# Changes in the Geographical Distribution of Inhabitants in Tuscany Since 1861

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**Abstract**

Geographical and administrative approaches provide a framework able to explain overtime variation in inhabitants distribution. In this chapter Tuscany Census Data are employed from 1861 (the unification of Italy) to 2001 (the most recent available census). A mathematical procedure able to remove the effect of (time) changes in local boundaries has been applied in order to compare Tuscany Municipalities over time and to better highlight modifications in the residential profile of the whole Region. Classification of municipalities by "crowns" represents a special focus of the analysis.

## 1 Background

In 1861 around 1.9 millions of inhabitants lived in Tuscany. In 2001 this number has nearly doubled (3.6 millions). However, variations were not homogenous in the whole Region: for instance, during the last 150 years the population of the Municipality of Florence (Regional Capital) grew about 400 %; in the same period the number of inhabitants in the whole Province grew of around 100 %. On the other hand the Province of Siena remained somewhat unchanged.

Despite this paper is the result of the work of all the authors, the paragraph sub-division is the following: Luca Faustini (Sects. 5.2 and 5.3), Linda Porciani (Sects. 1 and 2), Graziella Sanna (Sect. 6), Cristiano Tessitore (Sects. 4 and 5.1), Alessandro Valentini (Sect. 3).

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In order to highlight the role that geographical features (altimetry, proximity to the coast, and so on) play in affecting the settlement profile of Tuscany population, intra-period municipalities legislative boundaries changes have been removed (Faustini et al. 2011). The analysis has been then performed following three steps: (1) removing perturbations due to transformations in the administrative boundaries (via mathematical procedures); (2) classifying municipalities according to some significant criteria; (3) linking each group of towns to their population changes.

## 2 Data

The population census is an effective source for the observation of society and a unique way to analyze changes in the medium and long-term period. In this study, we focused our attention on Tuscany Census Data beginning from the first Italian census (1861) to the last available one (2001).

As previously mentioned, it has been necessary to remove local boundaries modification over time to make data comparable.

In 150 years some municipalities disappeared, some born, and many others experienced annexation and/or splitting-off of their confines. The comparison has been realized using a method, explained in Sect. 3, in order to actualize the local borders.

The territorial domain of analysis is represented by various types of aggregations: municipalities and Provinces[1] as administrative domains, altimetry/proximity to the coast and crown as geographical domains.[2]

## 3 Methodology

In 1861 the geographical territory of Tuscany was administratively divided into 269 municipalities (Istat 2001, 1994). Despite borders of the Region haven't been varied over time,[3] legislative actions changed the boundaries of nearly half of

[1]Tuscany is actually divided in ten provinces: Massa Carrara, Lucca, Pistoia, Firenze, Prato, Livorno, Pisa, Arezzo, Siena, Grosseto.

[2]Data used in this chapter are available on a Web Information System, called SITO. DEM (Porciani et al. 2011), containing basic census data since 1861–2001 and in a more detailed way data since 1951–2001. All of them are disaggregated by municipality and by other various spatial aggregations (such as Health Areas and Local Labor District). The database moves from Health for All (HFA) data base, which is a project promoted by WHO, and follows the same data structure (WHO Regional Office for Europe XXXX).

[3]The only exception is represented by the acquisition of about 200 residents from Fiumalbo (MO) in the 1950.

the municipalities and of various Provinces (Prato, for instance, was separated by Florence less than 20 years ago) affecting around 63 % of the total population. More in detail 40 municipalities have been created; 22 was dissolved; other municipalities experienced only partial increases or reductions (or both) of their territories. As a consequence of these changes between 1861 and 2001, it is firstly necessary to estimate the total population amount for each municipality at every preceding censuses considering actual boundaries.

Assuming $P(i, t)$ to be the population (at the borders of the time) of municipality $i$ at census $t$; $\hat{P}(i, t)$ to be the estimated level of such municipality with actual borders at time $t$, the following procedure was used:

- If during the period 1861–2001 no changes occurred in the borders, than $\hat{P}(i, t) = P(i, t)\ \forall\ t$;
- If at time $t^*$ a legislative change in the borders implies a shift of $X$ persons from $i$ to $j$, $X(i, j, t^*)$, the (historical) estimate of both populations at actual boundaries is:

Municipality $i$ (posting of boundaries)

$$\hat{P}(i,t) = \begin{cases} P(i,t) & \text{if } t > t^* \\ P(i,t)\left[1 - \left(\frac{X(i,j,t^*)}{P(i,t^*)}\right)\right] & \text{if } t \le t^* \end{cases}$$

Municipality $j$ (annexations)

$$\hat{P}(i,t) = \begin{cases} P(j,t) & \text{if } t > t^* \\ P(j,t) + P(i,t)\left[1 - \left(\frac{X(i,j,t^*)}{P(i,t^*)}\right)\right] & \text{if } t \le t^* \end{cases}$$

More complex cases (multiple annexations in subsequent years, annexations and detachments, and so on) are treated in a similar way.

## 4 Municipality Classification

Municipalities were classified according to various features. From an administrative point of view, we used two different splits: Provinces and "crowns." While the first criterion is widely applied in population studies, the second one is quite innovative. In particular, given a Province, three different "crowns" are identified (see Fig. 1 for an example):

- Provincial Capitals → crown 0;
- Adjacent to Capitals (neighbors of provincial Capitals) → crown 1;
- Other municipalities → crown 2.

From the geographical point of view, we focused on a mixed criterion based on altitude and proximity to the coast (Altimetry Zone: henceforth ZALT). Municipalities are then classified in:

- Inland mountain [IM],
- Coastal mountain [CM],
- Inland hills [IH],
- Coastal hills [CH],
- Plains [P].

A cross-distribution of the municipalities by ZALT and crown is provided in Table 1. From the altitude point of view, Tuscany Municipalities are settled mainly

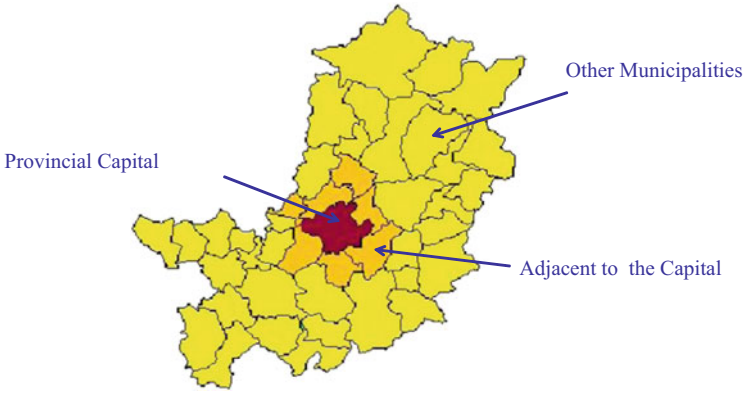


**Fig. 1** Province of Florence: crowns classification (boundaries 2001)

**Table 1** Municipality distribution by crowns and ZALT

| Crown | ZALT | | | | | |
|---|---|---|---|---|---|---|
| | Inland mountain | Coastal mountain | Inland hills | Coastal hills | Plains | Total |
| Provincial capital | 1 | 1 | 4 | 1 | 3 | 10 |
| Adjacent to the capital | 9 | 2 | 30 | 6 | 5 | 52 |
| Other municipalities | 66 | 2 | 106 | 34 | 17 | 225 |
| Total | 76 | 5 | 140 | 41 | 25 | 287 |

in Inland Hills (140 cities), Inland Mountains (76), Coastal Hills (41), and Plains (25). Only five municipalities are located in Coastal Mountains: considering their relative size, there is not enough evidence to highlight any kind of detailed trend.

From the crown point of view, the vast majority of municipalities are located in other municipalities (225), and the rest is divided in Adjacent to the Capital (52) and Provincial Capital (10). The same distribution affects every altitude area except for Coastal Mountain where, again, the distribution is affected by a small amount of municipalities.

For each of the above classifications, the average annual rate of population change between 1861 and 2001 (equal to 4.3 % for the whole Region) is illustrated in Table 2. In terms of administrative point of view, Prato is the most dynamic Province of the Region (+10.2 %), with a population incidence nearly of 6.5 %.

In terms of crowns, the Provincial Capitals (Crown 0) average annual rate of growth is 5.7 %, while for other municipalities (Crown 2) is 3.1 %.

Considering the geographical classification (ZALT), the growth rate is more intensive in Coastal Mountain (+8.2 %) and Plains (+5.6 %).

**Table 2** Average annual rate of change (per 1,000) between 1861 and 2001 for various groups of municipalities (in parenthesis the percentage weight on the regional population in 2001)

| | |
|---|---|
| *Provinces* | |
| Massa Carrara | +4.8 (5.7 %) |
| Lucca | +3.0 (10.6 %) |
| Pistoia | +4.5 (7.7 %) |
| Firenze | +4.9 (26.7 %) |
| Prato | +10.2 (6.5 %) |
| Livorno | +5.3 (9.3 %) |
| Pisa | +3.4 (11.0 %) |
| Arezzo | +2.9 (9.3 %) |
| Siena | +1.9 (7.2 %) |
| Grosseto | +5.3 (6.0 %) |
| *Crown* | |
| Provincial Capital (Crown 0) | +5.7 (35.0 %) |
| Adjacent to the Capital (Crown 1) | +4.8 (21.7 %) |
| Other municipalities (Crown 2) | +3.1 (43.3 %) |
| *ZALT* | |
| Inland Mountain [IM] | +0.1 (9.6 %) |
| Coastal Mountain [CM] | +8.2 (4.5 %) |
| Inland Hills [IH] | +4.5 (53.3 %) |
| Coastal Hills [CH] | +4.9 (12.7 %) |
| Plains [P] | +5.6 (19.9 %) |
| Total Trend | +4.3 |

## 5 Detailed Trend of Crown and Altitude Areas

### 5.1 The Crown Approach

Looking at Figs. 2 and 3, the classification criterion based on crowns seems to be particularly interesting. Figure 2 shows the population trend of the whole Region in absolute values stratified by crown; Fig. 3 shows crowns quotas over time. Both graphs witness a huge population increase in Provincial Capitals from World War II to 80's. Vice-versa municipalities adjacent to capitals performed a three-step increase in absolute values (1861–1881; 1891–1961; 1961–2001), and a constant trend in relative values. Population in other municipalities remains substantially unchanged since inter-war period, even if its quota decreases significantly in the same period (except for a weak gain in the last two censuses).

Various factors could affect this specific pattern of settlement: some of them could be referred to the demographic features of the population, such as different fertility profile or different force of migration by area. Others could be referred to socio-economic features such as the "economic miracle" experienced by Italy during '60s. Unfortunately, lack of detailed data represents a tough hurdle to overcome.

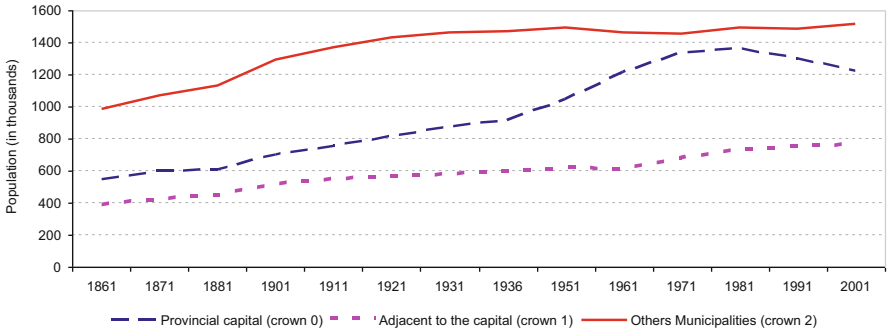


**Fig. 2** Population trend by crown, Tuscany (Absolute values)—years 1861–2001

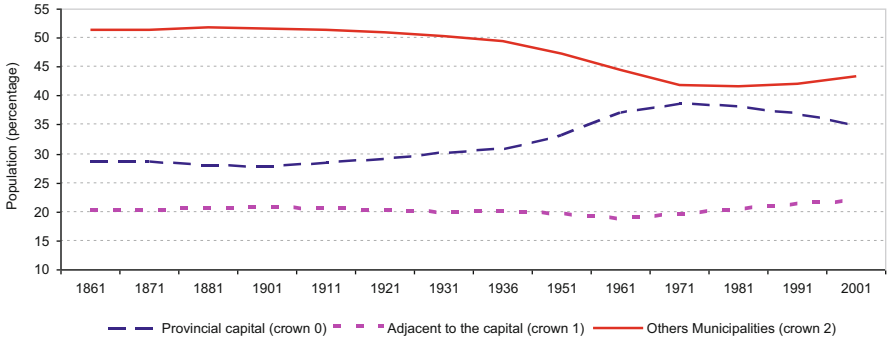


**Fig. 3** Population trend by crown, Tuscany (Relative values)—years 1861–2001

## 5.2 The ZALT Approach

Considering the five altitude/coastal zones, the relative settlement profile of Tuscany population seems to remain quite constant over years.

As showed in Fig. 4, the population quota remained substantially stable in all areas until the inter-war period. After that, the main changes regarded two areas: Inland Mountains and Plains. In particular, Inland Mountains population quota began to decrease constantly over years. On the other hand, Plains areas gained weight until to 20 % of the total amount of population at the last census (2001). This could be an effect of the de-population process experienced by rural areas mostly located in Inland Mountains or on the other point of view, the effect of the urbanization process experienced by urban (and sub urban) areas during the same period.

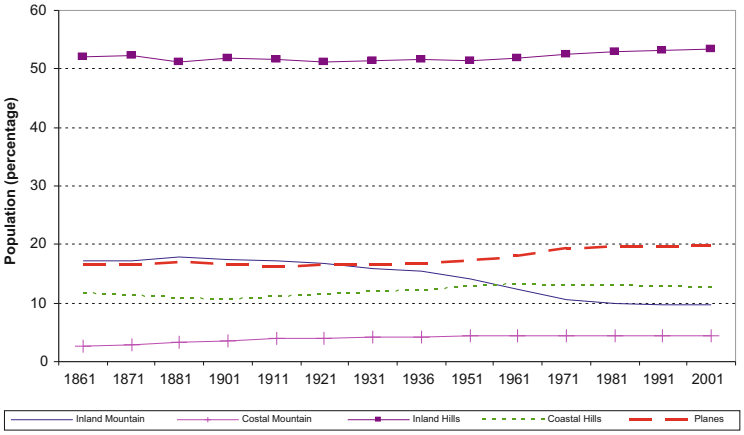


**Fig. 4** Total trend of population by altitude areas (*relative values*)

**Table 3** Average annual rate of change (per 1,000) between 1861 and 2001 by crown and ZALT

| Crown | ZALT | | | | |
|---|---|---|---|---|---|
| | Inland mountain | Coastal mountain[a] | Inland hills | Coastal hills | Plains |
| Provincial capital | 3.6 | – | 6.1 | 3.2 | 4.8 |
| Adjacent to the capital | −0.3 | – | 4.9 | 5.8 | 3.8 |
| Other municipalities | −0.8 | – | 2.6 | 5.4 | 6.7 |

[a]Coastal mountain rates are not included in the analysis due to the small amount of municipalities

## 5.3 The Crown-by-ZALT Approach

At a deeper level of analysis, a contingency table has been defined cross-tabulating each population census by ZALT and crown profile. After that, the average annual rate of change between 1861 and 2001 has been calculated (Table 3).

The above table shows that population increases over years, except for two cases in the Inland Mountains (Adjacent to capital, other municipalities), promoting the idea to control the specific time series.

While CM, IH, CH, P time series (population profile by crowns) have a similar trend to the whole Region, the ZALT area IM, with reference to other municipalities, shows (Fig. 5) an increasing population trend from 1861 till the inter-war period 1921–1931, and subsequently a general decreasing trend (stronger in the period 1951–1981).

Furthermore, the analysis shows a substantial homogeneity either considering the overtime population change by ZALT or considering both altimetry and crowns in absolute values.

More specifically, following the crown approach it has been possible to highlight how the geographical location is able to affect considerably the settlement profile of the whole population. Introducing the altimetry/coastal dimension, the main features

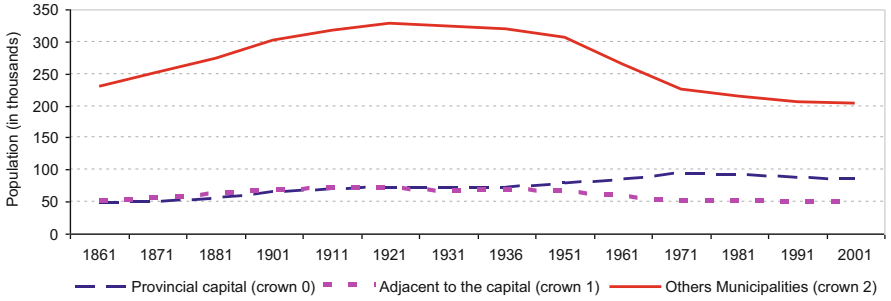


**Fig. 5** Total trend of population by crown for Inland Mountain (IM) Municipalities (*figure in thousands*)—years 1861–2001

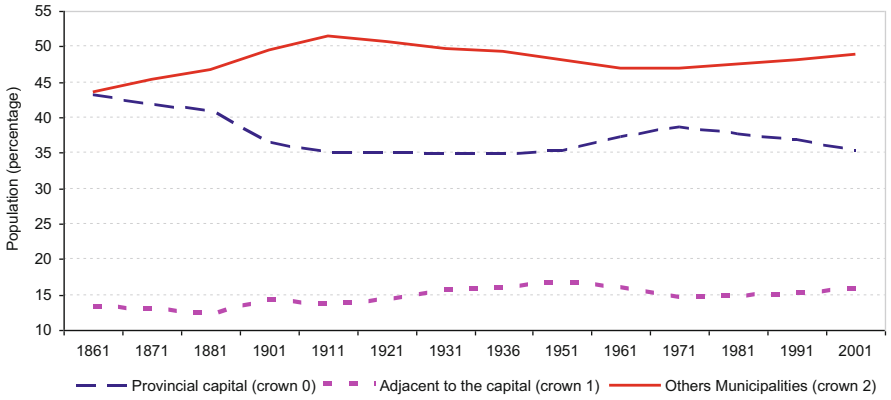


**Fig. 6** Distribution of Coastal Hills [CH] by crowns (*figure in percentage*)—years 1861–2001

observed for the whole Region remain stable for the three geographic areas: Inland Hills, Coastal Hills, and Plains.

Shifting from absolute values to relative ones, it is possible to analyze changes in quotas over time. More in detail only two ZALT, Inland Mountains and Inland Hills, are able to explain a trend comparable to the one previously described. Instead, as shown in details below, Coastal Hills and Plains display two specific profiles.

### 5.3.1 Coastal Hills [CH]

Despite their regional quota remains substantially stable (Fig. 4), municipalities classified as Coastal Hills present a non-monotonic increasing trend in Crown 2 mirrored by a general population reduction in Crown 0, composed by Lucca and Pisa (Fig. 6). Instead, population quota belonging to municipalities Adjacent to the Capital remains quite steady. This trend might be due to the presence of several industrial cities such as Empoli, Pontedera, Fucecchio, Ponsacco.

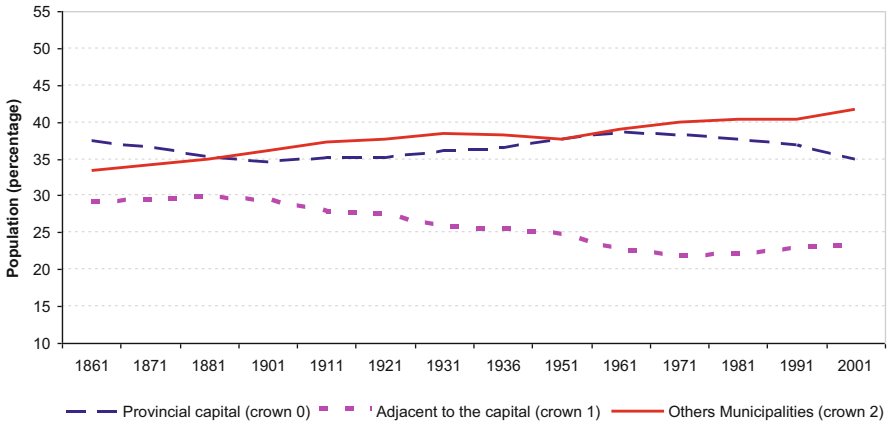


**Fig. 7** Distribution of Plains [P] by crown (*figure in percentage*)—years 1861–2001

### 5.3.2 Plains [P]

As shown in Fig. 4, the regional population quota in municipalities located in Plains increases steadily over years. This growth is mainly affected by crown 2 (Fig. 6) and this is partially balanced by the decrease in municipalities Adjacent to the Capital (crown 1). Livorno, the only Provincial Capital of this geographical division, keeps its relative weight approximately constant (Fig. 7).

## 6 Conclusions

The study of population trends over years can lead to some interesting results. In particular, classifying data by geographic and administrative variables may show some trends that could be hidden analyzing aggregate data. As showed in Sect. 5, drilling down data provides a deeper level of investigation. Indeed, cross-tabulating the number of inhabitants by crown and ZALT provides a more detailed understanding of the overtime trends of distribution.

This work showed that population settlement profiles in Inland Mountains and Inland Hills are qualitatively similar to the whole Regional profile. Instead, Coastal Hills and Planes are going to experience a continuous population increase, in relative values, in cities classified in other municipalities; this increase is part of a general process of population growth of the whole geographical area.

Clarifying some reasons of this process is not an easy task to cope with, particularly because of lack of data. Higher cost of living in Provincial Capital, difficulties or facilities to get the capital, work constrains, industrialization, economic development, population structure, changes in people preference of settlement could be good reasons able to explain this behavior. Nonetheless, crown approach seems to be able to help gathering geographical differences among areas highlighting heterogeneities.

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