE).

If we analyse the differences in terms of redistribution (DRI model) by applying the French system in Spain, the system will maintain 0.0104 of the current redistributive power, partly due to the potential of the Spanish distribution to be redistributed since the Spanish gross income is more unequal (DE). However, if the counterfactual scenario was applied, a loss of 0.003 points would be assumed by the changes in the tax structure since the French system, although more progressive than the Spanish one, would obtain a smaller "size" (average effective tax rate) with the Spanish distribution (SE).

Figure 6. The joint operation scheme of DRI-DTR models and its results



Source: Own elaboration.

So, if we wanted to use this exercise to make some kind of recommendation using the joint perspective of the models, the economic policy recommendation should be directed at policies that affect the pre-distribution of income, such as labour market policies with the aim of increasing the taxable income of the country, and not at improving the pre-existing tax design, which has been shown to better adjust to the intrinsic peculiarities of its distribution. This is the relevance of our proposed methodology: isolate which effect is more powerful to explain the determinants of the differences observed and recommend accordingly the target policies to be developed.

It should be noted that during the empirical exercise, we have estimated the average tax rate for the taxable income, which included labour income, pensions, and contributory benefits, which brings us closer to the definition of the average effective tax rate as it includes items after state intervention. In order to assess the sensitivity of the empirical exercise and the conclusions of the results of the model's decomposition, we performed a robustness check estimating average tax rates just on labour income. Since the reference income is lower, the only consequence is that the average effective tax rates are slightly higher, and therefore the progressivity (or regressivity) and the burden concentration curves are lower. We chose this income concept because it contains the original pure market income before state intervention via the cash-transfer system, which leads to the same conclusions reached in the previous empirical exercise.

5. Conclusions and extensions

The main objective of this article has been to propose a systematic methodology to analyse the differences in both the redistributive and tax-revenue-collecting impact of alternative tax systems. The main novelty of the proposed method is that these differences can be analysed by designing counterfactual scenarios in which the tax rules of one country are applied to the income distribution of another. The decomposition method shows that these differences not only respond to the tax system design but also to the characteristics of the income distribution in the country analysed. The real contribution to the literature is that this methodology isolates perfectly which parts of the DTR collection and the redistributive power of the tax systems are due to one reason or to the other (design/system or income distribution) through the decomposition of the proposed models.

To this end, the paper has followed a three-stage procedure. The first consisted of developing the DRI and DTR decomposition models to explain these differences, based on the design of counterfactual scenarios, which when compared with the reference scenarios, allow us to mathematically isolate both effects in a straightforward manner. As we have seen, we propose two models to explain two differences based on two effects. On the one hand, the DRI model allows us to explain the DRI of two tax systems, assuming that part of these differences is not only explained by the greater or lesser redistributive potential of the initial distributions (DE) but also by how the tax structure is designed to redistribute that income (SE). On the other hand, the DTR model explains the DTR collection between the two countries, assuming that one part of the differences is explained by the greater or lesser "size" of one tax with respect to the other (SE), and another part is explained by how different the taxable income is where the tax is applied (DE). As we have seen, the conclusions drawn from the two models can be connected based on the analysis of the average effective tax rate, the adjustment variable between the two models.

In a second phase, we described the usefulness of the design of counterfactuals by employing the Euromod tax-benefit microsimulation model. For this purpose, we proposed an empirical exercise to provide evidence of the validity and usefulness of the models in our approach. Not without some limitations, the empirical exercise consisted of adjusting the Spanish income tax on the basis of the specific characteristics of the French personal income tax. The selection of these two countries is based on the usefulness that their analysis provides in terms of the variables of interest, but as has been shown on several occasions, the methodology proposed here is generic and valid for analysing any other country or type of reform that might be proposed.

Finally, the third phase consisted of analysing the results of the reform using the DRI and DTR models in order to highlight the richness of the analysis that the isolated decomposition of the effects entails in terms of this specific exercise. Specifically, we answer questions such as the following: What would be the revenue in Spain if the French tax system were applied and why? What would be the redistributive impact on the distribution of Spanish income if the French tax system were applied and why?

The DTR and DRI models identify that the Spanish IRPF shows greater progressivity and "size" than the French IRPP. This result is evidence that Spanish policymakers have adapted the tax design to the characteristics of the Spanish income distribution, while the French normative does not fit this distribution as well. However, the Spanish IRPF also shows weaknesses since we could increase its progressivity by adjusting the rate to the width of the tax brackets and the nominal rates of the French IRPP in a direct way. We show the importance of analysing the average effective tax rate to understand the impact of any reform on tax revenue and redistribution, but we also show the importance of the income distribution for these purposes.

Although this exercise is a first attempt to identify the advantages and disadvantages of different tax systems in redistributive and tax collection terms, it is not exempt from some limitations that should be viewed as opportunities for further research. First, the process of comparing different tax rules in distinct countries should be documented because it does not constitute a simple task. Second, the DTR and DRI models cannot assume any efficiency cost that could generate any fiscal policy reform proposed. Third, we have calculated all measures for the whole distribution, but it would be convenient to differentiate along the income distribution by income deciles or in terms of winners and losers at different parts of the income distribution. In Spain, an interesting exercise could be the introduction of more progressive tax brackets with the restriction of maintaining the nominal (and effective) personal income tax rates that are trying to boost the redistributive impact and the tax revenue of the IRPF.

It is also interesting to note the utility of our exercise in terms of providing policy recommendations based on the powerfulness of fiscal policy swaps between countries. Despite the advantages of the Spanish design of the IRPF, in terms of capturing taxable income, the French tax raises more revenue with a less progressive design, and also with a size that is much smaller, than the Spanish one. The cause is the higher average income in France, which is practically three times the average income in Spain. This result would suggest that, given the advantages of the Spanish design, if Spanish labour income were to be increased under the same conditions as in France, the redistributive and tax-collecting impact of our tax would be much greater. This result calls for pre-redistribution policies in the labour market, which would allow increasing the average income of the country and therefore would contribute to improving tax revenue and redistribution. Thus, this is the relevance of our proposed methodology: isolate which effect is more powerful to explain the determinants of the differences observed and recommend accordingly the target policies to be developed.

References

Dardanoni, V. and Lambert, P. J. (2002), "Progressivity comparisons", Journal of Public Economics, 86 (1): 99–122.

Haughton, J. and Khandker, S. R. (2009), Handbook on poverty+ inequality, World Bank Publications.

Immervoll, H., Kleven, H.J., Kreiner, C. T., and Saez, E. (2007), "Welfare reform in European Countries: A microsimulation analysis", The Economic Journal, 117 (516): 1–44. https://doi.org/10.1111/j.1468-0297.2007.02000.x

Kakwani, N. (1977), "Measurement of tax progressivity: An international comparison", Economic Journal, 87: 71–80.

Kambayashi, R. and Lechevalier, S. (2021), "Why do redistributive policies differ across countries? Analyzing the multiple dimensions of preferences for redistribution", The Review of Income and Wealth. https://doi.org/10.1111/roiw.12541

Lambert, P.J. (1992), The distribution and redistribution of income: A mathematical analysis, Manchester University Press.

Lambert, P. J. (1993), "Evaluating impact effects of tax reforms", Journal of Economic Surveys, 7(3): 205–242.

Lambert, P.J., Nesbakken, R. and Thoresen, T.O. (2020), "A common base answer to the question 'Which country is most redistributive?'", The Scandinavian Journal of Economics, 122 (4): 1467–1479. https://doi.org/10.1111/sjoe.12366

Lindert, P.H. (2004), Growing public: Social spending and economic growth since the eighteenth century, Cambridge: Cambridge University.

Sutherland, H. and Figari, F. (2013), "EUROMOD: The European Union tax-benefit microsimulation model", International Journal of Microsimulation, 1 (6): 4–26.

Thoresen, T.O., Zhiyang, J. and Lambert, P.J. (2016), "Is there more redistribution now? A review of methods for evaluating tax redistributional effects", FinanzArchiv / Public Finance Analysis, 72 (3): 302–333. http://www.jstor.org/stable/24807497

Vellutini, C. and Benítez, J.C. (2021), "Measuring the redistributive capacity of tax policies", International Monetary Fund WP/21/252. https://www.imf.org/en/Publications/WP/Issues/2021/10/22/Measuring-the-Redistributive-Capacity-of-Tax-Policies-497221

Verbist, G. and Figari, F. (2014), "The redistributive effect and progressivity of taxes revisited: An international comparison across the European Union", FinanzArchiv / Public Finance Analysis, 70 (3), 405–429. http://www.jstor.org/stable/43297214