

Article

# Housing Affordability in Metropolitan Areas. The Application of a Combination of the Ratio Income and Residual Income Approaches to Two Case Studies in Sicily, Italy

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**Abstract:** Housing affordability problems have become more serious over the course of the last few decades and are now also affecting the middle-class, despite the fall in prices on the housing market. This study proposes a methodology to assess threshold-income as an index for measuring housing affordability by applying a combination of the ratio income and residual income approaches. The methodology is applied to two particular areas of Sicily in Italy as case studies consisting of medium-size metropolitan areas located in a less developed European region. The areas have been chosen on the basis of their different territorial structure: a polarized area that comprises a high-density city centre and a polynuclear urban region. The results are diversified for income level, as well as for town and urban zone, and allow us to compare the housing affordability problems between towns belonging to the same metropolitan area.

**Keywords:** housing affordability; ratio income approach; residual income approach; threshold-income; combined income approach; real estate market; metropolitan area

## 1. Introduction

Though metropolitan and post-metropolitan areas have different territorial structures in that the former comprises a high-density city centre with urban sprawl in its hinterlands, while the latter comprises a polynuclear urban region, in both areas, residential and economic activities are strongly interconnected with mobility and communication infrastructures, owing to continuous flows of people, commodities, information, capital, and investment. These flows follow dynamics that modify the economic and demographic relationships that generate the growth or decline of towns or metropolitan territories [1–3]. The relationships between towns may be classified as hierarchical-vertical relationships between the hierarchy levels or as network-horizontal relationships, which may form a synergic network when there is an alliance between similar towns to achieve economies of scale or a complementarity network when different economic sectors create a value chain connecting various towns. More often, mixed relationships are observed, the nature of which is partly hierarchical and partly network [4–6]. Each town contributes to the ‘external competitiveness’ of the metropolitan area to which it belongs against other urban regions in terms of its abilities to attract inhabitants, capital, and services, whilst at the same time facing the internal competitiveness within the very metropolitan area itself, according to its own demographic and economic ranking, which may attract more investment and migratory flows [7,8].

From the economic point of view, the traditional neoclassical analysis of the choice of place to live is based on the trade-off between housing price and transport costs under the income threshold [9,10]. Obviously, the choices also depend on many other factors such as cultural, aesthetic, ethical,

etc., but, nevertheless, housing price remains an acceptable conventional proxy of location quality (e.g., environmental, urban, and district quality) and of technological and architectural housing features, even if all these other factors may have diverse intensity and are variously combined in correspondence with the same overall price. Choosing a housing location may significantly depend on, or be seriously constrained by, the comparison of available income for housing and market prices (purchase or rental): 'housing affordability' is, precisely, a concept for analysing housing problems and defining housing need.

This study proposes to test a methodology to assess housing affordability problems in metropolitan and post-metropolitan areas in which, however, an all-encompassing housing policy has to be designed. The proposed methodology is applied to two areas, one in north-western Sicily (NWS) and the other in south-eastern Sicily (SES), as examples of medium-size metropolitan areas that are located in a less developed European region. These areas have been chosen on the basis of their different territorial structure: a polarized area that comprises a high-density city centre and a polynuclear urban region.

Starting from the basic concept that housing affordability always represents a relationship between people and price, the study is based on the analysis of the territorial distribution of both inhabitants' incomes and the local real estate market. In a metropolitan area, housing prices may vary considerably according to the location; for this reason, the analysis of local real estate has been considered an important step of the methodology because it will allow us to identify which areas or municipalities are affordable/unaffordable by each household type. The local housing market can be gathered by collecting the housing prices in the central and peripheral zones of each municipality of the two metropolitan areas.

The collected data on household incomes and local housing prices are the main inputs for the assessment of threshold-income (T<sub>I</sub>) by both the ratio income and the residual income approaches. According to the literature [11,12], the results of the ratio income approach may actually provide some distorted descriptions of the ability to purchase a house in correspondence to low and very low-income households. Consequently, a combined income approach is applied, as some others suggest [11,12], to reduce the methodological weakness of the income ratio, and for assessing the combined threshold-incomes. The combined threshold-income is used, not only to determine how many households have housing affordability problems, but also to show which locations in the metropolitan areas are affordable/not affordable. The mapping, in conjunction with other indexes, may support the metropolitan and urban planning by which the current 'form' of urban areas could be transformed in order to prevent, or to mitigate, the social polarization and ghettoization that are related to housing affordability problems [13].

In order to achieve this aim, Section 2 defines the concept of housing affordability and compares the most commonly used approaches for the assessment of housing affordability. In Section 3, a methodology is developed by using a combination of the ratio income and residual income approaches. In Section 4, the case study is presented, followed by the application of the ratio income, residual income, and combined approaches to two metropolitan areas. Section 5 discusses the results. In Section 6, the potential further development of the study is presented.

## 2. Housing Affordability: Concept and Measure

The debate in the literature is primarily focused on the very meaning of the term 'housing affordability' and on how to measure it.

The term 'housing affordability' began to be used from the 1980s and may be defined in various ways, among which we can cite: housing affordability refers to the capacity of households to meet housing costs, while maintaining the ability to meet other basic costs of living [14]; a rent is affordable when it leaves the consumer with a socially acceptable standard of both housing and non-housing consumption after rent is paid [15]; a household is said to have a housing affordability problem when it pays more than a certain percentage of its income to obtain adequate and appropriate housing [16].

Beyond a simple definition, however, it is important to underline that housing affordability is a complex matter that is related to various other issues such as affordable living, affordable standards, and affordable rents in social housing, and it presents policy implications, empirical analysis, norms, and standards [12]; further, it is opportune to clarify the difference between housing affordability and affordable housing.

The essential difference in the comparison of affordable housing and housing affordability lies in the fact that affordable housing addresses the problem from the point of view of the supply, whereas housing affordability addresses it from that of the demand. Public authorities can directly intervene in the supply by promoting social housing projects for middle-low income households [17]. An indirect public action could be to try to make market prices more affordable by applying fiscal incentives in return for tiered rents or by making subsidies available for refurbishments, consisting in interest subsidies or capital grants, to obtain adequate housing. An action on the demand side, on the other hand, could be to provide an 'increase' in household income through subsidies supporting rented housing [18].

Affordable living is another important and connected issue since achieving housing affordability is an insufficient constraint if it does not also occur that there is no housing deprivation and if minimum housings standards are respected (e.g., regarding inaccessible location, overcrowded conditions, or unsafe buildings) because affordable housing may bring, as a consequence, high commuting costs, especially when households live in outer areas or out of the metropolitan area.

However, affordability and lack of affordability are always relationships between people and housing (price or rent): at the same income, these relationships are affected by real estate market fluctuations and by housing types, while, at the same price, these relationships differ in regards to household type, income range, home purchase, and rental so that the specific income groups to whom the measure of affordability refers, as well as what the standard of affordability is, must be preliminarily defined [19].

In particular, the liquidity transmutation between different investment types and the speculative-financial actions of the investors in the markets (e.g., stock or real estate market, etc.) give raise to 'real-estate-basins', each one corresponding to a time section bounded by two *displuvium* points (maximum prices), and containing one *compluvium* point (minimum price). These can be described as boom and bust cycles in the residential property market; the former corresponds to the phase from the *compluvium* towards the *displuvium* point, and the latter, vice versa, decreases or amplifies housing affordability problems [20–22] and may influence housing policy and urban planning decisions.

Housing affordability may have several uses in fair public decision-making processes [23–25], especially regarding housing policy and metropolitan planning such as in terms of description, analysis, administration, definition, prediction, and selection [16]. It may be applied to describe household expenditures or to analyse and compare trends and different household types. It can also be a tool in the administration of public housing, used for defining eligibility criteria and subsidy levels in rent housing and, moreover, for defining housing need for public policy purposes. It can also be used for predicting the ability of a household to pay the rent or mortgage and so can be used as a selection criterion in the decision to rent or to provide a mortgage.

There are various approaches such as categorical, relative, subjective, family budget, ratio, and residual that can be used to define or assess housing affordability [12]. The most common are the ratio income and the residual income approaches.

The ratio income approach has roots going back to the Nineteenth Century in studies of household budgets and has gained broad acceptance as an appropriate indicator of the ability/problem to pay for housing since, for example, it is used by Housing and Urban Development (HUD) and National Association Realtors (NAR) in the USA, by the Observatory of the Real Estate Market (OMI) of the Ministry of Finance in Italy, and by the Housing Industry Association/Commonwealth Bank of Australia (HIA/CBA) [26–29]. This approach assesses the maximum acceptable housing cost to income ratio and asserts that, if a household pays more than a certain percentage of its income for housing,

then it will not have enough income left for other necessities. An explicit ratio is also specified, although this has gradually shifted up over the Twentieth Century; for example, in Canada, it was 20 percent until the 1950s, 25% until the 1980s, and has been 30% since then. The ratio approach has been criticised because the value of this ratio is not the result of statistical models; it is just a ‘rule-of-thumb’ and, in any case, tends to apply the same ratio for any household type and consumption standard, so it may be misleading [13,15,30]. Nevertheless, if used in conjunction with other affordability measures, it may provide a useful starting point for examining affordability problems [31].

The residual income approach was proposed as an alternative to the conventional ratio approach during the late 1960s and the first half of the 1970s in the USA [32–35]. It takes into account the comparison of housing costs and non-housing expenditure and assesses the minimum income required to meet non-housing needs at a basic level after paying for housing or, in other words, estimates what a household can afford to spend on housing after taking into account the minimal necessary expenditures of living. In this approach, the indicator, the residual income after paying for housing, is the difference between incomes and housing costs rather than a ratio [12,36].

According to a recent analysis [37], the residual income approach can be formulated in two ways, depending on what priority housing is given and having different policy implications. In the approach presented by Stone [38], housing expenditure receives the greatest policy priority: if the household’s residual income is not enough to pay for appropriate housing, it is considered indispensable to provide some housing subsidies. The approach proposed by Feins and Lane [39] is specular to the previous one: if a household cannot afford its non-housing necessary needs after paying the housing cost, housing policy is considered only one of the potential tools to help households, and the housing affordability problem is brought into the general issue of poverty.

### 3. Methodology for the Assessment of Housing Affordability in Metropolitan Areas

With regard to the aforementioned diverse uses of housing affordability (Section 2), the aim of this study is to provide a methodology for assessing housing affordability in metropolitan areas and for mapping the territorial distribution of the resulting threshold-income, which may be incorporated into regional and urban planning, as well as into public decision-making processes for introducing specific targeted measures on housing.

Several studies and reports in the literature have measured housing affordability, mostly at a national or regional scale. The detailed quantification of income gaps and subsidies per household type [40,41] was based on the housing cost of ‘adequate’ housing but did not take into account the particular urban zone in which the housing is located.

Some other recent studies focused on the spatial distribution of housing affordability and were based mostly on the spatial patterning of housing market [12] or on local flexible plans, which may provide affordable housing by defining a new urban form [42].

The methodology proposed by this study is also focused on the analysis of the spatial distribution of household incomes and housing prices [43–47], which are both key elements for assessing housing affordability. The former are collected for the taxpayers and the inhabitants in each municipality of the metropolitan area, and the latter are collected in different urban zones (e.g., inner, middle, and outer zones). These data are used to assess the T\_I, which does not correspond to generic housing affordability but rather shows which specific urban location is affordable for each household type. The T\_I is, then, the minimum income that makes the purchase of housing affordable in a given location for a given household, and it is assessed by applying the two most common approaches, namely, ratio income and the residual income.

The general methodology for applying the two approaches is well known, and several studies have examined many particular aspects of its application such as: the income gap between renting and owning [39]; the definition of the cost of housing consumption in the short run or the analysis of affordability in the long run [13,15,48]; the type of households that are vulnerable to housing stress per

age, location, composition, etc. [41]; and the housing standard based upon gross household income or disposable income [12].

According to some criticism [30], to compare the results highlights the methodological weakness of the two approaches and leads to the application of a combined approach [13].

The methodology has been tested for home purchase and for a unique type of household, namely, a family of two adults and one child, but may also be applied for home rental and for various types of households.

The key features of the method are:

- $T_I$  for home purchase based on a minimum affordable mortgage payment (per year) and a minimum amount of savings required to purchase;
- affordability measure for a broad range of incomes;
- affordability measure for various municipalities and urban zones;
- affordability measure based on both ratio income and residual income approaches;
- affordability measure based on a combined income approach.

### 3.1. Threshold-Income Based on the Ratio Income Approach

The threshold-income based on the ratio income approach, the  $T_I\_ratio$ , is derived from the Housing Affordability Index ( $HAI$ ) by NAR, which is used to make reports on the real estate market by region or geographical area in the USA and also, in Italy, by OMI of the Ministry of Finance.

The  $HAI$  measures whether or not a typical family could qualify for a mortgage loan on a typical home [27].

$$HAI = \frac{Med_{INC}}{Q_{INC}} \times 100 \quad (1)$$

where  $Med_{INC}$  is the Median Family Income and  $Q_{INC}$  is the Qualifying Income. If  $HAI > 100$ , then a family with a median income has more than enough income to qualify for a mortgage on a median-priced home.

NAR uses income data from the Census Bureau American Community Survey to obtain the Median Family Income, whereas the Qualifying Income, that is, the income necessary to qualify for a loan for the median priced home, is based on:

- the median price of existing single-family home sales, calculated by the National Association of Realtors (USA);
- monthly mortgage rates, reported by the Federal Housing Finance Board (USA);
- a down payment of 20% of the home price and a Loan to Value ( $LTV$ ) of 80%, which is the percentage of the housing price covered by loans;
- monthly principal and interest payment ( $P&I$ ) that cannot exceed 25% of the median family monthly income.

The principal differences between the  $T_I\_ratio$  and  $HAI$  consist of the household income  $I$  and the housing price  $P$  used in the correspondent equations. The former index is based on the territorial distribution of income levels and housing prices within a metropolitan area, whereas the latter is based on the median income of a typical family and the median housing price. Using data that expresses the percentage of the population earning a given income in a given municipality enables one to know how many inhabitants have housing affordability problems and in which areas they live.

In a similar way, the methodology proposes to analyse the local real estate market, not only in each municipality within the metropolitan area, but also in various zones within the same towns to comprehend which urban location, namely, inner, middle, or outer, is related to the minimum housing affordability.

The threshold-income may be assessed for various household types, for numerous income levels, or for purchase housings, which are located in different towns and urban zones.

The  $T\_I\_ratio$  based on the  $HAI$  index is calculated by applying Equations (2) and (3):

$$T\_I\_ratio_{jmz} = \frac{P \& I_{mz}}{I_j \times I_{ratio}} \quad (2)$$

$$P\&I_{mz} = f(i, T, P_{mz}, LTV) \quad (3)$$

where  $P\&I$  is the principal and interest annual payment for a loan;  $I_j$  is the annual income of the household type  $j$ ;  $I_{ratio}$  is the affordable income ratio;  $i$  is the annual mortgage rate;  $T$  is the loan term;  $P_{mz}$  is the house price in the urban zone  $z$  of the municipality  $m$ ; and  $LTV$  is the Loan to Value.

The value of the affordable Income ratio  $I_{ratio}$ , as aforementioned, results from a 'rule-of-thumb' and may vary in time and for country. According to the OMI parameter, this study has used a ratio higher than NAR's one, equal to 30% [28]. The household incomes  $I_j$  are available from statistical analyses undertaken by national or local public institutions. According to NAR's parameters, the  $P\&I$  calculation assumes that  $T$  is equal to 20 years and that  $LTV$  is equal to 80%; the current mortgage rate  $i$  is from a direct survey of the current financial market. The median housing prices within the metropolitan area, differentiated for municipality and for urban zones, may have been taken from public or private study centres' databases (e.g., National Association of Realtors in USA and OMI in Italy) or have been obtained through direct surveys.

The differences between the household incomes and the threshold-incomes indicate the absence/presence of housing affordability problems when they are respectively superior or inferior to zero. They also constitute the income gaps that should be filled through actions on housing demand and/or supply to achieve affordable housing in a given zone and municipality within the metropolitan area.

$$Gap\_ratio_{jmz} = I_j - T\_I\_ratio_{jmz} \quad \begin{array}{l} > 0 \text{ housing affordability} \\ < 0 \text{ housing affordability problem} \end{array} \quad (4)$$

### 3.2. Threshold-Income Based on the Residual Income Approach

The threshold-income based on the residual income approach,  $T\_I\_residual$ , is the minimum affordable income necessary to purchase a given housing unit in a given town and urban zone for a given household type. According to Stone's approach,  $T\_I\_residual$  is calculated by earmarking a steady part of the income such that a family's basic subsistence needs are met by purchasing a market basket of essential items.

The  $T\_I\_residual$  calculation requires that the minimum income for household type, which corresponds to both the poverty and 'nearly' poverty lines, such as the analysis of the family budget for quantifying the non-housing expenditure has to be preliminarily defined.

The methodology consists of the following steps:

- definition of the minimum income corresponding to poverty line for household type and of the income levels corresponding to the 'nearly' poverty lines;
- definition of non-housing expenditure for household type;
- threshold-income calculation for household type, for income level, for town, and for urban zone.

The  $T\_I\_residual$  is calculated by applying Equations (3) and (5):

$$T\_I\_residual_{jmz} = P\&I_{mz} + NHE_{min-j} \quad (5)$$

where  $NHE_{min-j}$  is the minimum non-housing expenditure of the household  $j$ .

National centre studies provide the required statistical data (for example, the Italian National Statistical Institute (ISTAT) provides data for Italy), which may be broken down on a geographical or regional basis to analyse household aggregate spending and to specify where the poverty lines lie.

The income gaps related to residual income are calculated by applying Equation (6):

$$\text{Gap\_residual}_{jmz} = I_j - T\_I\_residual_{jmz} \quad \begin{array}{l} > 0 \text{ housing affordability} \\ < 0 \text{ housing affordability problem} \end{array} \quad (6)$$

### 3.3. Threshold-Income Based on the Combined Income Approach

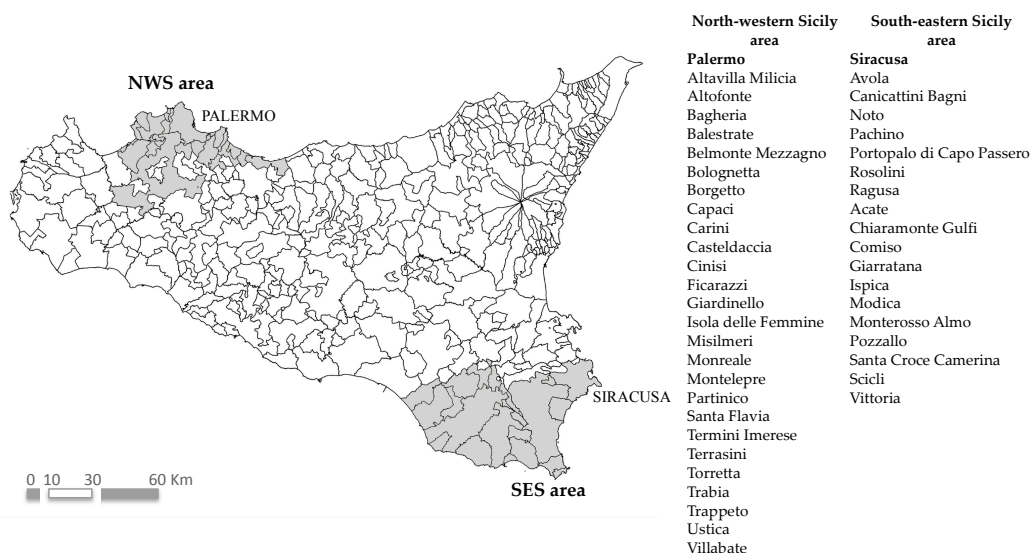
As previously mentioned, the income ratio is really a ‘rule of thumb’ that applies the same ratio to very different regions or household types and assumes that each income is always adequate to meet non-housing needs. Instead, housing affordability problems mostly occur in areas where incomes are very low and close to the poverty line, even if the middle class may now also be affected by the same problem, owing to the economic crisis and to specific conditions in the real estate market. In order to overcome this methodological weakness and to response to the principal criticism regarding this issue, a combined income approach is applied [12,13]. It consists of the two following steps:

- the assessment of the  $T\_I\_residual$ , to verify that the household’s income is adequate to pay for the minimum housing expenditure and the housing cost;
- the application of income ratio to those  $T\_I\_residuals$  that are affordable by verifying that the housing cost is lower than a given ratio, for example 30%, as expressed in Equation (7).

$$I_j - T\_I\_residual_{jmz} > 0 \text{ and } T\_I\_residual_{jmz} > \frac{P \& I_{mz}}{0.30} \Rightarrow \text{housing affordability} \quad (7)$$

## 4. The Case Study: Housing Affordability in Two Sicilian Metropolitan Areas

The case study consists of two areas of Sicily (Italy), which are medium-size metropolitan areas located in a less developed European region: the metropolitan area of Palermo, in north-western Sicily (NWS), and the south-eastern Sicily (SES) area in which the major city is Siracusa (Figure 1). The metropolitan area of Palermo had 1,070,681 inhabitants in 2015 and comprises the city of Palermo (which is the political and administrative capital of the Sicilian Region) and 26 municipalities. The SES area comprises the city of Siracusa, which had 552,766 inhabitants in 2015 and is the capital city of the homonymous province, as well as 18 municipalities.



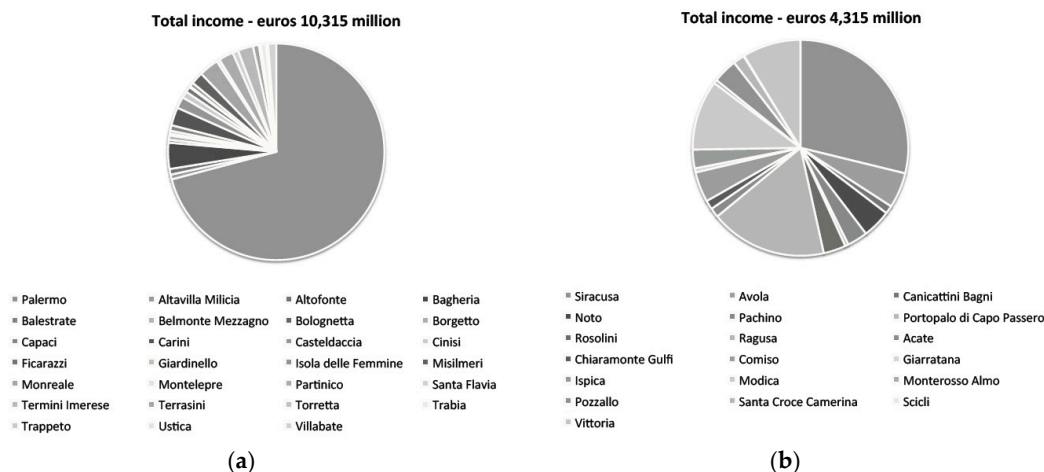
**Figure 1.** Geographical location of the north-western Sicily (NWS) and south-eastern Sicily (SES) areas in Italy.

The two areas are very different. In the former case, the capital city (Palermo) has 674,435 inhabitants, corresponding to 63% of the entire population of the metropolitan area; it is, therefore, a polarised and

hierarchical region, where small towns gravitate to the largest city in which the most important administrative, economic, and political functions are located. Palermo nowadays maintains a high attractiveness even if it is reaching a late disurbanisation stage according to the urban lifecycle theory [2,49,50], and a few surrounding towns have begun to form a potential polynuclear city-region [51]. In the latter case, on the other hand, the inhabitants of Siracusa number 122,291, corresponding to just 22.1% of the total SES population. The area includes several medium-size towns (over 50,000 inhabitants), and the territorial structure is closer to a network in which there is not a strong hierarchy, and horizontal relationships between towns are prevalent [52].

#### 4.1. Household Incomes in the Two Metropolitan Areas

From the point of view of wealth creation, expressed by the parameter of gross annual income in 2015 obtained from ISTAT, there are strong differences between the two areas. In fact, the gross annual income produced in the city of Palermo reaches 70.9% of that for the entire NWS area, meaning that it is two and a half times greater than that of the hinterland, and shows that the more profitable economic activities and jobs are located in the capital city. In the SES area, the gross annual income produced in Siracusa is just 28.8% of the total income, which is indicative of the fact that the territorial distribution of wealth is much more even (Figure 2).



**Figure 2.** Gross annual income (2015) per municipality and per metropolitan area for (a) NWS and (b) SES (our elaboration on Italian National Statistical Institute (ISTAT) data).

The relationship between the population and the annual average per capita income shows that the income of taxpayers living in the two capital cities is higher than that of those living in the small towns, and this grows as the city rank increases. On the other hand, the annual average per capita incomes of the two hinterlands (each area without a capital city) are very similar, with only a slightly higher average in the area with the smaller hinterland (SES) (Figure 3a). The results are overturned when the annual average per capita income is calculated per inhabitant, and Figure 3b shows that there is a levelling of the incomes: the gross average incomes of the two cities are almost identical and, moreover, are also very close to those of their respective hinterlands. The wealth seems homogeneously distributed within the two metropolitan systems.

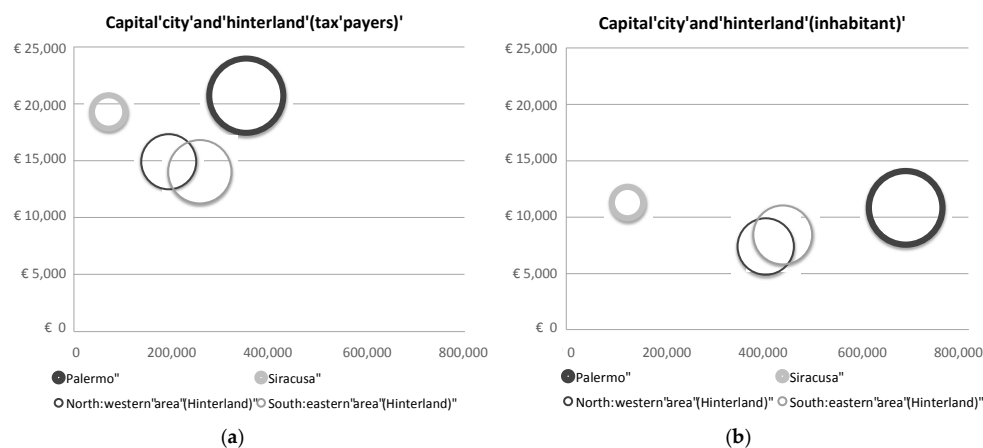
The analysis of the annual average per capita income per taxpayer for each municipality of the two hinterlands shows that the income range within the towns in the SES area is wider than that in the NWS area. In the first area, medium-size towns such as Ragusa and Modica (respectively 17,026 and 15,340 euros/year) show both the highest average incomes and the lowest ones (9857 euros/year). In contrast, the annual income range within the metropolitan area in Palermo is smaller, and high average incomes occur even in small towns (e.g., 17,685 euros/year in Isola delle Femmine) (Figure 4a).



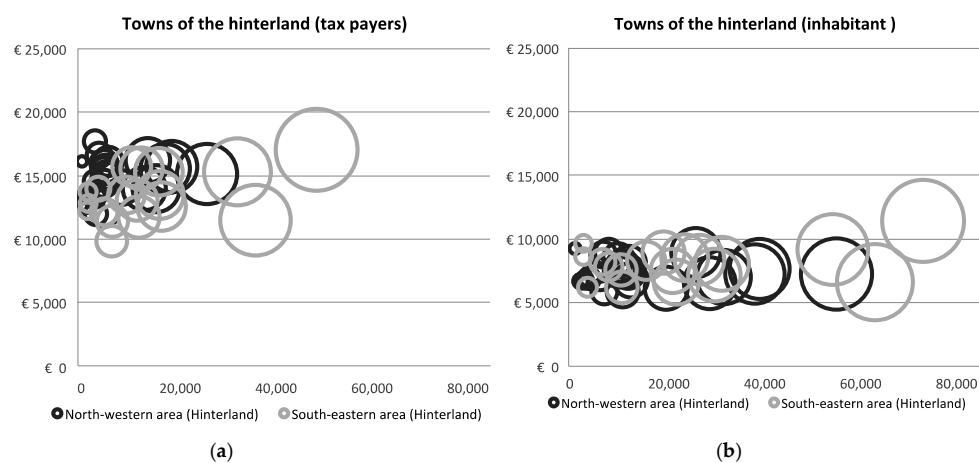
The annual average per capita incomes per inhabitant in the hinterlands are all extremely level; the annual income of Ragusa only just exceeds 10,000 euros, confirming, therefore, a homogeneous distribution of the wealth (Figure 4b).

To deepen the study into the territorial distribution of wealth, the analysis of the annual income levels per taxpayer has been made in each municipality, expressing the frequency of each level in percentage terms. The income data derived from ISTAT are broken down by municipality and according to eight levels, which are minor or equal to zero; 0 to 10,000; 10,000 to 15,000; 15,000 to 26,000; 26,000 to 55,000; 55,000 to 75,000; 75,000 to 120,000; and above 120,000 euros/year [53].

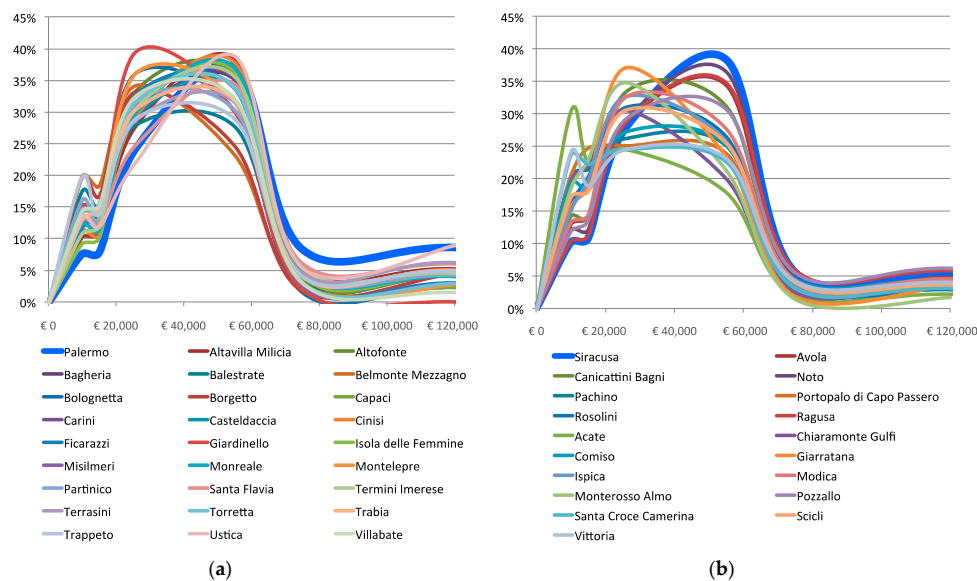
Figure 5a shows that the most frequent annual income levels in the NWS area are those in the ranges of 15,000 to 26,000 euros/year and 26,000 to 55,000 euros/year, even if several municipalities have significant percentages (up to 20%) in the lowest income levels, from 0 to 10,000 and from 10,000 to 15,000 euros/year. The highest income levels (75,000 to 120,000 euros/year) register small percentages, and the maximum one (8.6%) occurs in Palermo. In the SES area, on the other hand, the distribution is very diversified (Figure 5b). In many municipalities, the lowest income levels register high percentages of up to 30%, whilst, in a few municipalities, the 15,000 to 26,000 euros/year level registers the highest percentage, and, in other towns, the 26,000 to 55,000 euros/year level is the most common (e.g., Siracusa, Ragusa, and Noto). For all municipalities, the high-income levels have a small percentage, which is less than 5% or absent.



**Figure 3.** Population ( $x$ -axis) and annual average per capita income ( $y$ -axis) of (a) the taxpayers and (b) the inhabitants of the capital cities and their hinterlands (our elaboration on ISTAT data).



**Figure 4.** Population ( $x$ -axis) and average per capita income ( $y$ -axis) of (a) the taxpayers and (b) the inhabitants of each town of the hinterland (our elaboration on ISTAT data).



**Figure 5.** Percentage of the annual income levels (x-axis) per municipality in the NWS (a) and SES (b) areas (including capital cities) (our elaboration on ISTAT data).

ISTAT calculates the National poverty threshold for a household of a given size and type in Italy [53]. The incomes corresponding to the poverty line are disaggregated by geographical region (northern, central, and southern Italy), by municipality type (centres of metropolitan areas, suburbs of metropolitan areas or towns of more than 50,000 inhabitants, and towns of less than 50,000 inhabitants that are not a part of a metropolitan area), and by household size and type (number of members, ages of adults and children).

The basic poverty line is calculated for two adult households, and, therefore, the coefficients of equivalence are elaborated to convert the basic income into those of different household sizes. ISTAT has also termed households with an income that is up to +20% higher than the poverty line income as ‘nearly poor’.

To test the methodology, a specific household type, comprised of two adults from 18 to 59 years old and one child from four to 10 years old, has been selected. In 2015, the poverty threshold incomes for southern Italy were, respectively, 12,840, 12,516, and 11,952 euros/year for selected households living in the centre of a metropolitan area, in the suburbs of a metropolitan area or a town of more than 50,000 inhabitants, or in a town of less than 50,000 inhabitants that was not part of a metropolitan area.

With regard to Equation (5), the housing cost set by ISTAT has been subtracted from the minimum income of the poverty threshold to obtain the affordable non-housing expenditure for a poor household. The same calculation has also been made for a ‘nearly poor’ household (see Table 1).

**Table 1.** Poverty threshold and non-housing expenditure of a family of two adults (from 18 to 59 years old) and one child (from four to 10 years old) in 2015 (our elaboration on ISTAT data).

Town Size	Poverty Income		Non-Housing Expenditure	
	euros/month	euros/year	Poverty Income euros/year	Nearly Poverty Income euros/year
Centre of metropolis	€1,070	€12,840	€9,713	€11,656
Metropolitan suburbs and municipalities > 50,000 inhabitants	€1,043	€12,516	€9,673	€11,608
Municipalities < 50,000 inhabitants	€996	€11,952	€9,594	€11,513

#### 4.2. Housing Prices in the Two Metropolitan Areas

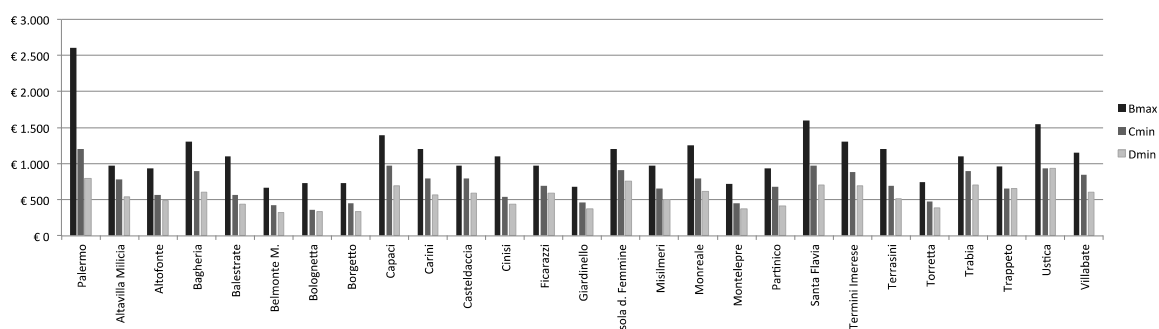
Housing price is a key factor for measuring housing affordability because its spatial distribution expresses the monetary form of the city corresponding to the particular characteristics of each zone (e.g., distance to the city centre, kind and number of amenities, housing quality, etc.). Market prices may be analysed by using several models [54–56]. In this study, the housing prices are taken from the OMI database since it is easily accessible and includes housing prices by town and by zone across the Italian territory. The minimum and maximum prices are available per housing type. The housing affordability could be calculated for each price, but, for an analysis at a metropolitan scale, a price range has been selected that may better briefly represent the location in a given town. According to the zone codification by OMI [57], to test the specific affordability in each municipality, the prices for purchasing selected types of housing have been considered to be representative of the local housing market:

- the maximum price  $B_{max}$  of a housing located in zone B1, which is an inner zone;
- the minimum price  $C_{min}$  of a housing located in zone C1, which is a middle zone;
- the minimum price  $D_{min}$  of a housing located in zone D1, which is an outer zone.

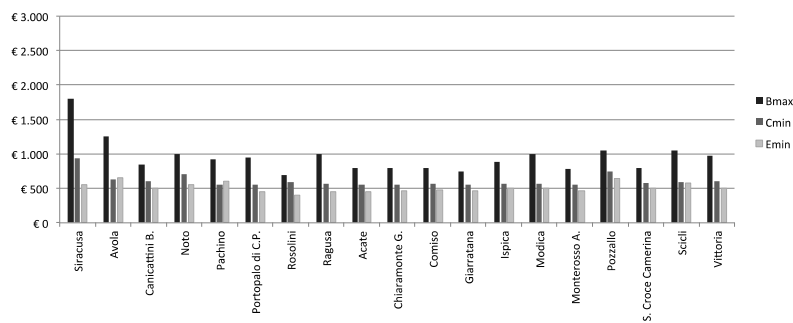
In zones B1 and C1, housing standards are respected because the prices refer to mid-range housing, namely ‘civil housing’ by OMI [57], whereas the minimum price in zone D1 is refers to low-range housing, namely ‘cheap housing’, where there may be some deprivation and the quality of housing is low. This latter datum is considered significant to verify the housing affordability, at least for low housing standards and peripheral locations. In the case of the city of Palermo, the selected zones are: B5 as the inner zone; C11 as the middle zone; and E22 as the outer zone.

The data are represented in the Figures 6 and 7 for the NWS and SES areas, respectively. The comparison of the prices within the metropolitan area of Palermo reveals a great differential between the inner zone (zone B5) in the capital city and those in the other towns; the differential depends clearly on Palermo’s high rank. In fact, it also occurs that the housing prices in the outer zones of Palermo are similar to those for the inner zones of the other towns. The minimum price of low-quality housing in zone D1 is very low and ranges from 320 to 940 euros/m<sup>2</sup> (Figure 6).

In contrast, the housing prices in the SES area are more homogeneous as a consequence of the regional polynuclear territorial structure. In fact, the differences between the housing prices in the principal city (Siracusa) and those in the other towns are not too pronounced (Figure 7), and the  $B_{max}$  average price within the hinterland is equal to 50% of the  $B_{max}$  in Siracusa. The minimum prices of ‘cheap’ housing are 510 euros/m<sup>2</sup>, and these never rise above 650 euros/m<sup>2</sup>.



**Figure 6.** Purchase. Housing prices in euros/m<sup>2</sup> (y-axis) in the municipalities of the NWA area (II semester 2016) (our elaboration on OMI data).



**Figure 7.** Purchase. Housing prices in euros/m<sup>2</sup> (*y*-axis) in the municipalities of the SES area (II semester 2016) (our elaboration on Real Estate Market (OMI) data).

#### 4.3. Calculation of the Threshold-Income in the Metropolitan Areas

The threshold-income has been calculated by applying both the ratio income and the residual income to the housing prices of zones B1, C1, and D1 of each town of the two metropolitan areas, applying Squations 2, 3, 5, and 7 and the parameters in Tables 1 and 2. Tables 3–5 respectively show the calculation of the  $T_I$  ratio, as well as the  $T_I$  residual and the  $T_I$  combined in some towns of the NWS area.

**Table 2.** Parameters for the  $T_I$  ratio calculations

Parameters	Unit	Value
Housing size	sqm	70
Down payment	%	20
Loan To Value	%	80
Loan term	years	20
Annual mortgage rate	%	2.54
Monthly mortgage rate	%	0.21167
Monthly P&I number	n	240
Ratio income	%	30

**Table 3.** Calculation of the  $T_I$  ratio in some towns of the NWS area (other data omitted).

Town	Zone	Housing Price		Down Payment	Mortgage	Monthly P&I	$T_I$ Ratio	
		Euros/m <sup>2</sup>	Euros	Euros	Euros	Euros/Month	Euros/Month	Euros/Year
Palermo	Bmax	2600	182,000	36,400	145,600	773	2576	30,910
Palermo	Cmin	1200	84,000	16,800	67,200	357	1189	14,266
Palermo	Emin	800	56,000	11,200	44,800	238	793	9511
Altavilla Milicia	Bmax	980	68,600	13,720	54,880	291	971	11,651
Altavilla Milicia	Cmin	780	54,600	10,920	43,680	232	773	9273
Altavilla Milicia	Dmin	540	37,800	7560	30,240	160	535	6420
Altofonte	Bmax	930	65,100	13,020	52,080	276	921	11,056
Altofonte	Cmin	570	39,900	7980	31,920	169	565	6776
Altofonte	Dmin	490	34,300	6860	27,440	146	485	5825
Bagheria	Bmax	1300	91,000	18,200	72,800	386	1288	15,455
Bagheria	Cmin	900	63,000	12,600	50,400	267	892	10,700
Bagheria	Dmin	600	42,000	8400	33,600	178	594	7133
Balestrate	Bmax	1100	77,000	15,400	61,600	327	1090	13,077
Balestrate	Cmin	560	39,200	7840	31,360	166	555	6657
Balestrate	Dmin	440	30,800	6160	24,640	131	436	5231
Belmonte M.	Bmax	670	46,900	9380	37,520	199	664	7965
Belmonte M.	Cmin	420	29,400	5880	23,520	125	416	4993
Belmonte M.	Dmin	320	22,400	4480	17,920	95	317	3804
Bolognetta	Bmax	730	51,100	10,220	40,880	217	723	8679
Bolognetta	Cmin	360	25,200	5040	20,160	107	357	4280
Bolognetta	Dmin	340	23,800	4760	19,040	101	337	4042
Borgetto	Bmax	730	51,100	10,220	40,880	217	723	8679
Borgetto	Cmin	450	31,500	6300	25,200	134	446	5350
Borgetto	Dmin	340	23,800	4760	19,040	101	337	4042
Capaci	Bmax	1400	98,000	19,600	78,400	416	1387	16,644
Capaci	Cmin	970	67,900	13,580	54,320	288	961	11,532
Capaci	Dmin	690	48,300	9660	38,640	205	684	8203

**Table 4.** Calculation of the  $T_I\_residual$  in some towns of the NWS area (other data omitted).

Town	Zone	Monthly P&I	Non-Housing Expenditure	$T_I\_Residual$	
		Euros/Month	Euros/Month	Euros/Month	Euros/Year
Palermo	<i>Bmax</i>	773	809	1582	18,985
Palermo	<i>Cmin</i>	357	809	1166	13,992
Palermo	<i>Emin</i>	238	809	1047	12,566
Altavilla Milicia	<i>Bmax</i>	291	800	1091	13,089
Altavilla Milicia	<i>Cmin</i>	232	800	1031	12,376
Altavilla Milicia	<i>Dmin</i>	160	800	960	11,520
Altofonte	<i>Bmax</i>	276	800	1076	12,911
Altofonte	<i>Cmin</i>	169	800	969	11,627
Altofonte	<i>Dmin</i>	146	800	945	11,342
Bagheria	<i>Bmax</i>	386	806	1192	14,310
Bagheria	<i>Cmin</i>	267	806	1074	12,883
Bagheria	<i>Dmin</i>	178	806	984	11,813
Balestrate	<i>Bmax</i>	327	800	1126	13,517
Balestrate	<i>Cmin</i>	166	800	966	11,591
Balestrate	<i>Dmin</i>	131	800	930	11,164
Belmonte M.	<i>Bmax</i>	199	800	999	11,984
Belmonte M.	<i>Cmin</i>	125	800	924	11,092
Belmonte M.	<i>Dmin</i>	95	800	895	10,736
Bolognetta	<i>Bmax</i>	217	800	1016	12,198
Bolognetta	<i>Cmin</i>	107	800	907	10,878
Bolognetta	<i>Dmin</i>	101	800	901	10,807
Borgetto	<i>Bmax</i>	217	800	1016	12,198
Borgetto	<i>Cmin</i>	134	800	933	11,199
Borgetto	<i>Dmin</i>	101	800	901	10,807
Capaci	<i>Bmax</i>	416	806	1222	14,666
Capaci	<i>Cmin</i>	288	806	1094	13,133
Capaci	<i>Dmin</i>	205	806	1011	12,134

**Table 5.** Calculation of the  $T_I\_combined$  in some towns of the NWS area (other data omitted).

Town	Zone	Annual P&I	$T_I\_Residual$	Ratio
		Euros/Year	Euros/Year	Threshold = 30%
Palermo	<i>Bmax</i>	9273	18,985	<b>49%</b>
Palermo	<i>Cmin</i>	4280	13,992	<b>31%</b>
Palermo	<i>Emin</i>	2853	12,566	23%
Altavilla Milicia	<i>Bmax</i>	3495	13,089	27%
Altavilla Milicia	<i>Cmin</i>	2782	12,376	22%
Altavilla Milicia	<i>Dmin</i>	1926	11,520	17%
Altofonte	<i>Bmax</i>	3317	12,911	26%
Altofonte	<i>Cmin</i>	2033	11,627	17%
Altofonte	<i>Dmin</i>	1748	11,342	15%
Bagheria	<i>Bmax</i>	4636	14,310	<b>32%</b>
Bagheria	<i>Cmin</i>	3210	12,883	25%
Bagheria	<i>Dmin</i>	2140	11,813	18%
Balestrate	<i>Bmax</i>	3923	13,517	29%
Balestrate	<i>Cmin</i>	1997	11,591	17%
Balestrate	<i>Dmin</i>	1569	11,164	14%
Belmonte M.	<i>Bmax</i>	2390	11,984	20%
Belmonte M.	<i>Cmin</i>	1498	11,092	14%
Belmonte M.	<i>Dmin</i>	1141	10,736	11%
Bolognetta	<i>Bmax</i>	2604	12,198	21%
Bolognetta	<i>Cmin</i>	1284	10,878	12%
Bolognetta	<i>Dmin</i>	1213	10,807	11%
Borgetto	<i>Bmax</i>	2604	12,198	21%
Borgetto	<i>Cmin</i>	1605	11,199	14%
Borgetto	<i>Dmin</i>	1213	10,807	11%
Capaci	<i>Bmax</i>	4993	14,666	<b>34%</b>
Capaci	<i>Cmin</i>	3460	13,133	26%
Capaci	<i>Dmin</i>	2461	12,134	20%

Note: The bold numbers highlight cases in which the housing cost is lower than the threshold ratio.

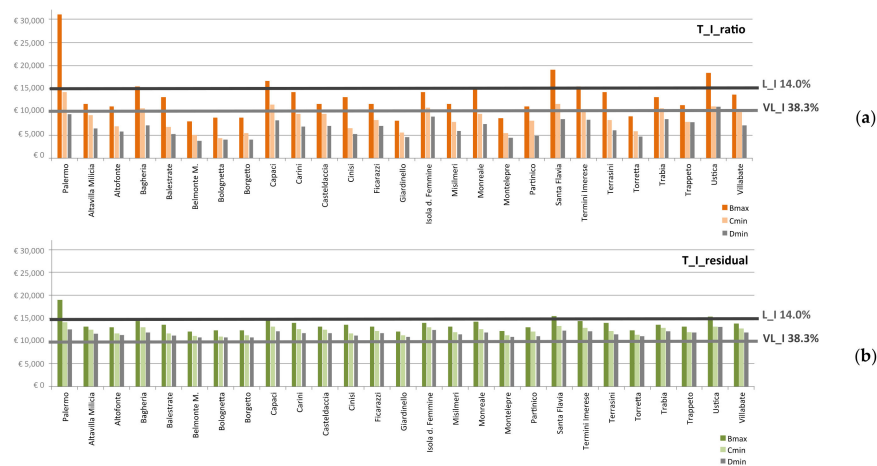
## 5. Results

The  $T_I$  ratios and  $T_I$  residuals calculated above are compared, according to the ISTAT income levels, with the very low income (VL\_I) level, from 0 to 10,000 euros/year, and with the low income (L\_I) level, from 10,000 to 15,000 euros/year, to verify the presence or absence of housing affordability problems in the two metropolitan areas (Figures 8 and 9).

Analysing the potential housing affordability problems of these household types is significant in terms of welfare policy and the actions of social and public housing since they exceed half of the total households in the NWS area, whereas they represent 37.3% of total households in the SES area, indicating that poverty affects a smaller percentage of people in comparison to the former area.

Figures 8 and 9 and Tables 6 and 7 show that the L\_I households have good housing affordability in almost all towns in the two metropolitan areas. They may purchase a house in all the zones, except for the inner zones of the capital cities and of two tourism-oriented towns.

On the other hand, with regard to the resulting  $T_I$  ratio, the central areas of almost all the towns are not affordable for the VL\_I households as their income level allows them to purchase housing in the inner zones of the smallest and most marginal towns or a housing of a low standard located in outer zones. The results of the residual income approach profoundly differ from those of the previous approach, as the VL\_I is greater than the  $T_I$  residual in none of the zones of any town.



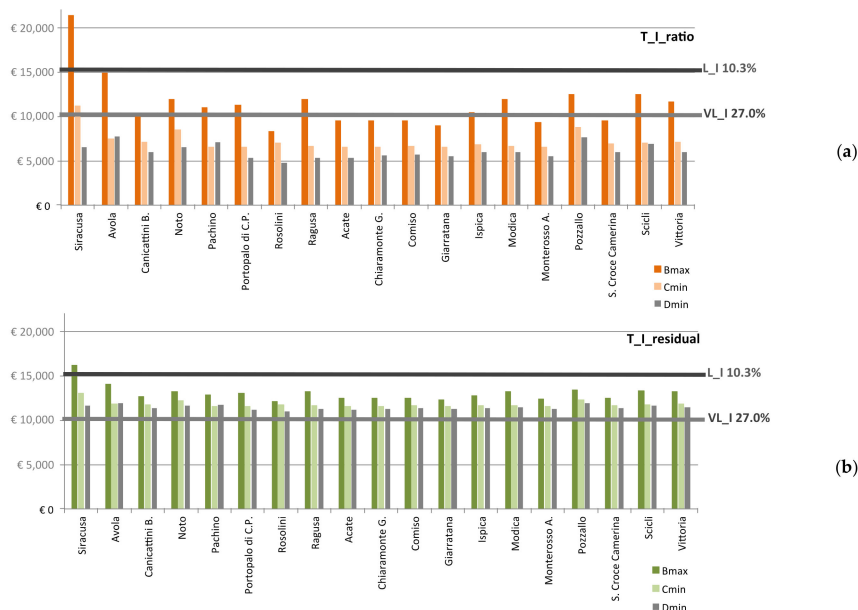
**Figure 8.**  $T_I$  ratio (a) and  $T_I$  residual (b) in euros/year ( $y$ -axis) per zone and per municipality of the metropolitan area of Palermo (NWS area).

**Table 6.** Frequency of housing affordability per income level and per zone in the NWS area.

Household Income Level	Income Level > $T_I$ Ratio			Income Level > $T_I$ Residual		
	$B_{max}$ No.	$C_{min}$ No.	$D_{min}$ No.	$B_{max}$ No.	$C_{min}$ No.	$D_{min}$ No.
VL_I (0–10,000)	5/27	18/27	27/27	0/27	0/27	0/27
L_I (10,000–15,000)	22/27	27/27	27/27	24/27	27/27	27/27

The comparison of the results of the two approaches confirms, in general, that the housing affordability for the VL\_I households, which seems real according to the residual income approach, is actually fictitious since the income left is insufficient to meet the minimum needs of the poverty line, even if the housing cost is lower than 30% of the income. On the contrary, the value of the housing affordability is zero, as the results of the residual income approach show, so the VL\_I households cannot purchase housing in any zones of any towns in both the NWS and SEA areas.

The similar results for the upper income levels, such as the L\_I households, proves that the ratio income approach, although it should be thought of as a ‘rule-of-thumb’, more useful the farther from the poverty line.



**Figure 9.**  $T_I$  ratio (a) and  $T_I$  residual (b) in euros/year (y-axis) per zone and per municipality in the SES area.

**Table 7.** Frequency of housing affordability per income level and per zone in the SES area.

Household Income Level	Income Level > $T_I$ Ratio			Income Level > $T_I$ Residual		
	<i>Bmax</i>	<i>Cmin</i>	<i>Dmin</i>	<i>Bmax</i>	<i>Cmin</i>	<i>Dmin</i>
euros/year	No.	No.	No.	No.	No.	No.
VL_I (0–10,000)	7/19	18/19	19/19	0/19	0/19	0/19
L_I (10,000–15,000)	18/19	19/19	19/19	18/19	19/19	19/19

The application of the combined income approach provides further results (Table 8):

- the calculation of the residual income approach is confirmed with regard to the VL\_I households. There is not housing affordability in any zone of either metropolitan area;
- the housing affordability of the L\_I households decreases (i.e., from 24/27 to 17/27 in the NWS area) and is absent in those zones in which the prices are high such as in zone B of the most important towns.

The previous results have two significant implications; one from a methodological point of view, the other from a territorial point of view.

From a methodological point of view, the combined income approach allows us to avoid the most serious distortions in the assessment of housing affordability:

- distortion 1 refers to the ratio income. The same ratio (i.e., 30%) is always used, even if the remaining income is so low that it does not allow the household to cover the non-housing expenditure corresponding to the poverty threshold.
- distortion 2 refers to the residual income. The housing cost is affordable but is too high because it equals a large part of the income, leaving only enough to cover just the minimum non-housing expenditure.

From a methodological point of view, the combined income approach makes it evident that the VL\_I households in the metropolitan areas—38.3% in the NWS area and 27% in the SES area—need housing subsidies to locate themselves even in the peripheral zones of small and marginal towns.

The L\_I households have, unexpectedly, good housing affordability and may decide to migrate within the metropolitan area and choose to localise in the inner zones of many towns, even if they are excluded from the inner zones of the capital cities and of the most important towns.

**Table 8.** Combined income approach. Frequency of housing affordability per income level and per zone in the NWS and SWS areas.

Household Income Level	North-Western Area			South-Eastern Area		
	<i>Bmax</i> No.	<i>Cmin</i> No.	<i>Dmin</i> No.	<i>Bmax</i> No.	<i>Cmin</i> No.	<i>Dmin</i> No.
euros/year						
VL_I (0–10,000)	0/27	0/27	0/27	0/19	0/19	0/19
L_I (10,000–15,000)	17/27	26/27	27/27	17/19	19/19	19/19

## 6. Concluding Remarks

This study has assessed the housing affordability in two metropolitan areas in a less developed European region with the aim of defining the spatial distribution of the income gap and the affordable zones, which may support metropolitan and urban planning.

The methodology has used a combined income approach, including ratio income and residual income, which was proposed in the literature. This has been applied with a particular emphasis on the analysis of the real estate market, which is considered a key factor. Consequently, the housing prices were collected for each town and urban zone. Nevertheless the ratio income approach has been applied by several national public institutions, and the results confirm its methodological weakness, which can be overcome by using the combined income approach.

The assessment of the combined income in two Sicilian metropolitan areas shows that the fall in prices on the housing market has made the purchase of housing more affordable even for low-income households that live in a marginal European region. On the other hand, very low-income households need housing subsidies, as well as planning able to transform the urban form in order to mitigate social polarization. Public programs or projects are necessary, for example, in the NWA, because its polarized territorial structure has generated high differentials with respect to housing prices. The increase of these differentials tends to exclude very low-income households from the biggest towns or to ghettoize them in a very spatially constrained market on the fringe of the metropolitan area.

The elaboration and representation of the results may be improved in further studies by applying the geographic information system (GIS) system to represent the territorial distribution of income levels and *T\_I\_combined* in order to better identify the weakest zones in terms of low-income levels or high market prices. In the assessment of the threshold-incomes, transportation costs could also be included [26] in order to study the potential internal migratory flows within the metropolitan area.

**Conflicts of Interest:** The author declares no conflicts of interest.

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