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Measuring profit shifting in Italy with propensity score matching and receiver operating characteristics analysis (PS-ROC) method

Abstract

Aggressive Tax Planning (ATP) includes a set of practices aimed at exploiting mismatches and loopholes in the international tax framework in order to reduce the tax burden of Multi-National Enterprises (MNEs). The measurement of Base Erosion and Profit Shifting (BEPS) is relevant not only for monitoring the phenomenon and informing policies aimed at contrasting it, but also for assessing related illicit financial flows and adjusting gross domestic product (GDP) in national accounts. The main contribution of this work is to provide a firm-level estimate of BEPS by using a bottom-up method relying on the analysis of Italian microdata. In particular, the PS-ROC method presented here identifies tax avoiding MNEs and provides a point measurement of the amount of profits they shift abroad. Results show that about 60% of Italian MNEs use ATP strategies, under-reporting 32.3 billion euros, about 2% of the Italian GDP.

Key words: Base erosion and profit shifting, Aggressive tax planning, Multi-national enterprises, Propensity score matching, ROC analysis



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1. Introduction

In the last decades, the free movement of capital and labor, the gradual removal of trade barriers, and the development of communication technologies increased the integration of markets for trade and investments and boosted the formation of global value-chains. This mixture of legal, technological and organizational developments enhanced the possibility for multinational enterprise groups (MNEs) to manage the geographical allocation of production processes along (progressively globalised) value-chains.

The fast development of information and communication technology (ICT), the increasing digitalisation and the raising relevance of trade in services further increased what Slemrod (2010) defined as *mobility*, loosening technical and cost constraints in the geographical allocation of production processes. Such an increased mobility opened the possibility for MNEs to use their global strategies also as a lever to minimize the tax burden by identifying and exploiting legal arbitrages, mismatches and loopholes in the international tax framework.

The opportunity for MNEs to localize production of tangible and intangible goods and manage intra-group trade and structure of debt in order to shift profits from high- to low-tax countries has been raising several issues, ranging from the non-optimal allocation of resources to the reduction in market competition (OECD, 2013a, 2013b). Consequently, Base Erosion and Profit Shifting (BEPS) has become a relevant topic in the international debate, while Aggressive Tax Planning (ATP) is now deeply investigated by national tax authorities and international bodies (e.g. G20, OECD, UN, and European Commission).

According to the European Commission (2017), ATP refers to a set of (generally legal) practices aimed at exploiting mismatches and loopholes in the international tax framework in order to reduce the overall tax burden of MNE groups. In particular, ATP leverages on the geographical allocation of manufacturing plants and financial headquarters with the aim of adjusting the structure of costs and revenues of the MNE group in order to make the bulk of income and profits emerge in low-tax countries.

Alongside the definition and the understanding of ATP, also the measurement of BEPS has become a central topic. Indeed, assessing the magnitude of BEPS is crucial for several reasons, ranging from monitoring the phenomenon and informing policies aimed at contrasting it (OECD, 2013b), to measuring related illicit financial flows (as claimed by SDGs indicator 16.4) (UNCTAD, 2018; GFI, 2019) and adjusting GDP in national accounts (Moulton and Van de Ven, 2018; Ahmad, 2018).

Starting from the early 90's, several studies approached the issue of assessing the magnitude of BEPS and its relationships with tax differentials among countries. In particular, two main strands of literature can be acknowledged.

The first one is rooted in the seminal works of Hines and Rice (1994), and Ghruber and Mutti (1991). Here, econometric models are used to study how tax differentials among countries affect the distance between the profits reported by MNEs and theoretical profits estimated based on the application of standard production and behavioural models, or on the geographical allocation of Foreign Direct Investments (FDIs).¹ Econometric models use both macro² and micro data,³ where, according to Heckermeyer and Overesch

¹ See Dharmapala (2014) and, more recently, Dharmapala (2019) for a survey.

² Among others, Dharmapala and Riedel (2013) use macro data in order to measure the sensitivity of the behaviour of MNEs with respect to exogenous changes in tax differentials among countries. Acciari *et al.* (2015) use instead the distribution of FDIs to test to what extent the geographical allocation of investments in foreign companies is sensitive to tax differentials. Finally, using a general equilibrium model, Alvarez-Martinez *et al.* (2018) use macro data from a large set of OECD countries in order to estimate the amount of profits that are shifted abroad by MNEs.

³ Among others, Egger *et al.* (2010) use microdata about European foreign and domestic manufacturing plants to test to what extent their geographical allocation is connected with strategies aimed at reducing the tax burden. In a similar vein, Huizinga and Laeven (2008) use commercial micro databases to estimate the semi-elasticity of BEPS with respect

(2013), macro analyses tend to involve an overestimation of the BEPS-tax differential relationship. In this context, the tax differential-profit gap elasticity may provide indicators about the magnitude of BEPS at national level and may shape the cross-country distribution of the shifted income.⁴

The second strand is rooted in accounting literature and uses different variants of the formulary apportionment developed by Avi-Yonah (2010) and Fuest *et al.* (2007) to measure the amount of BEPS. Structural variables such as sales and compensation of employees (or a composite of them) are used to determine if, and to what extent, the income declared by MNEs is coherent with their economic structure. In this context, BEPS can be assessed by exploring possible inconsistencies between the economic structure and the declared income of business units belonging to the same MNE group.⁵

In both strands of literature, the use of microdata in empirical studies has been severely limited by the lack of a complete and reliable worldwide firm-level information (Acciari *et al.*, 2015). Indeed, though new commercial databases (e.g., Bureau Van Dijk) have attempted to fill this informative gap in recent years, issues related to microdata availability are far from being completely solved.

This work presents an innovative method to provide point firm-level estimates of BEPS using microdata related to only domestic (MNEs and non-MNEs) business units.⁶ The method allows to overcome the aforesaid informative gap, since data about domestic enterprises are generally available at national level for National Statistical Offices, National Tax Authorities and, though with some administrative burden, for scholars.⁷

From a methodological point of view, the hereby presented PS-ROC approach moves away from both model-based methods and formulary apportionment. It jointly applies propensity score matching (PS), which has already been used in the exploration of this topic (Finke, 2013), and the receiver operating characteristics analysis (ROC), which has not been used as yet, though not constituting an absolute novelty in economics (Costa *et al.*, 2019a, 2019b).⁸

The PS-ROC method conceptually grounds on the idea that ATP strategies tend to produce an “abnormal” set-up of structural and economic variables of MNEs with respect to the “normal” behaviour of similar enterprises, where the distance between the normality and the declared set-up can be, at least partially, traced back to a measure of BEPS. In particular, the method exploits the information coming from a double comparison: “between” MNEs and non-MNEs (which is coped with by using PS matching) and “within” MNEs (which is dealt with by using ROC analysis).

This method represents a relevant innovation in the measurement of BEPS. Indeed, firm-level point estimates of BEPS relying on microdata, which are generally available at national level, can be used in several contexts, ranging from the adjustment of GDP in national accounts to the measurement of illicit financial flows. Furthermore, the possibility to assess BEPS at micro level based on structural, organizational and behavioural characteristics of business units may also represent a relevant information for contrast

to tax differentials. More recently, Reynolds and Wier (2016) use microdata about South African corporations to estimate profit and debt shifting, using taxation as explicative variable in modelling firms' behaviours, while Barrios and d'Andria (2016) used worldwide firm-level data to account for BEPS coming from the geographical management of intangibles.

⁴ See Clausing (2016) and Dowd *et al.* (2017) for USA.

⁵ In particular, Dyreng and Markle (2013) use sales to adjust the income declared by business units belonging to MNE group headquartered in USA, Guvenen *et al.* (2017) use for the same goal an average of sales and compensation of employees, while Bruner *et al.* (2018) use the number of workers.

⁶ The database will therefore include resident headquarters and affiliates but will exclude non-resident headquarters and affiliates. In other words, if a group headquartered in Italy have two affiliates, one in Italy and one in another country, only the headquarter and the Italian affiliate will be included in the database.

⁷ In Italy, the National Statistical Office (Istat) allows scholars and researchers to access microdata on request by using a secure platform for accessing data.

⁸ Indeed, ROC analysis has been used to define the export threshold for Italian firms (Costa *et al.*, 2019a, 2019b), in the credit risk literature (Khandani *et al.*, 2010), and to measure under-reporting of SMEs in Italy (Sallusti and Cavalli, 2019).

authorities and policy makers, by providing them with the possibility of profiling ATP behaviours and defining risk indicators.

The rest of the work is organized as follows. Section 2 describes the dataset used for the analysis and stresses the role of MNEs in Italy. Section 3 presents the methodology. Section 4 summarizes the results. Section 5 comes to the conclusions.

2. Italian business system and the role of MNEs

The PS-ROC method is aimed at measuring the amount of BEPS connected with the adoption of ATP by Italian MNEs. The method relies on a bottom-up approach and uses firm-level data collected by Istat and referred to 2015.

Starting from 2014, Istat produces the Structural Business Statistics (SBS) archive Frame-SBS (Luzi and Monducci, 2016), which integrates administrative and survey data, and contains economic and structural information for the whole population of about 4.4 million of Italian firms.

Coherently with the goal of this work, Frame-SBS has been further integrated with two other databases. The first is COE-TEC database, which contains micro information about imports and exports of Italian firms by product and country of origin/destination. The second is the ASIA-group register (the Italian version of the European Group Register), which includes information about the role of Italian firms within MNE groups (with Italian or foreign headquarter).

Table 1. Main characteristics of the business units in the database, by industry (2015)

Industry	NACE rev.2 divisions	Business units		Size		Turnover		Value added		EBIT		Exports		Imports	
		Number	Composition	Average per unit	Composition per industry	Average per unit	Composition per industry	Average per unit	Composition per industry	Average per unit	Composition per industry	Average per unit	Composition per industry	Average per unit	Composition per industry
Mining and quarrying	06 07 08 09	1247	0.0	5.9	0.1	142.4	0.1	59.2	0.1	28.5	0.1	8.5	0.1	0.5	0.0
Food and beverage	10 11	46 093	1.3	5.2	2.5	177.1	4.1	36.0	2.7	19.2	2.4	19.4	7.0	12.9	6.9
Tobacco	13	10 863	0.3	5.8	0.7	129.6	0.8	40.9	0.8	19.5	0.6	29.7	2.8	18.4	2.6
Wearing apparel	14	22 862	0.6	5.0	1.2	89.8	1.0	28.2	1.0	12.8	0.8	21.8	3.8	9.4	2.4
Leather	15	12 599	0.3	6.7	0.9	123.9	1.0	35.3	1.0	15.0	0.7	39.6	5.1	18.5	3.5
Wood	16	24 728	0.7	3.2	0.8	101.0	0.8	31.2	0.8	15.3	0.6	7.5	0.9	12.5	2.2
Paper	17	2742	0.1	9.8	0.3	217.4	0.6	53.6	0.5	26.9	0.4	30.6	1.2	23.2	1.4
Printing	18	12 687	0.3	4.0	0.5	102.7	0.5	37.1	0.6	17.6	0.5	5.2	0.4	3.7	0.4
Chemical and pharmaceuticals	20 21	2697	0.1	8.9	0.3	270.0	0.6	67.5	0.5	36.5	0.5	64.4	2.4	38.2	2.0
Rubber and plastic	22	7216	0.2	9.5	0.7	190.4	1.3	53.6	1.2	27.0	1.0	40.5	4.2	19.6	3.0
Non metallic minerals	23	14 750	0.4	4.6	0.7	118.3	0.8	39.8	0.9	19.0	0.7	19.5	2.0	4.1	0.6
Metals	24	2241	0.1	11.9	0.3	327.0	0.8	64.5	0.6	38.5	0.5	95.0	3.9	66.2	4.0
Metal products	25	53 550	1.5	5.8	3.3	122.0	3.7	45.9	4.5	20.8	3.3	18.6	8.7	5.4	3.7
Electronics	26	3387	0.1	6.7	0.2	144.8	0.3	52.8	0.4	25.7	0.3	36.0	1.3	18.0	0.9
Electric machinery	27	6216	0.2	7.2	0.5	148.9	0.7	47.6	0.7	21.2	0.5	35.6	2.4	12.0	1.2
Machinery	28	15 914	0.4	9.3	1.6	172.9	2.5	59.1	2.8	26.7	2.0	63.6	14.3	8.3	2.7
Motor vehicles	29	1331	0.0	15.6	0.2	293.5	0.6	55.5	0.4	37.6	0.4	102.7	3.2	43.1	2.0
Other transport equipment	30	1512	0.0	9.3	0.1	131.7	0.2	46.9	0.2	24.4	0.2	36.6	0.8	17.0	0.5
Furniture	31	14 961	0.4	5.1	0.8	123.6	0.9	37.6	0.9	17.5	0.7	30.7	3.6	4.4	0.8
Other manufacturing	32	26 450	0.7	2.6	0.7	91.8	0.6	30.4	0.7	17.1	0.6	31.1	3.3	8.1	1.2
Repair and installation	33	34 706	1.0	3.3	1.2	94.8	1.1	39.5	1.5	18.9	1.1	4.0	0.7	1.9	0.5
Energy, water and waste	35 36 37 38 39	10 314	0.3	6.8	0.7	296.6	2.0	65.5	1.5	46.9	1.7	2.6	0.3	2.3	0.4
Construction	41 42 43	444 397	12.2	2.3	11.0	91.5	9.2	33.0	10.9	17.5	9.4	0.3	0.4	0.3	0.8
Trade in automotive	45	97 948	2.7	2.8	2.9	173.5	4.6	29.9	2.6	15.7	2.2	3.6	1.5	6.0	3.6
Wholesale trade	46	332 442	9.1	2.2	7.7	266.4	18.7	42.4	9.8	28.3	10.7	19.6	21.7	28.0	45.2
Retail trade	47	506 680	13.9	2.3	12.1	137.1	15.2	23.9	8.7	14.9	8.8	1.4	2.4	2.3	5.8
Transportation	49 50 51	89 167	2.4	3.4	3.2	110.3	3.2	36.7	3.6	18.0	2.8	0.1	0.1	0.2	0.2
Warehousing and postal services	52 53	17 580	0.5	10.2	1.9	92.0	1.6	34.4	2.0	21.2	2.0	1.6	0.4	0.4	0.2
Hotels	55	37 856	1.0	4.4	1.8	76.6	1.2	36.1	1.9	18.8	1.6	0.0	0.0	0.2	0.1
Restaurants	56	212 896	5.8	3.6	8.1	50.0	3.7	18.4	4.5	8.9	3.5	0.0	0.0	0.1	0.1
Communication	58 59 60 61	12 161	0.3	2.3	0.3	137.8	0.4	43.8	0.4	25.7	0.4	1.5	0.1	2.0	0.1
Informatics	62 63	67 136	1.8	2.4	1.7	71.4	1.1	38.0	2.0	20.8	1.7	0.3	0.1	0.3	0.1
Real estate	68	174 451	4.8	1.5	2.9	69.7	1.8	37.5	3.2	34.8	4.9	0.1	0.0	0.1	0.1
Professionals	70 71 72 73 74 75 76	674 670	18.5	1.4	10.3	62.6	5.9	38.6	11.9	32.0	16.1	0.3	0.4	0.1	0.3
Other business services	78 79 80 81 82	116 759	3.2	4.5	5.6	61.8	3.1	24.5	4.1	14.8	4.0	0.3	0.2	0.3	0.3
Personal services	85 86 87 88 90 91 92	534 142	14.6	2.2	12.3	48.6	5.5	27.7	10.3	20.5	12.3	0.1	0.1	0.1	0.3
Total		364 7351	100.0	2.6	100.0	109.4	100.0	33.2	100.0	20.4	100.0	7.0	100.0	4.8	100.0

Source: Author's elaboration on Istat data

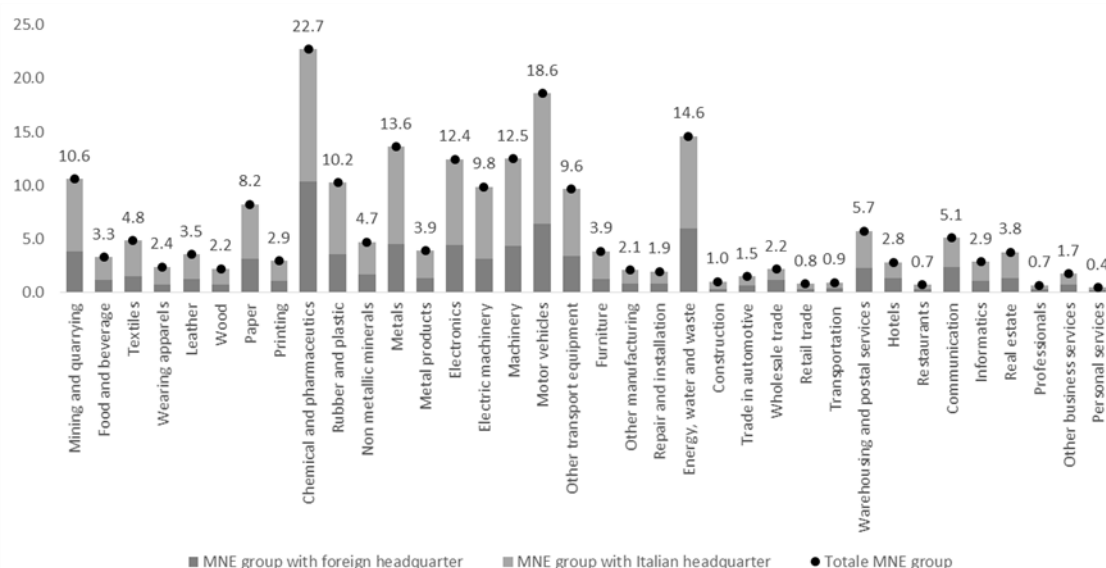
For each Italian firm (MNEs and non-MNEs), therefore, this integrated database includes comprehensive structural and economic information, the characteristics of its international trade network and, where relevant, its position within MNE groups.

In order to include in the analysis only relevant business units and industries, firms with a value added or turnover lower than – or equal to – 0, or employing less than 1 worker were excluded, as well as business units operating in industries characterized by regulated markets such as tobacco, coke and refined petroleum products, and financial intermediaries.

The final database for the analysis contains 3.6 million firms, where about 400 thousand are internationalized (they export and/or import) and 61.706 belong to MNE groups. In particular about 41% of MNEs belongs to slightly less than 12 thousand MNE groups headquartered abroad in 121 countries, while roughly 59% belongs instead to slightly more than 8 thousand MNE groups headquartered in Italy with affiliates in 125 countries.

Considering this dataset, the Italian business system is confirmed as being characterized by a strong predominance of small firms: the average size is 2.6 workers (only about 11 thousand enterprises employ more than 100 workers, while more than half of the population is under 2 persons employed). The average turnover is roughly 100 thousand euros, while value added per unit is about 33 thousand euros and average profit per worker (proxied by the Earnings Before Interests and Taxes (EBIT)) is 20 thousand euros. Considering internationalization, Italian firms export 7.0 thousand euros and import 4.8 thousand euro per unit on average.

Figure 1. Share of MNE business units by industry and type of group (2015)

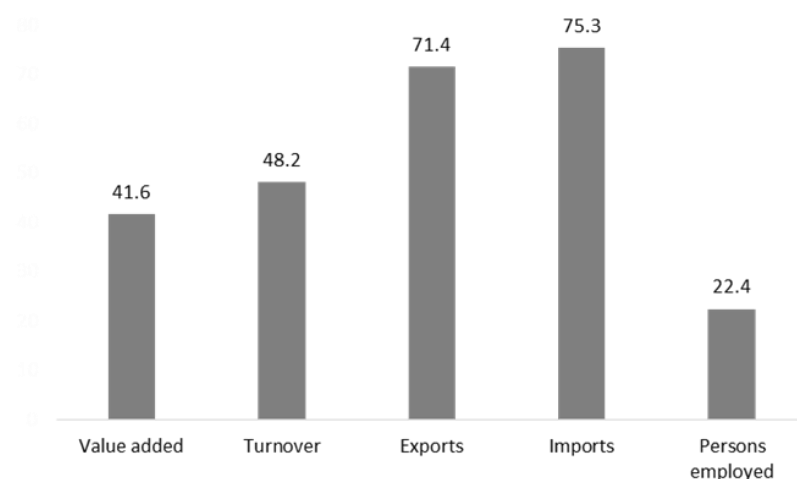


Source: Author's elaboration on Istat data

As Figure 1 shows, the role of MNEs in the Italian business system strongly varies across industries. In seven sectors, mainly in manufacturing, MNEs represent more than 10% of firms (22.7% in chemical and pharmaceuticals, 18.6% in motor vehicles and 14.6% in energy, water supply and waste management). On the other hand, the weight of MNEs is lower in construction (1.0%) and services (lower than 6%), where the presence of MNEs is particularly weak (lower than 1%) in retail trade, transportation, restaurants, professionals and personal services, which account for about 2 million business units (i.e. roughly 60% of the population under analysis). In all sectors, furthermore, a prevalence of MNE groups with Italian headquarters is found.

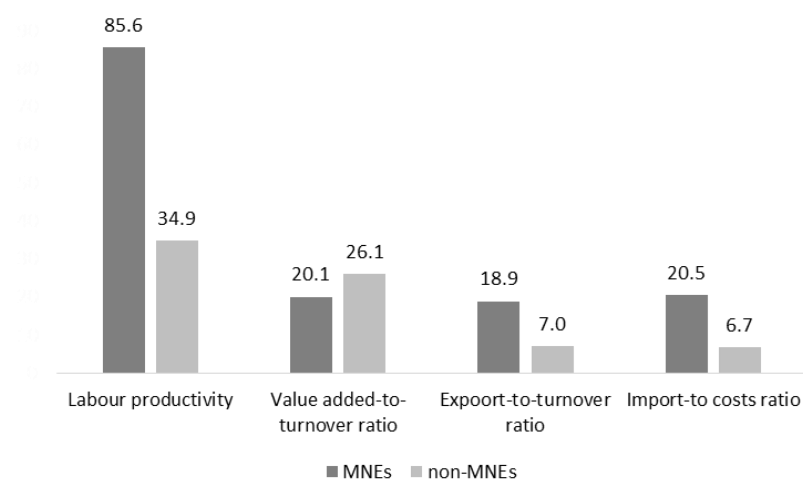
Notwithstanding MNEs represent less than 2% of firms, they play a relevant role in the Italian business system. Indeed, as Figure 2 displays, MNEs account for 22.4% of the workforce, generate a sizeable share of value added (41.6%) and turnover (48.3%), and they have a leading role in the interaction with international markets, generating 71.4% of exports and 75.3% of imports.

Figure 2. Contribution of MNEs in the Italian business system (shares) (2015)



Source: Author's elaboration on Istat data

Figure 3. MNEs vs. non-MNEs (thousands euro, shares) (2015)



Source: Author's elaboration on Istat data

Considering economic and performance indicators as in Figure 3, it is possible to pin down some relevant heterogeneity between the characteristics of MNEs as compared to those of non-MNEs. In particular, MNEs show a higher export-to-turnover and import-to-costs ratios (respectively, 18.9% vs. 7.0%, and 20.5% vs. 6.7%) and they are strongly more productive than non-MNEs (labor productivity is more than double in

MNEs, 85.6 vs. 34.9 thousand euros). The value added-to-turnover ratio is instead lower in MNEs (20.1%) than in non-MNEs (26.1%).⁹

3. Methodology

This section presents the PS-ROC method, which is composed by two phases: the identification of tax avoiding MNEs, and the measurement of the related amount of BEPS.

The identification of tax avoiding MNEs grounds on the idea that ATP strategies tend to produce an “abnormal” set-up of economic variables of MNEs with respect to the “normal” behaviour of similar enterprises. This is true with respect to both similar non-MNEs that cannot freely manage the geographic allocation of their manufacturing and financial bases (“between” comparison), and other MNEs that do not use ATP strategies (“within comparison”).

The PS-ROC method uses the information provided by both types of comparison, where PS matching is used in the “between” comparison in order to define the most efficient control group of non-MNEs to be compared with the given MNE, and ROC analysis is used in the “within” analysis in order to compare MNEs with each other.

The measurement grounds in turns on the idea that the amount of BEPS is connected with the distance of tax avoiding MNEs from the threshold of “normality” based on which business units have been classified in the identification. In this context, the estimate of BEPS is obtained, for each tax avoiding MNEs, by calculating the amount of profits that they should have had to declare in order to being classified as non-tax avoiding.

3.1 Identification

The identification is composed of two steps, which respectively exploit the “between” and the “within” comparison in order to classify MNEs into tax avoiding and non-tax avoiding.

In the first step, the comparison between MNEs and non-MNEs is used to identify a proxy for possible “abnormal” behaviours by MNEs. In particular, this proxy is obtained by comparing the EBIT-to-turnover ratio of the given MNE with the average one calculated over a control group of domestic firms, which is defined by using PS matching.

In the second step, starting from the proxy, and using a set of indicators that are intended to capture economic and strategic behaviours of MNEs as well as possible ATP levers (i.e. royalties, R&D, imports and exports, tax differentials), ROC analysis is performed to define the threshold of “normality” based on which tax avoiding MNEs are finally identified among the whole population of MNEs.

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