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TREMODO: a Microsimulation Model for the Province of Trento (Italy)*

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Abstract

This paper presents the main characteristics of TREMOD, a tax-benefit microsimulation model for the Italian province of Trento (Italy). TREMOD is based upon the Italian adaptation of the EUROMOD platform microsimulation model, and its purpose is to inform local tax and welfare policies. TREMOD is a flexible tool that allows simulation of the effects of different types of public policies on a plurality of outcomes such as, for example, individuals' and households' income and well-being. The main strength of TREMOD is the high quality of the data used for its construction. The input database has been obtained by matching survey data (derived from a local representative survey on households' life conditions, *Indagine sulle condizioni di vita delle famiglie trentine, ICFT*) with administrative data on individual income tax returns. This aspect is one of the main strengths of TREMOD compared with other experiences in microsimulation modelling. As we show in this paper, the combination of survey and administrative data ensures good precision in the simulations and will allow for the integration of other administrative data sources including pension and labour market records. The first version of TREMOD is a 'static' microsimulation model.

Keywords: Fiscal policies, microsimulation model, validation, administrative data

JEL classification: H24, I32, I38.

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1. Introduction

In this paper, we present and describe the main goals and features of TREMOD, the microsimulation model for the Province of Trento. TREMOD has been developed by FBK-IRVAPP by adapting the EUROMOD microsimulation model platform to the Province of Trento (Sutherland and Figari, 2013).

TREMOD is a highly flexible tool that can produce *ex-ante* estimates of the effects of different tax-benefit policies on a plurality of outcomes of interest such as, for example, households' income distribution and well-being. However, to ensure that TREMOD achieves these objectives, at least two necessary conditions must be met.

The first condition relates to the quality of the data used for construction of the model (Sutherland, 1991). In this regard, TREMOD provides a substantial improvement on most of the existing microsimulation models because it uses a combination of survey and administrative micro data (instead of just survey data). More precisely, TREMOD uses a combination of microdata from a local representative survey on households' life conditions (*Indagine sulle condizioni di vita delle famiglie trentine*, hereafter also called 'ICTF data') with official administrative data on individual income tax returns obtained from the Italian Revenue Agency (RA). This combination of data sources allows for high precision in the measurement of individual incomes, and it also makes it possible to analyze the effects of redistributive policies, at both the individual and the household levels.

The second condition required for this model to be satisfactorily reliable is that it should contain detailed and updated information on the tax and social security legislation in force. This enables the analyst to simulate different economic scenarios of interest with the highest degree of accuracy. This condition is guaranteed by the fact that TREMOD relies on the Italian version of EUROMOD, which contains updated information integrated, in TREMOD, with information on particular policies in the province of Trento.

The paper is structured as follows. Section 2 provides an overall description of TREMOD, highlighting its analytical potential and distinctive characteristics, as well as illustrating some of its potential practical uses. Section 3 describes the database used for the construction of TREMOD and its statistical representativeness. Section 4, assesses the estimation power of TREMOD, comparing some economic variables simulated by the model with the same variables observed in external administrative data sources. Section 5 conducts a comparison between the microsimulation model that we propose (which, as mentioned, integrates survey data and administrative data) with an alternative model based only on survey data (IT-SILC, as in the case of EUROMOD). Finally, Section 6 concludes by summarizing the main strengths of the model and presenting possible developments.

2. TREMOD

The microsimulation model for the Province of Trento (TREMOM) is based on the EUROMOD platform (particularly, on its Italian version EUROMOD-IT). EUROMOD is a tax-benefit microsimulation model developed since 1998 as part of the European programme, Targeted Socio-Economic Research, and it is currently funded by DG Employment, Social Affairs and Inclusion. The project is led by an academic consortium representing several European countries coordinated by the Institute for Social and Economic Research (ISER), and it is regularly updated so that it represents the fiscal disciplines and, in part, social security legislations of the 27 EU Member States. The information contained in the standard platform of EUROMOD derives from individual databases, typically surveys (for example, EU-SILC), combined with information simulated by the same model (for example, taxes and subsidies).

EUROMOD can produce ‘before-after’ calculations. It therefore enables analysts to simulate changes in individual and households’ income induced by simulated changes in the levels of taxation or introduction of new subsidies or benefits. Moreover, with EUROMOD, researchers and analysts can address ‘what if’ questions. For example, it is possible to simulate ‘counterfactual income’ (i.e. the income that would be observed if a new policy was introduced or eliminated). This makes it possible to have ex-ante assessments of the effects of policies. Hence, as emerges from a growing body of literature, EUROMOD can be used to answer a wide range of research questions. To date, it has been used to build microsimulation models in different national contexts: for example, South Africa (Wilkinson, 2009), Russian Federation (Popova, 2012) and the Republic of Serbia (Zarković-Rakić, 2010). To our knowledge, EUROMOD has never yet been adapted to sub-national contexts.

The definition and construction of the model that we propose, TREMOD, is based upon the Italian model EUROMOD-IT (Ceriani et al., 2013). This ensures a detailed reconstruction of the national legislation with regard to income taxes, assets and social security contributions, taking into account regional variations (e.g., additional regional income tax). Through a combination of official administrative data (taxes and contributions) and the local survey on households’ life conditions (see Section 3), TREMOD can be used to assess the effects of a wide range of policy changes introduced in the province of Trento.

This first version of TREMOD can be termed a ‘static model’. Static models yield estimates of the immediate effect (so-called ‘morning-after effect’) of policy, ignoring the fact that the same policies may alter individuals’ and households’ behaviours. In the future, TREMOD could be developed further as a ‘dynamic’ or ‘behavioural’ model exploiting longitudinal data on individuals and households (Figari et al. 2013).

3. The data sources of TREMOD

The starting point for the construction of a microsimulation model is the availability of micro data on individuals’ working conditions and social security. This first version of TREMOD

uses 2010 data from two different sources: *Indagine sulle condizioni di vita delle famiglie trentine* (ICFT data) and administrative data on individual income tax returns provided by the Italian Revenue Agency (RA). Section 3.1 briefly describes the two sources and the merging procedures. Sections 3.2 and 3.3 present the results of several statistical tests performed to assess the representativeness of the database and applying post-stratification weights.

3.1 Sources of data

The main source of data used for the construction of TREMOD is the *Indagine sulle condizioni di vita delle famiglie trentine* (ICFT). The ICFT is a sample survey containing rich socio-economic information at the individual and household levels. It is a retrospective ICFT based on interviews with subjects older than 18 years old and resident in the province of Trento. In this first version of TREMOD, data are limited to the sixth wave of the survey carried out in 2010 on 7,200 respondents. The second source is individual income tax returns 2011 (*Dichiarazioni dei Redditi 2011, Modello Unico, 730 and 770*), thus containing the individual data for year 2010.

The exact matching of the two databases has been possible by using individual tax codes as a matching key. The entire process of building the basic input dataset for TREMOD was supervised by the Statistical Office of the Province of Trento, which ensured the compliance of all activities with data protection and privacy legislation throughout the entire process.

The TREMOD database is divided into three sections. The first section includes socio-demographic variables, which provide information on individual-level characteristics such as age, gender, level of education attained, and at the family level, the composition and kinship relationships. The second section includes variables concerning the employment status of the individual and his/her working history in terms of months worked, months of retirement, months of unemployment, as declared at the time of the interview. The third section contains all income variables that allow reconstruction of total gross income, such as income from employment, retirement income, income deriving from property and land, income from investments, earnings from other self-employment, private transfers received (such as checks from ex-spouses, for example).¹

3.2 The validation of the data source

The use of survey data - by definition a representation of a sub-set of a broader aggregate - is critical when they are employed to draw inferences at a more general level (i.e. population). In this case, it becomes crucial to perform 'validation' checks on the survey data in order to verify their representativeness of the total population. To accomplish this, we compared the

¹ All the variables of the first two sections derived from *Indagine sulle condizioni di vita delle famiglie trentine*, while those of the third section came from the administrative records of individual income tax returns.

distributions of some socio-economic, labour market and income variables available in the sample that we use in TREMOD (ICFT data) and from external official sources (Statistical Office of the Province of Trento, National Institute of Statistics ISTAT, and Italian Revenue Agency). The latter served as a reference (since official data sources are based on larger samples and are thus characterized by less variability, or they refer to the entire population) to validate the sample that we utilized. If large discrepancies emerged from this comparison, then problems in generalizing the results obtained using survey data would materialize. This would have negative implications on the analysis performed using the ICFT survey and, consequently, on the credibility of the resulting policy indications deriving from TREMOD. Moreover, it is particularly important to verify the representativeness of the sample data with respect to different socio-demographic segments of the population (particularly by age class, or by employment status), since these may be recipients of specific public policies.

Among the socio-demographic characteristics available in the ICFT data comparable with external data sources, we had: age, gender, nationality, household composition, education level and employment status of individuals. The estimates of the distributions of these variables were performed using the weight provided by the Statistical Office of the Province of Trento (henceforth ‘original weight’) to re-proportion to the population size.²

Table 1. Number of residents in the Province of Trento by age classes. Comparison between ICFT data and External data.

Age	Freq. ICFT data (1)	Freq. External data (2)	Ratio % (1/2)
Aged less than 15	73,300	80,469	91.1
15-24	58,693	52,131	112.6
25-34	51,912	64,328	80.7
35-44	74,440	85,304	87.3
45-54	79,203	77,682	102.0
55-64	75,183	63,497	118.4
More than 64	106,802	101,415	105.3
Total Population	519,533	524,826	99.0

Note: FBK-IRVAPP calculations. Data refer to the province of Trento in year 2010. The original weight is used for ICFT data. The external data source is ISTAT (www.demoistat.it).

Table 1 compares estimates on the number of individuals resident in the Province of Trento, grouped by age classes, from the ICFT data and from the external source. The first two columns of the table show the frequencies of the individuals, for different age groups, as found in the survey and in the external source respectively. The third column is the ratio between the two different sources (multiplied by 100). A value of 100 for the ratio would show perfect comparability in the number of persons between the ICFT data and the external data source; lower values of the ratio would indicate a problem of under-representation of the

² The Statistical Office of the Province of Trento built the weights based on the following variables: size of households, residence, presence of foreign citizens and people aged over 65 in the household.

sample; vice versa, values greater than 100, would indicate the existence of an over-representation.

Table 1 shows that the main differences between the survey sample and official sources, as regards age classes, consist in the under-representation of young people aged 25-34 years (of whom there are 51,912 in the survey sample instead of 64,328 in the external data source) and in the over-representation of individuals aged 55-64 years (75,183 individuals in the ICFT instead of 63,497 in the external source). The percentage differences between the ICFT data and the external source, in these cases, are respectively equal to -19.3% and +18.4%. As regards the other age groups, problems are more limited. The number of persons in the 45-54 age class, and the over-65s, is very well represented, while the estimate is less precise, though overall acceptable, for the remaining bands (with differentials in representation close to 10%).³

Table 2. Distribution of socio-demographic characteristics. Comparison between ICFT data and External data.

Socio-demographic characteristics	Freq. % ICFT data (1)	Freq. External data (2)	Ratio % (1/2)
Non-Italian citizen	8.9	9.2	97.2
Gender (women)	52.2	51.1	102.2
Single-person households	30.1	32.9	91.4
Couples with children	38.7	36.8	105.2
Couples without children	23.5	24.9	94.6
Single-parent households	7.7	5.4	142.2
Primary education or no qualification	17.6	18.0	97.9
Lower secondary education	29.0	28.7	101.1
Upper secondary education	41.0	41.5	99.0
Tertiary degree or above	12.3	11.8	104.1

Note: FBK-IRVAPP calculations. Data refer to the province of Trento in year 2010. The original weight was used for ICFT data. The external data source is ISTAT.

Other socio-demographic characteristics that could be used to validate the ICFT survey were: citizenship, gender, household composition and the level of education of individuals. Table 2 shows that, for most of the cases, the ICFT source provides highly representative data of the population. The ICFT is particularly able to represent the composition of the provincial population of Trento by citizenship: the estimate of the proportion of individuals with non-Italian citizenship is 8.9% compared to 9.2% resulting from the external source. The ICFT

³ The problem of representation of individuals by class of age in survey samples comes as no surprise here, given that participation in the survey is voluntary and the response rate often differs by age levels. Generally, to avoid problems of distortion in the sample, the problem is addressed at a final stage by the application of appropriate techniques of post-stratification (this is what we propose later, see section 3.3).

data are also highly representative in terms of gender composition: the proportion of women in the sample is 52.2%, only slightly higher than the 51.1% resulting from external statistics.

Regarding the variables relative to household composition, survey data are representative, in large part, of the number of couples with children (38.7% of total households instead of 36.8%), couples without children (23.5% instead of 24.9%) and the number of people who live alone or who do not form a family (single-person households are 30.1% instead of 32.9%). A problem arises, however, in regard to the representativeness of single-parent households, which are largely over-estimated in the ICFT survey (7.7% instead of 5.4% of households). However, it is evident that the measurement of a phenomenon with low incidence in the population (i.e. low values) is more complicated and unstable than one much larger in magnitude.

Very convincing results concern the ability of the ICFT survey to reproduce the distribution of educational qualifications across the population. The representativeness of the number of individuals who had received no education, only primary level education, lower or upper secondary education and tertiary education has no critical issues, in that frequencies in the ICFT data are very similar to those of ISTAT, apart from a slight over-estimation of persons with tertiary qualifications.

Table 3. Labour-market indicators. Comparison between ICFT data and External data.

Labour-market participation	Freq. % ICFT data		Ratio % (1/2)
	(1)	Freq. External data (2)	
Activity rate	62.6	69.0	90.7
Employment rate	58.8	66.0	89.1
Unemployment rate	5.9	4.3	138.0
Unemployment rate (15-24)	21.4	15.1	141.6
Activity rate (Women)	64.3	60.5	106.2
Employment rate (Women)	59.6	57.3	104.0
Unemployment rate (Women)	7.3	5.2	140.2

Note: FBK-IRVAPP calculations. Data refer to the province of Trento in year 2010. The original weight was used for ICFT data. The external data source is ISTAT (Labour Force Survey).

A further group of variables used to verify the representativeness of the ICFT survey with respect to the values from external sources were those relative to the labour market: in particular, the labour market status of the respondents. Table 3 shows the employment, activity and unemployment rates (defined for the total population, young people aged 15-24 years old and women respectively) in the ICFT (column 1) and in the external ISTAT source (column 2). Comparison between the two data sources shows that the ICFT data represent fewer persons active (62.6% instead of 69.0%) and employed (58.8% in the ICFT compared to 66.0% from ISTAT). On considering the same indicators by gender, also evident is a slight over-representation in the number of women interviewees who belonged to the labour force.

The unemployment rate also appears to be over-estimated. In the ICFT the unemployment rate among respondent is 5.9%, while the value from the external source is 4.3%. Women are

unemployed in 7.3% of cases in the ICFT survey versus 5.2% in the ISTAT data and, similarly, the rate of youth unemployment in the ICFT is 21.4% against 15.1% from ISTAT.⁴

Table 4. Number of income recipients and total income (in thousands of euros) referred to main sources of income. Comparison between ICFT data and Population data.

Source of income	Freq. ICFT data (1)	Total income ICFT data (2)	Freq. Population (3)	Total income Population (4)	Ratio % (1/3)	Ratio % (2/4)
Labour income	206,234	4,164,646	239,591	4,426,109	86.1	94.1
Self-employment income	11,321	201,996	14,022	323,119	80.7	62.5
Retirement income	142,255	2,309,307	135,183	2,036,244	105.2	113.4
Disposable income	373,556	6,668,324	408,046	6,858,059	91.5	97.2

Note: FBK-IRVAPP calculations. Data refer to the Province of Trento in year 2010. The original weight was used for ICFT data. Data on income provided by the Italian Revenue Agency.

Finally, we controlled for a set of variables of interest concerning income by considering four categories of interest: labour income (for employee), self-employment income, retirement income (pensions) and disposable income. As described above (Section 3.1), this information was obtained from the Italian Revenue Agency (RA) providing income data for the year 2010. Table 4 shows the measures of income that we considered in two different ways. The first was obtained by linking information on income from the Italian Revenue Agency to individuals interviewed in the ICFT survey. For this case, column 1 shows the number of income recipients based on different types of income, and the sum of the income that they declared (referred to as ‘total’ in column 2). The second way concerned income measures for the total population from official administrative archives. Columns 3 and 4 indicate the same information as from the ICFT survey (columns 1 and 2) for external sources, which, here, is relative to the entire population and not limited to the subjects interviewed by the ICFT.

Comparison of the number of subjects declaring different sources of income in the ICFT and in total population (penultimate column) shows an underestimation by the ICFT survey of persons reporting labour income (about 14% less than in the population) and self-employment income (about 20% less). Also partially over-estimated is the representativeness of the number of pensioners in the ICFT survey, which are present in excess (+5.2%) with respect to the population value.

Considering the total amount of income that respondents declared, the last column in Table 4 shows the ratios between the amounts declared by persons in the ICFT and in the total population. Labour incomes are under-estimated by 5.9%. By contrast, incomes from pensions are over-estimated by 13.4%. The most critical fact, however, concerns the amount of incomes related to self-employed persons, which, according to the ICFT survey, turn out to

⁴ The increased frequency of unemployed people interviewed in the ICFT survey may be a consequence of their easier availability and willingness to respond to the interview.

be much lower than those of the population (about 40%). In other words, the ICFT survey, besides under-representing the large number of self-employed workers, also largely under-estimates their income. A comforting result comes, however, from the disposable income of the respondents: this turns out to be representative, with a very small deviation (-2.8%) from the value valid for the entire population.

3.3 The post-stratification procedure

As described in the previous section, the ICFT survey is unable to represent correctly population values with respect to some demographic, social and income aspects of importance when performing microsimulation analysis. The problem is evident with regard to population by age classes, employment status and number and incomes of self-employed workers. Other differences, though less significant, regard households composition and labour market indicators of respondents to the survey. It is therefore necessary to correct the sample in the ICFT via re-balancing for such characteristics with the ‘post-stratification’ statistical procedure. By means of this procedure, it is possible to build appropriate weights readjusting the sample size in order to make them more representative of the population data (Judkins, 1990).

We constructed the post-stratification weights using the STATA *survwgt* program. This program enables calculation of a vector of weights which, when applied to ICFT data, minimizes the discrepancy between the survey sample frequencies and those arising from external sources. The starting point of the correction process was the re-proportioning of the original weight released by the Statistical Office of the Province of Trento. Unfortunately, this type of procedure is not without problems due to a ‘short blanket’ issue. Indeed, control for balancing along one dimension (variable) may lead to a correction of another one in the opposite direction. In other words, the correction along one or more marginal distributions does not yield the correctness of the joint distribution. Moreover, the problem is more evident, the greater the number of variables considered in the post-stratification algorithm.

Table 5 shows the percentage ratio between the sample size in the ICFT and from external sources according to socio-demographic variables, household composition and status in the labour market, as evidenced by the use of different weights for post-stratification. In particular, four different weights were calculated which, incrementally, increased the number of variables inserted in the post-stratification procedure. The first weight (Weight 1) took into account the main socio-demographic variables considered as relevant (age, nationality and gender of individuals). Weight 2 summed the level of education to the control of the characteristics just mentioned. Weight 3 added to Weight 2 the characteristics of individuals related to their labour-market status. Finally, Weight 4 added the representativeness for the number of persons self-employed.

Table 5. Distribution of socio-demographic characteristics and labour-market participation indicators. Percentage ratios between ICFT data (different weights) and External data.

Variables	Original Weight	Weight 1	Weight 2	Wight 3	Weight 4
Aged less than 15	91.1	100.0	100.0	100.0	100.0
15-24	112.6	100.0	100.0	100.0	100.0
25-34	80.7	100.0	100.0	100.0	100.0
35-44	87.3	100.0	100.0	100.0	100.0
45-54	102.0	100.0	100.0	100.0	100.0
55-64	118.4	100.0	100.0	100.0	100.0
More than 64	105.3	100.0	100.0	100.0	100.0
Total Population	99.0	100.0	100.0	100.0	100.0
Nationality (not Italian)	97.2	100.0	100.0	100.0	100.0
Gender (women)	102.2	100.0	100.0	100.0	100.0
Single-person household	91.4	89.3	89.2	89.8	90.0
Couples with children	105.2	110.3	110.1	109.6	109.4
Couples without children	94.6	88.8	89.3	89.2	89.3
Single-parent households	142.2	146.0	146.4	146.6	146.2
Primary education or no qualification	97.9	91.5	100.0	100.0	100.0
Lower-secondary education	101.1	97.7	100.0	100.0	100.0
Upper-secondary education	99.0	102.3	100.0	100.0	100.0
Tertiary degree	104.1	110.6	100.0	100.0	100.0
Activity rate	90.7	94.9	94.4	97.4	97.4
Employment rate	89.1	93.3	92.7	97.3	97.3
Unemployment rate	138.0	136.2	138.9	101.5	101.1
Unemployment rate (15-24)	141.6	140.5	141.0	106.2	105.1
Activity rate (Women)	106.2	109.7	108.4	111.6	111.5
Employment rate (Women)	104.0	107.4	106.1	111.5	111.4
Unemployment rate (Women)	140.2	139.1	141.6	104.2	103.6

Note: FBK-IRVAPP calculations. The data refer to the province of Trento for 2010. The first weight (Weight 1) takes into account age, nationality and gender. Weight 2 sums the education level to the control of the characteristics just mentioned. Weight 3 adds to Weight 2 characteristics of individuals related to their labour-market status. Finally, Weight 4 adds the representativeness for the number of self-employed individuals (data sources are presented in Section 3.2).

As shown in Table 5, whilst, initially, the ICFT survey frequencies concerning age classes were not always correctly representative of external sources (in particular, in the 15-24 and 25-34 age groups), the post-stratification process allowed important improvement to be made to the quality of the data available. The increase in the correspondence between the ICFT and the external source proved to be constant with respect to all the weights specifications and, despite the inclusion of numerous variables, the distributions of the different age classes in the ICFT data and in the population were fully coincident.

Table 5 show that, also with regard to gender and citizenship, the differences between the observed frequencies in the ICFT data and those found in external sources were completely corrected.

Household characteristics were not included directly in the post-stratification procedure due to the limited degrees of freedom (impossibility to control for any variable in the optimization process). However, following the application of different weights, differences in the distribution of such variables with those from external sources differences were very limited. More effective was the over-representation of single-parent households, as already found by the application of the original weight. As previously mentioned, this error was, however, not crucial given the limited size of the phenomena analyzed.

The characteristics compared to the level of education of the respondents were – as in the case of variables related to age, gender and nationality – fully representative of the actual values from the application of Weight 2, which took account of the education variables in the calculation process.

The post-stratification procedure affected the labour-market variables starting from the application of Weight 3, and it proved effective in correcting the initial imbalance between ICFT data frequencies and the external source. The aggregate unemployment rate (but also disaggregated by groups for young people and women) was reduced to percentage values close to those of the external source. We thus overcome a problem that, while covering small values (unemployment rates are small values), may be particularly relevant to the analysis of policies in Trentino, since many public policies specifically target the category of unemployed people. Employment and activity rates largely corresponded to the reference data, with slight over-estimates only in respect of the indicators related to gender.

Table 6. Ratios between ICFT data (different weights) and overall population data on individual income tax returns (different weights). Income earners number and total amount of main sources of income.

Source of income	Original weight	Weight 1	Weight 2	Weight 3	Weight 4
<i>A. Ratio between frequencies</i>					
Labour income	86.1	90.0	89.3	91.1	90.8
Self-employment income	80.7	82.4	79.2	77.7	99.5
Retirement income	105.2	97.0	97.6	96.6	96.5
Disposable income	91.5	91.7	91.6	92.3	92.3
<i>B. Ratio between total amount</i>					
Labour income	94.1	98.5	96.7	99.9	99.3
Self-employment income	62.5	64.0	60.0	60.8	78.0
Retirement income	113.4	104.7	102.7	100.9	100.8
Disposable income	97.2	98.0	96.5	98.1	98.4

Note: FBK-IRVAPP calculations. Data refer to the province of Trento for 2010. The first weight (Weight 1) takes into account age, nationality and gender. Weight 2 sums the education level to the control of characteristics just mentioned. Weight 3 adds to Weight 2 characteristics of individuals related to their labour-market status. Finally, Weight 4 adds the representativeness for the number of self-employed individuals (data source is presented in Section 3.2).

Table 6 shows, respectively, the relative percentages of the number of individuals (Part A of the table) and the total amounts of income (Part B of the table) by type of income declared by individuals. Weight 4 corrected for the distortion due to the under-representation of the number and the average income level of self-employed workers, including the balance condition for the number of self-employed workers in the optimizing process. The application of Weight 4 significantly increased the number of self-employed workers represented in the ICFT survey. The large number of individuals reporting other types of income (employees, retirees and disposable income) remained in fair approximation of the real data. Despite the correction for the relative frequencies, Table 6 shows an incremental improvement in the ability to represent incomes of self-employed people even if it cannot bring their representativeness to entirely satisfactory levels. Income from self-employment is thus underestimated compared to the values for the population, while those of employee income and retirement income, as well as disposable income, are instead good approximations of the actual values.

Overall, the post-stratification procedure described made it possible, through Weight 4, to rebalance the data source in the ICFT data in order to make it particularly suited to representing the population of the Province of Trento on most of the variables considered essential for policy analysis using TREMOD: in particular, the representation of different segments of the population (age classes), the distribution by gender and nationality, level of education, household composition and employment status. The number and the income situation in the ICFT sample, moreover, are now able to effectively capture the actual

conditions of the population of the Province of Trento particularly in regard to employees and pensioners. There remain some critical issues relative to the amount of declared income by self-employed workers, which is partly under-estimated. Unfortunately, numerous dimensions were involved in the post-stratification process, and the results clearly cannot account for everything at the same time. However, the starting conditions were significantly improved, and the post-stratification process produced great improvement.

4 Assessing TREMOD's performance

TREMOD makes it possible to simulate the amount of income taxes and to calculate individual and household disposable income starting from information on total income and family composition. The performance analysis of estimates produced using TREMOD, described in this section, sought to verify that each of the components calculated by the microsimulation model (for example taxes, tax credit and deductions) was equivalent to real data. More precisely, our analysis focused on the ability of our model to calculate total income, taxable profit, gross and net taxes, and various types of tax credits and deductions.

Table 7. Analysis of simulated fiscal variables using TREMOD. Comparison of various sources of income between TREMOD estimates and administrative data (RA) based on persons in the ICFT survey. Income earners number (Freq.) and average amount (in Euro).

Source of income	Freq. TREMOD (1)	Mean TREMOD (2)	Freq. RA (3)	Mean RA (4)	Ratio % (1/3)	Ratio % (2/4)
Total income	5,132	21,415	5,132	21,403	100.0	100.1
Other deductions	5,132	21,415	5,132	21,403	100.0	100.1
Net taxable income	2,347	1,568	2,343	1,570	100.2	99.9
Gross Tax	5,114	21,193	5,072	20,716	100.8	102.3
Net tax	5,079	5,561	4,956	5,705	102.5	97.5
Tax credit for income source	4,026	4,993	4,105	4,942	98.1	101.0
Family tax credits	4,768	1,114	4,604	1,127	103,6	98.8
Tax credit (dependent spouse/children)	1,315	1,085	1,280	1,077	102.7	100.7
Other family tax credits	1,308	1,082	1,277	1,072	102.4	100.9
Other tax credits	12	948	12	874	100.0	108.5
Total tax credit	3,268	647	3,261	645	100.2	100.3
Disposable income	5,029	1,760	4,949	1,701	101.6	103.5

Note: FBK-IRVAPP calculations. Data refer to the Province of Trento for 2010. Weight 4 was used to correct ICFT data freq. (see Section 3.3). Data on income provided by the Italian Revenue Agenc.

We first compared the estimates obtained with TREMOD with the real values gathered from individual income tax returns for individuals present in the ICFT survey. Table 7 shows that TREMOD's estimates were very similar to the real values along all the dimensions that we took into account. The relationship between TREMOD's estimates and those of the

individual income tax returns are always very close to 100. This result demonstrates the goodness of TREMOD in estimating individual tax and social security benefits.

Table 8: Analysis of simulated fiscal variables using TREMOD. Comparison of various sources of income between TREMOD estimates and administrative data (RA) referring to total population. Income earners number (Freq.) and declared total amount (in thousands of Euro).

Source of income	Freq. TREMODO (1)	Total TREMODO (2)	Freq. RA (3)	Total RA (4)	Ratio % (1/3)	Ratio % (2/4)
Total income	380,505	8,100,595	412,367	8,218,799	92.3	98.6
Taxable income	379,373	7,989,332	407,555	7,873,687	93.1	101.5
Gross tax	376,961	2,066,770	399,786	2,110,699	94.3	97.9
Net tax	302,892	1,461,191	326,563	1,515,161	92.8	96.4
Tax credit for income source	355,729	400,676	370,366	421,017	96.0	95.2
Disposable income	379,373	6,561,434	412,367	6,703,856	92.0	97.9

Note: FBK-IRVAPP calculations. Data refer to the province of Trento for 2010. For TREMOD data we used weight 4 as population size weight (see Section 3.3). Data on income provided by the Italian Revenue Agenc.

Furthermore, since the purpose of TREMOD is to provide estimates valid for the entire population, it should be verified whether the results of TREMOD are close to the tax returns data of the entire population (Table 8). To compare survey and population data, we used the ‘optimal’ weight (i.e., weight 4), since it included all relevant dimensions, as seen in Section 3.3. Table 8 shows that the number of people who declare a total income (of any type) is slightly underestimated, 92.3% compared to the actual population, while the amount of total income is close to 100%. This error influences the relationship between the frequencies, but it is only marginally relevant when we consider income amount instead of the number of individuals. TREMOD also performs well in simulating other variables (i.e., taxable income, gross tax, net deductions from work and retirement, disposable income), albeit with slight differences.

5 A comparison between TREMOD and EUROMOD-IT

The most innovative aspect of TREMOD compared to EUROMOD-IT consists in the data sources that we used. TREMOD’s database is about ten times larger than the sub-sample of individuals resident in the Province of Trento in the IT-SILC survey (the data source for EUROMOD-IT), and it is matched with administrative data that provide information more detailed and precise than self-reported declarations. The matching of survey and administrative data has huge potential in terms of future developments of the input database and the model that will be discussed in the conclusions (see Section 6).

To assess the specific gains in using TREMOD instead of EUROMOD-IT, we compared results obtained with the two models. Table 9, for different segments of the total population

(some relevant age classes, and gender) compares the estimates of the number of income recipients and the average amount of income obtained using TREMOD, EUROMOD-IT using SILC data (subsample SILC-TN for the Province of Trento) and the Italian Revenue Agency (RA).

On average, TREMOD estimates of total and disposable income show lower deviations from official statistics data (NTI) than do SILC-TN estimates, even though the net tax estimated in SILC-TN is closer to the NTI. The standard errors show that the SILC-TN estimates are more variable, partly because of the smaller SILC-TN sample size where 793 respondents are present in the survey, while the ICFT involved 7,200 in 2010. Overall, the results obtained from the two samples are quite satisfactory, even if real population values sometimes do not fall within the confidence intervals obtained from the estimates performed using TREMOD and SILC-TN samples.

The following tables (Tables 10 and 11) show comparisons between estimates using TREMOD, EUROMOD-IT (subsample SILC-TN for the Province of Trento) and the Italian Revenue Agency (RA) by percentiles of the income distribution.

Table 9: Comparison among the results of TREMOD, EUROMOD-IT (subsample Province of Trento SILC-TN) and Italian Revenue Agency (RA) data. Number of income earners (Freq.), average amount (in euros).

Source of income	Freq. TREMOD	Mean TREMOD	Freq. SILC-TN	Mean SILC-TN	Freq. RA	Mean RA
<i>A. Population</i>						
Total Income	380,505	21,289 (290)	400,425	21,845 (731)	412,367	19,931
Disposable Income	379,373	17,295 (197)	402,686	17,710 (539)	412,367	16,257
Net tax	302,892	4,824 (120)	331,010	4,519 (239)	326,563	4,640
<i>B. Age class 25-45</i>						
Total Income	132,429	21,500 (391)	139,731	23,605 (967)	143,355	19,569
Disposable Income	132,127	17,744 (277)	139,731	19,267 (728)	143,355	16,181
Net tax	113,031	4,276 (137)	119,976	4,499 (306)	117,672	4,129
<i>C. Age class 46-65</i>						
Total Income	125,836	26,379 (615)	129,558	27,400 (1,615)	134,800	25,444
Disposable Income	125,453	20,943 (400)	131,819	21,586 (1,168)	134,800	20,242
Net tax	106,833	6,169 (257)	113,742	5,806 (530)	113,766	6,164
<i>D. Men</i>						
Total Income	193,121	26,585 (493)	199,697	27,641 (1,178)	213,289	24,196
Disposable Income	192,947	21,114 (325)	199,697	22,274 (849)	213,289	19,302
Net tax	167,834	6,033 (198)	174,750	5,707 (390)	180,564	5,781
<i>E. Women</i>						
Total Income	187,384	15,831 (257)	200,728	16,079 (728)	198,966	15,362
Disposable Income	186,426	13,343 (190)	202,989	13,220 (560)	198,966	12,994
Net tax	135,058	3,322 (93)	156,260	3,191 (227)	145,894	3,229

Note: FBK-IRVAPP calculations. Standard errors in parentheses. Data refer to the province of Trento for 2010. For TREMOD data we used weight 4 as population size weight (see Section 3.3). SILC-TN are estimates based on the EUROMOD-IT model (using as datasource the subsample of individuals, in the IT-SILC survey, resident in the Province of Trento). Italian Revenue Agency (RA) data refer to the whole population of data on individual income tax returns.

Table 10. Comparison among the results of TREMOD model, EUROMOD-IT (subsample Province of Trento SILC-TN) and Italian Revenue Agency (RA) data. Percentiles 10, 50 and 90 (in euros)

Source of income	10% TREMOD	50% TREMOD	90% TREMOD	10% SILC-TN	50% SILC-TN	90% SILC-TN	10% NTI	50% NTI	90% NTI
<i>A. Population</i>									
Total Income	4,000	18,306	37,729	2,210	20,236	42,161	2,001	16,772	36,027
Disposable Income	4,099	15,664	29,240	1,415	16,721	32,930	1,915	14,627	28,445
Net tax	600	3,121	9,723	416	3,271	9,863	329	2,839	9,159
<i>B. Age class 25-45</i>									
Total Income	5,684	19,997	35,125	6,183	23,014	39,884	1,670	18,346	33,812
Disposable Income	5,589	16,908	28,209	5,810	18,961	31,194	1,578	15,863	27,172
Net tax	775	3,195	7,646	1,238	3,699	8,292	340	2,966	7,934
<i>C. Age class 46-65</i>									
Total Income	5,987	22,131	44,859	5,081	23,185	51,999	3,964	20,818	45,314
Disposable Income	5,986	18,654	34,314	2,443	18,753	41,775	3,771	17,812	34,681
Net tax	637	3,730	11,650	463	3,664	12,158	547	3,594	12,500
<i>D. Men</i>									
Total Income	6,754	22,224	45,983	7,475	24,325	50,003	2,093	20,126	43,498
Disposable Income	6,583	18,686	34,933	7,239	19,912	38,873	2,000	17,240	33,436
Net tax	952	3,672	12,565	746	3,846	11,501	528	3,407	11,656
<i>E. Women</i>									
Total Income	2,545	13,791	29,243	1,186	14,261	31,782	1,953	13,118	28,968
Disposable Income	2,639	12,193	23,445	653	12,282	25,403	1,854	11,848	23,532
Net tax	399	2,428	6,601	261	2,408	6,627	225	2,124	6,534

Note: FBK-IRVAPP calculations. Data refer to the province of Trento for 2010. For TREMOD data we used weight 4 as population size weight (see Section 3.3). SILC-TN are estimates based on the EUROMOD-IT model (using as datasource the subsample of individuals, in the IT-SILC survey, resident in the Province of Trento). Italian Revenue Agency (RA) data refer to the whole population of data on individual income tax returns.

Table 11. Comparison among the results of TREMOD model, EUROMOD-IT (subsample Trentino - SILC(TN)) and Italian Revenue Agency (RA) data. Percentiles 95, 99 and 99,9 (in Euro)

Source of income	95% TREMOD	99% TREMOD	99,99% TREMOD	95% SILC-TN	99% SILC-TN	99,99% SILC-TN	95% NTI	99% NTI	99,99% NTI
<i>A. Population</i>									
Total Income	49,813	100,210	472,828	51,047	87,050	217,918	49,202	103,705	534,857
Disposable Income	37,331	66,174	293,789	40,217	60,193	160,569	37,095	70,568	324,296
Net tax	14,757	35,343	179,039	13,055	27,431	57,349	14,695	37,461	231,011
<i>B. Age class 25-45</i>									
Total Income	46,426	87,134	130,396	44,431	62,905	128,550	44,587	82,734	485,502
Disposable Income	35,503	59,358	88,369	34,728	42,438	85,008	34,137	58,633	286,031
Net tax	12,735	29,102	42,348	11,501	18,532	43,542	11,991	27,488	203,735
<i>C. Age class 46-65</i>									
Total Income	61,947	136,149	472,828	76,824	109,211	217,918	66,498	132,706	643,790
Disposable Income	45,152	87,719	293,789	56,488	74,716	160,569	48,324	88,402	387,563
Net tax	17,822	48,175	179,039	20,379	37,127	57,349	21,130	48,198	276,924
<i>D. Men</i>									
Total Income	64,741	126,244	472,828	62,872	91,110	217,918	61,859	126,488	680,924
Disposable Income	46,354	84,962	293,789	45,889	62,748	160,569	45,318	84,501	404,000
Net tax	18,973	42,027	179,039	17,102	34,495	57,349	19,187	46,055	298,537
<i>E. Women</i>									
Total Income	35,760	61,947	162,281	35,904	49,136	97,086	35,540	66,484	302,308
Disposable Income	28,116	46,300	150,582	29,366	37,583	64,711	27,909	47,851	182,720
Net tax	9,159	21,141	56,730	9,774	14,747	35,920	9,302	22,748	121,001

Note: FBK-IRVAPP calculations. Data refer to the province of Trento for 2010. For TREMOD data we used weight 4 as population size weight (see Section 3.3). SILC-TN are estimates based on the EUROMOD-IT (using as datasource the subsample of individuals, in the IT-SILC survey, resident in the Province of Trento. Italian Revenue Agency (RA) data refer to the whole population of data on individual income tax returns.

Table 10 shows that the lower part of the income distribution, and in particular the tenth percentile, is approximated better in SILC-TN than in TREMOD. This result, however, is less noticeable when stratifying the population by relevant age class and gender. Nevertheless, these results counsel caution in the analysis of fiscal policies targeted on individuals with lower incomes. Regarding the median and the ninetieth percentile, TREMOD's estimates better approximate the distribution of the population. The result is confirmed in subsamples obtained in relation to age and gender. This confirms that the ICFT survey is representative of the income distribution of the population of the Province of Trento with some limitations in the representativeness of the lower part of the income distribution.

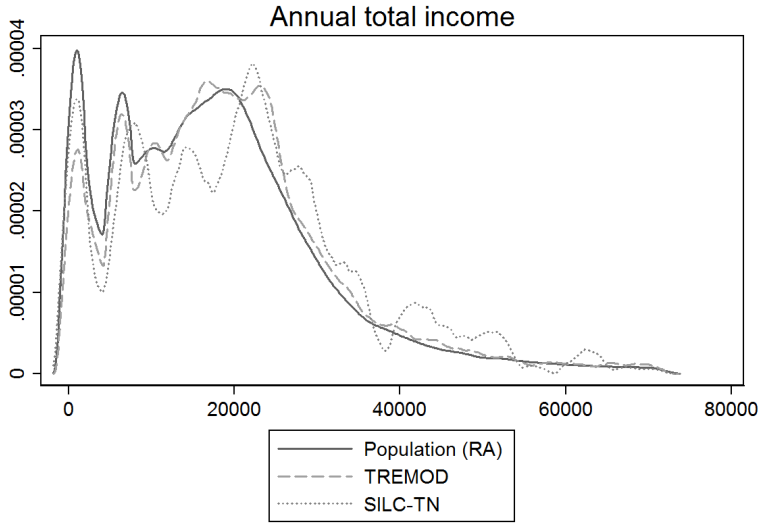
As shown by Table 11, a significant advantage of TREMOD over EUROMOD-IT (using SILC-TN) is that it is able more accurately to capture the distribution of the highest percentiles of the distribution. In recent years, the economic literature has emphasized the importance of analysis of top incomes, focusing on the share of total income held by 5%, 1% or even 0.01% of the wealthiest population (see, for example, Atkinson et al., 2011). Given that the representativeness for the highest percentiles of the income distribution may be very limited in small samples, the TREMOD model, which is based on a dataset that contains over 7,000 interviews, may have some structural advantages compared to EUROMOD-IT. Table 11 confirms that TREMOD is more accurate in representing the distribution of high incomes and therefore more suitable for analysing the impact of fiscal policies on the disposable income of the wealthiest segment of the population.

Thus far, we have analysed the quantiles and have produced some descriptive statistics of the income distribution. We now also provide a more detailed comparison based on the entire income distribution using non-parametric density estimates (see Silverman, 1986). Figures 1 and 2 below show the distribution of total and disposable income, respectively. The solid line represents the income density estimated on the population (RA data), the dashed line refers to TREMOD, and the dotted line is estimated on SILC-TN. Both figures show that the income distribution of the population is represented with greater precision using TREMOD rather than SILC-TN, except for individuals with low incomes.

Finally, we focus on a synthetic analysis using the household income distribution. It should be noted that distribution statistics are not available from external sources and therefore it was not possible to validate the results obtained with TREMOD. We simply show some popular statistical distributions of equivalent household income by comparing the results obtained with each model. The disposable household income was obtained in order to take account of the different sizes of families, based on the so-called OECD-modified equivalence scale that assigns a weight equal to 1 to the householder, 0.5 to other adults (those with more than 14 years) and 0.3 to minors. Table 12 shows the Gini index and the individual and household poverty rate⁵. The two sample estimates of the levels of inequality and poverty are very similar.

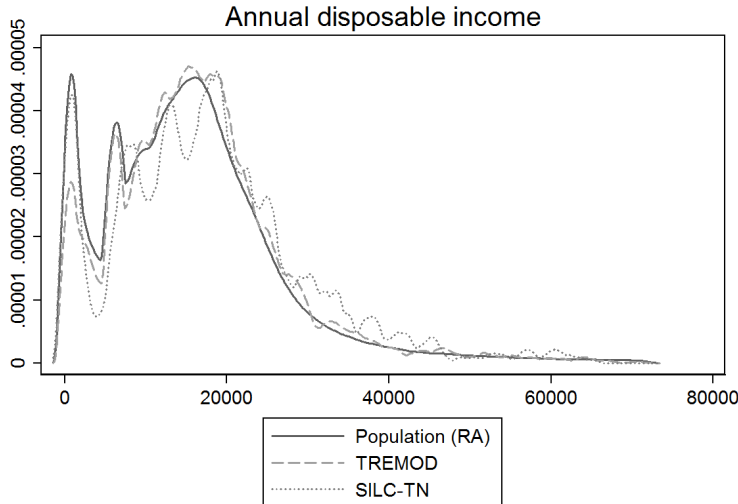
⁵ In accordance with a common convention, we considered as 'poor' those individuals living in households whose income did not reach 60% of the median of the reference population.

Figure 1. Total income: comparison among the results of TREMOD model, EUROMOD-IT (subsample Province of Trento SILC-TN) and Italian Revenue Agency (RA) data.



Note: FBK-IRVAPP calculations. Data refer to the province of Trento for 2010. For TREMOD data we used weight 4 as population size weight (see Section 3.3). SILC-TN are estimates based on the EUROMOD-IT model (using as datasource the subsample of individuals, in the IT-SILC survey, resident in the Province of Trento). Italian Revenue Agency (RA) data refer to the whole population of data on individual income tax returns.

Figure 2. Disposable income: comparison among results of TREMOD model, EUROMOD-IT (subsample Province of Trento SILC-TN) and Italian Revenue Agency (RA) data.



Note: FBK-IRVAPP calculations. Data refer to the province of Trento for 2010. For TREMOD data we used weight 4 as population size weight (see Section 3.3). SILC-TN are estimates based on the EUROMOD-IT model (using as datasource the subsample of individuals, in the IT-SILC survey, resident in the Province of Trento). Italian Revenue Agency (RA) data refer to the whole population of data on individual income tax returns.

Table 12: Comparison between Gini index in TREMOD model and in EUROMOD-IT (subsample Province of Trento SILC-TN).

Sample	Gini index	Individual poverty rate (60% threshold)	Family poverty rate (60% threshold)
TREMOD	0,29	17,88	16,98
SILC-TN	0,27	17,45	17,80

Note: FBK-IRVAPP calculations. Data refer to the province of Trento for 2010. For TREMOD data we used weight 4 as population size weight (see Section 3.3). SILC-TN are estimates based on EUROMOD-IT (using as datasource the subsample of individuals, in the IT-SILC survey, resident in the Province of Trento).

6 Concluding remarks

This paper has presented the main features of TREMOD, the tax-benefit microsimulation model developed by FBK-IRVAPP for the Province of Trento. The model is intended for use as an analytical tool to support policy-makers and analysts interested in simulating *ex-ante* desired and undesired effects of fiscal and/or welfare policies. TREMOD is a highly flexible model that makes it possible to answer several questions regarding the effectiveness of a wide range of public interventions on different types of outcomes.

As described above, TREMOD is based upon the EUROMOD platform and combines survey and administrative data relative the resident population of the Province of Trento. In order to assess the success of this process and then evaluate the capacity of TREMOD to produce reliable estimates of policy relevant variables, various statistical analyses were performed. The results of the analyses have been the main subject of the present paper.

We have shown that TREMOD is robust with regard to some aspects crucial for the reliability of microsimulations estimates. First, the database proved to be highly representative of the entire population of the Province of Trento with respect to many socio-economic and demographic indicators. Second, TREMOD proved to be highly reliable in the simulation of various quantities of interest, including different definitions of income, tax and tax credit. Third, the analyses presented in this paper confirm the importance of using objective measures of income based on administrative sources (in our case tax returns) compared with self-reported information collected by surveys, since the latter are much more affected by measurement errors.

This (albeit first) version of TREMOD model can be used to simulate the effects of different provincial policies with high levels of accuracy. It should be stressed, however, that TREMOD is conceived as a tool that should be constantly maintained, updated and improved. In particular, TREMOD is expected to be upgraded as a ‘behavioural’ model in order to produce estimates of the effects of policies that take account of changes in individual and family behaviours induced by public policy.

Moreover, it should be borne in mind that TREMOD can be integrated with other databases. For instance, data relative to compulsory contributions and all the social security benefits of individuals might be included in the input database, allowing the simulation of the effects of a wide range of policies that affect taxation, employment and pensions.

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