BANCA D'ITALIA
EUROSISTEMA

Temi di Discussione

(Working Papers)

Please in my back yard: the private and public benefits of a new tram line in Florence

by Valeriia Budiakivska and Luca Casolaro

January 2018

Number 1161

BANCA D'ITALIA
EUROSISTEMA

Temi di discussione

(Working Papers)

Please in my back yard: the private and public benefits of a new tram line in Florence

by Valeriia Budiakivska and Luca Casolaro

Number 1161 - January 2018

ISSN 1594-7939 (print)
ISSN 2281-3950 (online)

Printed by the Printing and Publishing Division of the Bank of Italy

PLEASE IN MY BACK YARD: THE PRIVATE AND PUBLIC BENEFITS OF A NEW TRAM LINE IN FLORENCE

by Valeriia Budiakivska* and Luca Casolaro**

Abstract

Urban agglomerations, displaying the highest levels of productivity and growth, pose severe congestion problems. This issue can be mitigated by the construction of transport facilities enabling a higher centre-suburbs permeability. The returns from these infrastructures are, however, the subject of debate, especially in cities that have major artistic and urbanistic constraints. The purpose of this paper is to estimate the private and public benefits of a new tram line recently built in Florence. We apply the synthetic control method to metropolitan micro-zones in order to estimate the impact of the tram line on house prices in the suburbs located close to the stops. We also estimate a hedonic pricing model on individual bids downloaded from a popular real estate agency. The results, which are consistent for the two approaches, demonstrate that houses located close to the new tram network have registered a price increase of €200 to €300 per square meter, 7-10 per cent of the total value. The study also confirms the presence of public benefits related to the facility, in terms of accident reduction and improved air quality.

JEL Classification: O18, L92, R41, R42.
Keywords: synthetic control, transport facility impact, house prices.

Contents

---

* University of Pisa.

** Bank of Italy, Economic Research Unit, Florence Branch.

1 Introduction[1]

In the urban economics literature it is undisputed that, due to firm selection and agglomeration economies, the highest levels of productivity and growth are localized within the cities (see between the others, Combes et al. (2012)). This phenomenon is indicated by many scholars as the principal driving force of the economic activity for entire countries. On the other hand, vast urban agglomerations suffer severe problems of congestion. Hsieh and Moretti (2015), looking at the house prices in the US metropolises, show that the growing constraints to housing supply in big cities constitutes a major impediment to a more efficient spatial allocation of labor, limiting the number of workers who can be employed in the most productive sites.

The drawbacks related to congestion can be mitigated by infrastructures which permit to enlarge the size of the cities by cutting commuting cost, so allowing a higher permeability between the centre and the suburbs of the local labor markets. On the other hand, the construction of big public work carries with it serious issues related to the economic feasibility and the social and environmental impact of the infrastructure, especially when it is situated in an ancient city with several artistic constraints.

The issue of the private and social return of public works is a very debated one. In the case of undesirable land use, such as dangerous or pollutant infrastructures – even in the case of transportation ones such as highways – the acronym NIMBY (not in my back yard) reflects the negative perception for people living in the proximity of treated areas, that can be resumed by the well documented drop in the property values associated with these public works (see, among the others, Kohlhase (1991) and Zhao et al. (2016)). On the other hand, other types of infrastructure can present positive externalities for the neighbouring population. Looking in particular at transit facilities, the economic theory predicts that the advantages related to a logistic empowerment are capitalised totally or partially into land and house prices. Indeed, several studies, mainly using hedonic models, demonstrate that residing nearby a transit station improves the accessibility of citizens to commercial activity centers, resulting in increased utility and therefore in a rise in property values (see, for example, Nelson (1992), Ganesan et al.

[1]We thank Laura Conti for her crucial help in the collection of micro data, Guglielmo Barone for his thorough review of earlier versions of this manuscript, Marco Tonello and the participants of the Bank of Italy ARET seminar. We especially thank Massimiliano Sifone, Gianni Dugheri and the Statistical Service of the Municipality of Florence for their magnificent cooperation in providing data for this research. The views expressed in this paper are solely the responsibility of the authors and do not necessarily correspond to those of the institutions to which they are affiliated.

(1997), Hennebery (1998), Coffman and Gregson (1998), Hess and Almeida (2007), Wadu et al. (2015)). Other studies, on the contrary, do not find a significant impact on the house prices (see Debrezion et al. (2007) and Hess and Almeida (2007) who provide an extensive analysis across the transportation and real estate literature review).

In this paper we contribute to this branch of literature on urban economics, trying to evaluate the impact of a major infrastructure using a rigorous identification strategy. The infrastructure we focus on is the new T1 tram line in Florence, a recent, highly debated public work, looking for perturbations on property prices in the neighbourhood of the new stations.

The project of the tram line has been widely discussed in Florence since the beginning of the last decade. From one side, focusing on previous studies - mainly concerning cities in developing countries - the infrastructure is expected to give positive returns related to traffic improvements and commuting time cuts; on the other hand, there are serious concerns related to the peculiarity of the city of Florence: a unique, renaissance urban area characterized by narrow streets, important monuments and open air works of art, contrasts the project of an impacting public work such as the tramway. Given all these issues, it was under debate if the tram line would have represented an actual value added for the city of Florence or not.

The infrastructure has been finally approved in the nineties, but the works started only in the 2005, leading to the entry into service at the beginning of 2010. The final expense was about 265 million euro, out of which around 156 million were financed by national and regional funds, and around 109 million by the municipalities of Florence and Scandicci, the two districts involved in the project. The line connects the central area of Scandicci, a peripheral district outside Florence, with the main railway station, situated in the heart of the city. The tram goes through its 14 stops covering 7.4 km in 23 minutes, less than the half of the journey time covered by bus. The route crosses suburbs with a very high population density (Figure 1), having a positive impact on commuting time within Florence and especially between Scandicci and Florence. Given these characteristics, the facility has been exhibiting very positive and increasing statistics: in 2015 the passengers have been more than 13 million, with an increase of the 7 per cent with respect to 2011[2]. Recent in-progress expansions and planned additions of the tram network in Florence highlight the importance of the overall tramway project, the key infrastructures for the city of Florence in the long run. The relevance of the project makes it of immediate interest to examine both the private and

[2]Based on statistics published on the Florence municipality's website: *mobilita.comune.fi.it*

the public benefits of the current line. The first ones, which constitute the core of our analysis, can all be resumed by the increase in prices for those properties located close to the tram line: the rise in the value of properties, indeed, reflects the net present value of all the future benefits (in terms of time, petrol, risk etc.) driven by the tramway for those inhabitants that have the possibility to exploit it. The public benefits, on the other hand, are mainly related to the decrease in congestion, which we measure in terms of a decline in motor vehicle accidents and pollution in the proximity to the tramway.

Figure 1: T1 route

To analyze the impact of the tram line on house prices in Florence we use a dual approach. The principle analysis is conducted at macro level, applying the synthetic control method to a set of average house prices referred to the micro-zones of Florence and its contiguous districts. A subsequent robustness check is performed by the estimation of a standard hedonic pricing model based on individual real estates listings downloaded from one of the top online agencies in Italy.

Our results demonstrate the presence of private benefits related to the tramway: after the beginning of the works, in 2005, the property prices in the zones crossed by the facility displayed a significant increase. This rise in value, as expected, is not homogeneous, but is directly related to the intensity of the treatment: it is maximum in the district of Scandicci, close to the terminus, where the importance of the infrastructure is the most significant. The positive price-proximity relationship becomes less pronounced when moving towards the center and vanishes in proximity of the central station terminus, where the added value of the tram line in terms of commuting time is negligible. These findings are corroborated by the micro level analysis, showing that houses located far from the tramway stops demonstrate, ceteris paribus, a lower price with respect to the properties situated closer. We participate also to the debate about the timing of the economic impact of infrastructures, finding strong evidence that the increase in house prices is concentrated at the start of the construction works, when it became undisputed in the mind of people that the project, after several years of legal disputes, would have be accomplished. On the contrary, the entry into service of the tramline, completely anticipated by the market, has not significant effects. Finally, our results highlight the presence of public benefits induced by the tram line, related to the decrease of congestion: we observe a significant drop in both pollution and car accidents in the areas of study.

Summing up, in the paper we offer novel evidence of the way a new public transit facility can shape urban development even in a peculiar European city as Florence. The number of constraints, the potential stickiness of prices and the low level of mobility made it more challenging to measure high returns from a transit facilities with respect to infrastructures build in modern or changing cities, perhaps in developing countries, where constraints are less binding and it is simpler to reshape entire neighborhoods. To our knowledge, we are the first to apply the combination of a macro approach, exploiting the synthetic control method, with a micro hedonic pricing model as a robustness check, in order to conduct a vast empirical assessment of the impact of a new transit on private benefits.

2 Property values: macro analysis

2.1 The new tram line in Florence

The T1 tram line, in the Florence long run logistic plan, is designed to connects the peripheral area of Scandicci with the center of the city. The choice of the west area of Florence and in particular of Scandicci as a path for the first stretch of the infrastructure was motivated by strong logistic advantages.

The municipality of Scandicci has started developing significantly in 60s-70s due to the intensive population growth favoured by the immigration flows (in the 1970 census the increase was more than 50% with respect to 1960). This period is also characterized by the creation of an industrial district in the area, due to both relocation of businesses from Florence and local initiatives. In the following decades the number of residents has stabilized and amounts currently to about 50 000 inhabitants, with a high population density. Given these premises, it comes clear that the motivation of the choice is not related to the necessity of serving a growing strand of population, but to the strategic location of the suburb, which can be summed up in three point. First, the western part of Florence up to the center of Scandicci is completely flat, without the presence of hills, so suitable to a transport facility. Second, the central area of Scandicci is one of the most populous area contiguous to the Florence district, with intense commuting flows. Finally, this area is also crossed by important highways (the A1 highway characterized by three traffic lanes with a toll assessed for passage, and the two lanes free road towards Livorno and Pisa), which permit to build up an integrated logistic center (by the creation of transit parking spaces) to reach the heart of the city of Florence.

Data on mobility confirm the relevance of the project. According to the research conducted by the Region of Tuscany[3], 54.8 per cent of the new tram line users move between Scandicci and Florence, while only 24.8 per cent do the Florence–Florence route (the remaining 20.4 per cent of users start or continue their journey outside the mentioned municipalities). Workers constitute 49 per cent of the T1 users while 19.6 per cent are composed of students. The majority of travellers are people commuting from the Scandicci area to Florence (during the morning rush hours 71 per cent of users in the sample were travelling towards Florence while in the evening rush hours 68 per cent of individuals in the sample were going the opposite way towards Scandicci). The tram line takes 23 minutes to complete its journey, saving about 40 minutes with respect to the bus, the alternative way to reach the center.

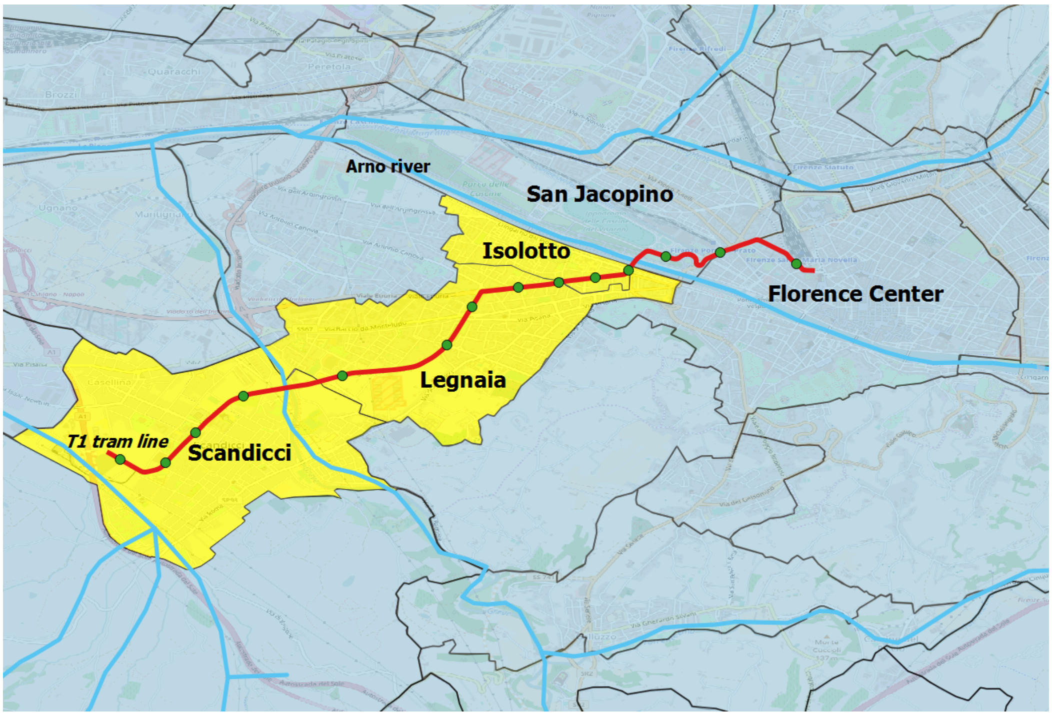
The new tram line crosses 5 micro-zones of the OMI property market observatory of the Italian Revenue Agency (Figure 2)[4], four of which belonging to the municipality of Florence (Florence Center, San Jacopino, Isolotto and Legnaia) and one to the municipality of Scandicci (Scandicci Center). The

[3] *I fiorentini e la tranvia. Indagine conoscitiva sull'utilizzo della linea 1 della tranvia*, Regione Toscana, October, 2012

[4] The acronym OMI stands for Osservatorio del Mercato Immobiliare; the micro zones are homogeneous areas according to which the real estate market values are revealed. Section 2.3 contains a detailed discussion about this dataset

areas of Florence Center and San Jacopino, located beyond the Arno river, are very central, highly touristic suburbs, where the tram line passes only marginally and is very close to the city centre terminus; for these reasons, they are not considered in our further analysis. The study will be focused on the three yellow zones highlighted in Figure 2, very congested areas between the Arno river and the tram terminus, located in the center of Scandicci, for a total of 11 stops.

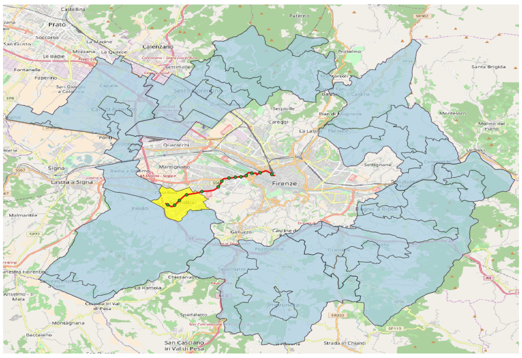
Figure 2: T1 route across PMO zones



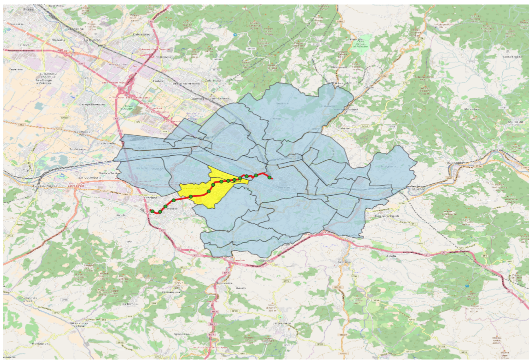
According to Abadie et al. (2015), using the synthetic control framework, the donor pool units should be sufficiently similar to the units of interest. Given the strong heterogeneity between the micro-zones belonging to the city of Florence – characterized by an urban environment and a high population density – and those in the satellite districts – most of which present a rural structure – we split our analysis focusing separately on each of the three zones. We first compare the central area of Scandicci with other OMI zones belonging to the municipalities contiguous to the city of Florence; afterwards, we compare the two zones of Florence served by the tram line, Legnaia and Isolotto, with OMI areas of Florence (see Figure 3).

We expect the intensity of the effect in these three areas to be proportionally related to the intensity of the treatment, which will be higher the longer is the distance from the terminus in the centre of Florence. In Scandicci, where the time saving due to the facility is maximum, the impact on house prices is expected to be higher, since the intensity of the treatment is the most pronounced.

Figure 3: PMO zones of Florence and adjacent municipalities



(a) Scandicci center vs adjacent municipalities



(b) Legnaia and Isolotto vs Florence

The treatment is smaller in Legnaia, the zone located at the extreme west of Florence: the area is entirely crossed by the tram line but is closer to the center, so the time saved to get to the central station declines to less than 20 minutes. Finally, the suburb of Isolotto, the zone contiguous to the Arno river, is crossed only marginally by the tram line and the intensity of the treatment is minimum, since the saved time is negligible. For these reasons, we expect the increase in prices to be maximum in Scandicci, smaller in Legnaia and negligible in Isolotto.

2.2 The synthetic control method

Our core analysis is based on a counterfactual approach suitable for small samples, the synthetic control method, proposed by Abadie and Gardeazabal (2003) and further developed by Abadie et al. (2010 and 2015). When a comparative case study is performed, the baseline is to estimate the evolution of aggregate outcomes (house prices in our analysis) for a unit affected by a certain event, comparing it with the evolution of the same aggregates estimated for a control group of unaffected units.

The synthetic control method allows to evaluate the effect of a treatment applied to one or more units in a small sample analysis. Indeed, after obtaining a synthetic counterfactual (a weighted average of potential controls that replicates the treated unit's initial conditions), the treatment effect is computed by simply comparing the actual outcome of the treated unit against the outcome of the synthetic control.

A growing literature has applied the synthetic control approach to study various topics on both national and sub-national levels. However, to our knowledge, the synthetic control methodology has not been extensively applied in urban economics. Ando (2015) examines the impact of nuclear power facilities in Japan in the 1970s and 1980s on local per capita income levels. Munasib and Rickman (2015) analyse the net economic impacts of oil and gas production from shale formations in Arkansas, North Dakota and Pennsylvania. Our paper is the first to apply the synthetic control method to analyse the impact of transit facility on property prices. Following Abadie et al. (2010 and 2015), suppose that the sample is composed of J units observed at time periods $t = 1, 2, ..., T$. We assume there is a positive number of pre-intervention periods T_0 and post-intervention periods T_1, so $T = T_0 + T_1$. Let Y_{jt} be the outcome of unit j at time t. Unit 1 is exposed to the intervention (the "treatment") at time $T_0 + 1, ..., T$ and the intervention has no effect during the pre-treatment period $1, ..., T_0$. The other units from $j = 2$ to J are the control units (or "donor pool"), that are supposed not to be subjected to the intervention nor to be affected by the treatment of unit 1. A synthetic control can be defined as a weighted average of the control units. To determine the weights w_j, $j = 2, 3, ..., J$ let x_{1mt} be a set of $m = 1, 2, ..., M$ control variables for the outcome variable of the treated unit, while the corresponding variables of the donor units are given by the analogous set x_{jmt}, $j = 2, 3, ..., J$. The covariates are averaged over the pre-intervention period to obtain $\bar{x}_{1m}$ and $\bar{X}_m$, which is the $J - 1 \times 1$ vector of predictor m in the synthetic control. Then the $J - 1 \times 1$ vector of weights $W^* = (w_2^*, w_3^*, ..., w_J^*)'$

is chosen to minimize:

$$\sum_{m=1}^{M} = v_m(\bar{x}_{1m}^{T_0} - W'\bar{X}_m^{T_0})^2 \tag{1}$$

subject to $\sum_{j=2}^{J} w_j = 1, w_j \geq 0$; where v_m is a weight that reflects the relative importance assigned to the variable m. A data-driven regression based method is used to obtain the variable weights contained in the V-matrix[5].

The outcome variable and its lags can be included among the control variables if it helps to control for the unobserved factors influencing the outcome of interest. Recall that Y_{jt} is the outcome of unit j at time t. The synthetic control estimator of the treatment effect is given by the comparison between the outcome of the treated unit and the outcome of the synthetic control in the post-intervention period t (with $t \geq T_0$) :

$$d_{1,t} = Y_{1,t} - \sum_{j=2}^{J} w_j^* Y_{j,t} \tag{2}$$

In order to correctly attribute a hypothetical increase in prices to the tram line construction, using the synthetic control method, several issues have to be highlighted, related to the potential endogeneity of the results and their magnitude.

Firstly, in the case of a suburb in rapid growth, indeed, a correlation between the tramway construction and the rise in house prices could represent a spurious link between variables both related to urban expansion. This way, the house prices variation would be not due to the tram line but to the demographic pressure, which, in turn, motivates the tram line construction. The synthetic control, equalizing the outputs for the treated zone and the controls, is expected to rule out the problem, because it permits to compare areas that are experimenting similar dynamics. The dynamics of the suburbs involved, however, will still be discussed further. Moreover, looking at the magnitude of the effect, it is important to keep in mind that the synthetic

[5] Alternatively, the variable importance weights (v_m) can be chosen by cross-validation, splitting the pre-treatment period in two sub-periods: training period and validation period. While averages from the control in the training period are used as predictors in the validation period, for any given v_m the w_j is calculated, which minimizes the RMSPE in the validation period. Then the optimal v_m is computed, which allows to obtain the minimum w_j in validation period. Finally, the optimal v_m is used to calculate the w_j using predictors calculated in the validation period. Being advantageous, this method, however, requires longer pre-intervention period.

control analysis provides, by construction, not an estimation of the pure effect of the treatment, but a relative one, i.e. the effect is computed as the difference between our target zone and the synthetic control. In the paragraph related to the results we present a thorough discussion related to this issue, which could lead to an upward bias of the estimated effect.

2.3 The OMI data on property values

In Italy the OMI has been publishing each semester since 2002 the maximum and minimum selling prices of properties with a very detailed breakdown by location and quality of houses. Areas are revealed at the infra-district level, sharing in general similar socio-economic and urban characteristics, building infrastructures and quality, namely the features which are crucial to determine prices.

The prices reported in the OMI dataset are taken from various sources: the principal one is the analysis of actual prices specified in administrative archives or quoted by market operators. In the case of incomplete or missing information data are integrated by the assessments of local experts aimed at correcting imperfections or attributing a reference price whenever the low number of transactions limits the representativeness of the reported values.

In this study we use the OMI data on average $euro/m^2$ house prices for the city of Florence (disaggregated by OMI in 30 micro-zones) and the 6 contiguous municipalities (divided in 31 micro-areas)[6]. Average values are computed starting from the minimum and maximum market values per zone, provided by OMI. The resulting dataset is a balanced panel covering the period from 2002-II to 2013-II, when a break in the OMI micro zones distribution occurred, making it hard the comparison with previous zones.

The OMI database contains also information on the type of property (villas, private apartments, economic buildings) and the state of conservation. Given the very low dimension of the zones and the thickness of the market, the database presents many cells with missing or low accuracy data. This way, in order to get information on as many zones as possible and to work on a homogeneous sample (given that even an average value computed among the different categories would be affected by the presence of missing), we decide not to exploit all the information of the dataset and to consider the value of prices only for the most representative categories, i.e. private apartments (excluding chalet, villas and economic buildings) in a normal state of conservation.

[6]The 6 administrative municipalities bordering Florence are the following: Scandicci, Campi Bisenzio, Sesto Fiorentino, Fiesole, Bagno a Ripoli and Impruneta.

2.4 Empirical estimation and results

In this section we present our leading analysis, based on the synthetic control approach. Our outcome variable is the average market price per square meter by zone (in euros) related to residential apartments in normal conditions. The covariates describing the micro-zones in the pre-treatment period are the following, taken from the Census 2001-2011: population density, a proxy of human capital [7], house concentration ratio [8] and share of senior residents (older than 65), all varying per OMI zone. We also include some characteristic of the municipalities, such as the altitude of the central zone of the municipality (to control for the presence of hills in the area), and the average per capita income (and in case of Florence this information is available per OMI area), taken from tax returns. In addition to the mentioned predictors we include in the analysis, following Abadie et al. (2010 and 2015), the property values of two semesters of the pre treatment period, the second semester 2003 and the second semester 2004.

The goal of our empirical estimation is to compare house prices in the area served by the tramway (the treated area) with those of a synthetic zone, created as a linear combination of districts chosen among the donor pool so that the pre-treatment prediction error, conditioning on a number of covariates, is minimized. Once the algorithm creates that synthetic zone, which is supposed to be equivalent to the treated one except for the treatment, we can estimate the treatment effect (i.e. we determine the price increases caused by the transit facility) simply taking the difference in the post-treatment period between the treated cohort and the synthetic one.

To choose the starting date of the treatment, it is worth to look at the long process leading from the initial project to the implementation of the tram line in Florence. The first discussions of launching the tram line date back to 1994, together with a preliminary plan of the route. In the beginning of the new millennium numerous debates and legal disputes of the companies involved in the project took place. Only at the end of 2002, after the unification of the associations interested in the project, it was announced that the construction works would start in 2003, although with a smaller financing than eventually required. Finally, the works actually began in the first semester of 2005, ending almost 5 years after.

Given the extremely long and hard way to move from the idea of the tramway to the final infrastructure, it is important for our study to choose a point in time when it was undisputed to everyone that the tramway would have been realized. Several studies in the literature set the beginning of the

[7] Share of residents in possession of a university degree.

[8] The fraction of dwellings occupied by at least one resident over the total area.

treatment when the infrastructure began to be operative (see, among the others, Yan, Delmelle and Duncan, 2012). Other studies estimate an anticipated effect of infrastructures, sometimes finding that just the announcement of a transportation improvement project itself does cause an increase of residential property prices[9].

Given these premises, we decided to choose the first semester of 2005, the *de facto* starting date of the construction works, as the "treatment date", for a matter of credibility: indeed, the length and the conflict of the decision process, together with the frequent postponement of the works starting date produced in the mind of the people a strong uncertainty about the feasibility of the project even after the announcement. This way, only when the work started people began to be confident about the positive conclusion of the project. Of course, we will perform several robustness checks in order to control for different starting dates of the effect, for example when the laying rain was completed or when the facility was put into operation. Unfortunately, the length of the sample, starting in 2002, make it impossible to choose the announcement date as starting point for the treatment.

A serious caveat of this choice is that we are forced to perform our analysis with a pre-intervention period which is extremely short, equal to six semesters. This issue, has not been widely explored in the literature: a recent paper of Allegretto et al. (2017), estimating the effect of minimum wage on teen employment, performed a synthetic control analysis with a pre-treatment period of just 4 quarters. Carling and Li (2016), in their review of the synthetic control method, find that the most crucial features that identify an intervention effect under this approach are the treated-synthetic discrepancy in the outcome variable in the pre-intervention period, the length of post-intervention period and the size of the donor pool, while the length of the pre-treatment period is indicated as a less critical issue. However, aware of this drawback, we will propose several robustness tests for validating our results. Dates prior to 2005 were also analyzed as treatment dates, but they showed no impact on housing prices – as well as the periods between 2005 and 2010, the year of the actual introduction of the tram line – confirming instead the existence of a positive perturbation in prices only in 2005.

[9] Agostini and Palmucci (2008) suggest that the Line 4 of the Santiago metro system has impact on property values already after the constraction was announced. McDonald and Osuji (1995) observe that the land market had begun to adjust well before the railway line between Chicago and the Midway Airport was completed (in their case three years before the connection actually opened). Also Bae et al. (2003) state that in Seoul property values were affected significantly prior to the opening of the line 5 of the subway. Yiu and Wong (2005) demonstrate the presence of positive anticipatory effect before the completion of the tunnel under analysis.

2.4.1 Scandicci

As mentioned before, the three zones crossed by the tram line (Legnaia, Isolotto and Scandicci Center) will be examined separately. We expect the effect on property values to be maximum in Scandicci, since the gain in commuting time is the higher close to the Scandicci terminus and tends to decrease approaching the city of Florence.

The municipality of the town is composed of four OMI zones, out of which Scandicci Center constitutes the most urbanely developed one. This central zone is bordering Florence on the north-east, on the west is crossed by the A1 highway while the south is characterized by a hilly area.

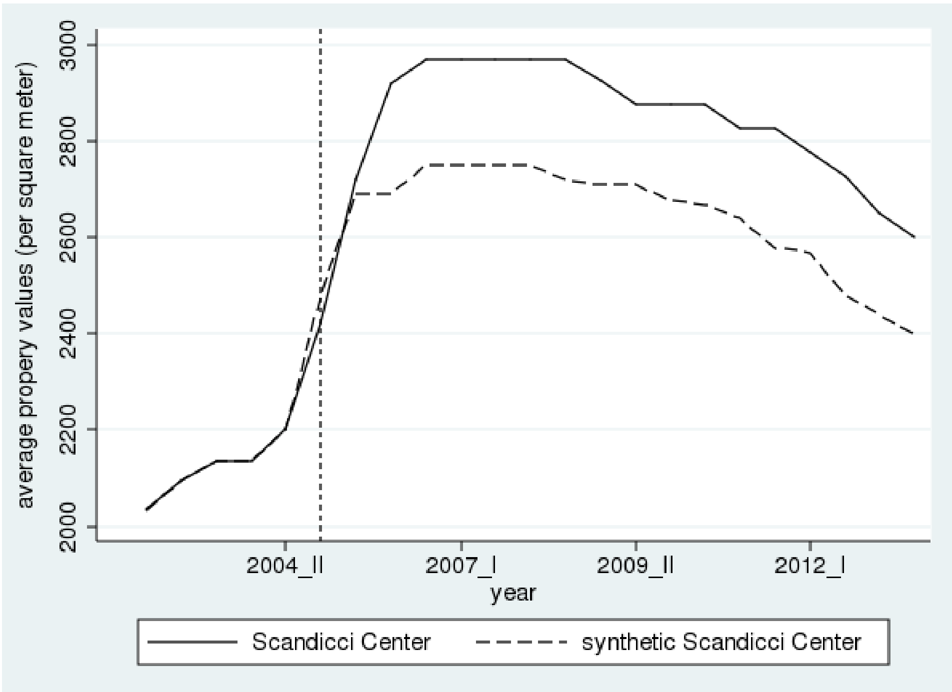
In order to analyze the effect of the tram line on Scandicci house prices, we compare this district with the other suburbs contiguous to the city of Florence. As stated previously, the 6 municipalities bordering Florence are disaggregated by OMI in 31 areas. Compared to other peripheral areas, the Scandicci Center zone is characterized by a high population density (77.7 inhabitants per hectare, a value similar to those of central areas of Sesto Fiorentino and Campi Bisenzio, two suburbs with comparable urban characteristics). The level of per capita income is relatively similar to the one of Campi Bisenzio, Impruneta and Sesto Fiorentino. When performing the synthetic control we exclude from the donor pool two areas adjacent to Scandicci Center, which could be affected by some treatment given their closeness to the tram line.

Looking at the results [10], the synthetic control is a weighted average of four zones: the largest weight (almost 60 per cent) is attributed to the central area of Sesto Fiorentino, a highly populated district presenting strong similarities with Scandicci in terms of income, surface, density, amenities and commuting interest towards the city of Florence; smaller weights are associated to areas of Campi Bisenzio (Center and Sant'Angelo), a municipality having common features with Scandicci as well, while the weight of the last area (Poggio of Impruneta) is negligible. Figure 4 shows the house prices dynamics of the Scandicci Center area. The synthetic counterpart in our exercise almost exactly reproduces the real estate values for the actual Scandicci Center during the entire pre-treatment period; the covariates as well exhibit a close fit (see Table 1). The third column of the table shows the pretreatment characteristics of a population-weighted average of the 28 areas in the donor pool; it can be noticed, as axpected, that the synthetic Scandicci Center zone provides a better comparison with respect to the average of our sample.

[10] We estimate the model with the SYNTH routine in Stata created by Abadie, Diamond and Hainmueller.

According to our findings (fig. 4), from the second semester of 2005 onward the synthetic control and the actual Scandicci area diverge considerably. From the beginning of the construction works the property values demonstrated an increase of about 200 euros per square meter, which amounts to approximately 8%, and maintains constant till 2013. This magnitude is in line with many studies on the effect of other transit facilities[11]. One can also clearly notice the persistence of the price increase of Scandicci Center in time.

Figure 4: Evolution of property values: Scandicci Center vs synthetic Scandicci Center



Looking for potential endogeneity risks in the estimation, already presented in section 2.2, it is important to look at the evolution of Scandicci during the period of analyses. The district of Scandicci in 2005 appeared already as a populous satellite district close to Florence; the suburb presented

[11]For instance, Agostini and Palmucci (2008) show that average apartment price increased by between 4.2 per cent and 7.9 per cent after the construction of Line 4 of the Santiago metro system was announced (and by between 3.1 per cent and 5.5 per cent after the location of the metro stations was clarified). Billings (2011) analyses the light rail-transit system in Charlotte, North Carolina and suggests that within 1 mile neighbourhood from the transit area single-family properties increased in value by 4 per cent while condominiums – by 11.3 per cent.

Table 1: Property values predictor means in Scandicci Center

Variables*	**Treated area**	**Synthetic area †**	**Sample average**
housing prices(2003.02)	2135	2134.76	2080.875
housing prices(2004.02)	2200	2199.705	2142.167
pop. density	77.73785	77.12707	25.67819
altitude of the capital	47	49.249	102.5073
per capita income	12579.84	13018.48	13788.31
human capital	0.0540802	0.0576985	0.0722821
house concentration	30.34811	29.96716	9.766665
share of elderly	0.216634	0.2211247	0.2043772

* Units of measurement: housing prices – €/m^2, population density – inhabitants/hectare, altitude of the municipality's central area – meters above sea level, per capita income – €/inhabitant, human capital is the share of residents in possession of a university degree, house concentration is the share of dwellings occupied by at least one resident per total surface of the area (in hectares), share of elderly is the proportion of senior citizens (older than 65) in the population of the area. Population density, human capital, house concentration and the share of elderly are related to the census of 2001 (Source: Statistical Service of the Municipality of Florence) and are thus kept constant over time. Per capita income is also available for 2001. Source: ISTAT.

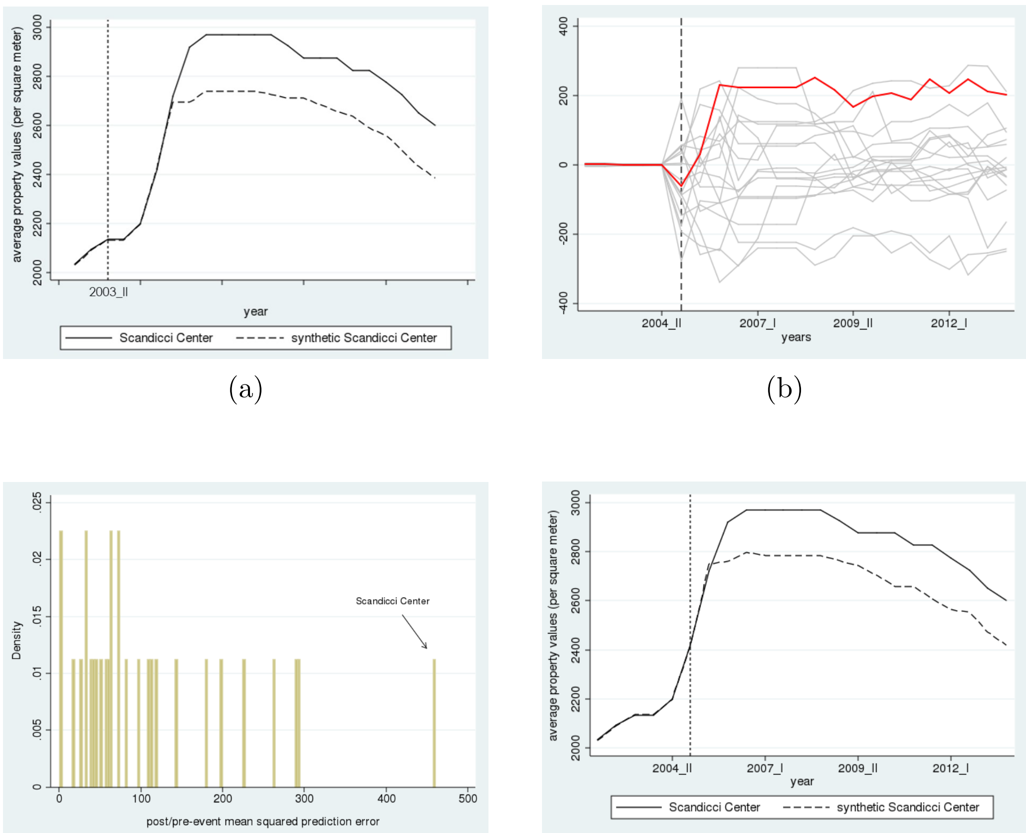
† The synthetic control weights are allocated in the following way: Sesto Fiorentino Center (0.592), Sant'Angelo (0.202), Campi Bisenzio Center (0.201), Poggio (0.005).

important commuting flows to the metropolis, but was completely structured from an urban point of view, with a population and an urban context being stable during the last 30 and, high level of land use and a severe zoning legislation. This way, we can assume that the tram line has been motivated by Scandicci's structural characteristics and not by demographic dynamics, thus ruling out potential endogeneity issues.

Looking at the magnitude of the effect, as already mentioned, our analyses produces a relative estimation of the tramline impact. This way, if people living in other Florence satellite districts decided to move to Scandicci due to the tram line construction – thus producing a price drop in those districts – the increase in property price in Scandicci has to be interpreted jointly with the simultaneous decrease in similar areas not interested by the tramway. If these areas are part of the donor pool of the synthetic control, as expected, our estimates would present an upward bias. However, looking at the data of residents in all the districts surrounding Florence, we do not observe an increase in the population of Scandicci and a related drop in other municipalities: from 2001 to 2011, the population of Scandicci remained stable, while we observe a slight increase in the average of the other districts around Florence. The stability of the population in Scandicci could be related to the high level of land use reached by the district before the 2000, in particular in the area close to the tramline, which makes it hard to achieve an increase in population, given also the severe local legislation in terms of new buildings. This way, even if our estimator is a relative one, we can assume that the upward bias due to the indirect effect of the tram line on donors is negligible.

2.4.2 Placebo tests

Figure 5: Robustness tests



(a) (b) (c) (d)

To evaluate the credibility of our results we conduct several robustness tests also called “placebo studies” or “falsification tests”. The first test we perform is the “in-time placebo” which is aimed to check the stability of the model to perturbation in time. The idea is to rerun the model considering a different date as a treatment starting period: if the trajectories of the treated area and its synthetic counterpart do not diverge substantially in the pre-treatment period, then the confidence of the validity of the results increases. The "in-time placebo" test (Figure 5a) demonstrates that, even after reassigning the event to the middle of the pre-treatment period, namely the second semester of 2003, the synthetic control reproduces almost exactly the evolution of prices in the actual Scandicci Center area both in the pre-treatment period before 2005, both in the post treatment. This implies that no shock has occurred to the treated unit prior to the intervention, confirming the reliability of the magnitude of the treatment effect and the stability of our estimation. We also reassigned the treatment starting date to years following the 2005, including the actual introduction of the tram line in 2010, but the results, not reported, demonstrate that the housing price change occurred in 2005. Finally, in order to reduce the risk of overfitting on idionsyncratic variations in the 2002-2004 period, we try not to consider the outcome among the predictors, or to include just its average pre-treatment value: the results remained unchanged. Concerning the treatment date of 2005, both semesters show the increase of property values, however, the first semester is characterized by smaller RMSPE.

A second way to check the robustness of the results is to conduct an "in-space placebo" test, namely a falsification test where we reassign artificially the intervention to each unit of the donor pool, i.e. the areas which have not received the treatment. This way we obtain a distribution of placebo effects that can mimic a p-value for the treated unit, computed as the fraction of placebo effects greater or equal to the effect estimated for the unit of interest. This computation allows us to assess if the effect estimated for the treated area is large relative to the distribution of the effects for the non treated areas. The significance of our results would increase if the probability of obtaining an estimate at least as large as the one obtained for the treated unit is small. In fact, when we reassign the treatment to the 17 comparison units that did not experience the event of interest[12], one can observe (Figure 5b) that the Scandicci Center gap line is the highest for almost the entire post-treatment period, making the estimation results significant at about 5 per cent level.

One more way to evaluate the Scandicci Center gap relative to the gaps obtained from the placebo estimations is to look at the distribution of the ratios of post/pre-treatment mean squared prediction errors (RMSPE), i.e.

[12]Following Abadie et al. (2010) we discarded 11 areas which were characterized by a very bad fit of the synthetic control, exhibiting a RMSPE at least 5 time higher than the error of the treated unit; these areas cannot be well reproduced by a convex combination of housing prices of the donor pool, therefore the results regarding the ex-post behaviour of prices are meaningless (e.g. Fiesole Center, fashionable district characterized by the most expensive property values in the donor pool, exceeds the Scandicci Center's RMSPE by around 700 times).

to rescale the estimated price gap with the synthetic control by a measure of the accuracy of the synthetic control itself in the pre-treatment period. Figure 5c shows the post/pre-event ratios of Scandicci Center and the other 28 PMO areas. The estimated ratio for Scandicci Center is much bigger relative to the distribution of the placebo effects, with a post-treatment RMSPE more than 460 times bigger than the pre-intervention one. If the treatment was assigned randomly to the data, one could obtain a post/pre-treatment RMSPE ratio as large as this one with probability $1/29 = 0.034$.

Finally, since one area in the synthetic control estimate retains a weight of about 60 per cent (Sesto Fiorentino Center), it is useful to check how much our results are driven by this control unit. Excluding Sesto Fiorentino Center from the donor pool allows us to verify the persistence of the outcome even with a potential loss of goodness of fit (Figure 5d). The synthetic control is now composed of three areas, with the domination of Campi Bisenzio Center (80%), the area which also exhibits strong similarities with Scandicci. The exclusion of Sesto Fiorentino Center worsened minorly the goodness of fit of some of the covariates; the relative increase in property values remains, even though of a slightly smaller magnitude. The pre-treatment RMSPE increases by almost 6 times when eliminating the Sesto Fiorentino Center and increases further when discarding other control units proving that the synthetic control is an advantageous technique for such comparative research.

All the robustness checks show that our main results are significant: Scandicci Center does demonstrate a strong rise in house prices after the beginning of the construction works of the new tram network in Florence.

2.4.3 Within Florence

We now compare the two zones of Florence served by the tram line (Legnaia and Isolotto) with the other suburbs of the city, namely the other 23 OMI zones. The other treated zones and the adjacent ones were excluded from the donor pools. The covariates remain the same though with the following differences: the income per capita is used at the OMI level in case of Florence (while outside Florence it is aggregated by the municipality) while the altitude of the capital is excluded since it shares the same value across the municipality of Florence.

Both areas of interest exhibit modest property values with respect to other micro-zones of Florence. Isolotto is characterized by a very high population density (108.4 inhabitants per hectare) and a very high concentration of houses across the area. The population density in Legnaia is smaller, due to a high heterogeneity in the kind of buildings involved. Both OMI zones demonstrate relatively low share of residents in possession of a university degree with respect to other areas of the city.

Figure 6 shows the evolution of the average house prices in Legnaia with respect to its synthetic counterpart for the 2002-2013 period. The pre-treatment period (2002-2005) is reproduced relatively well by the synthetic control. Four OMI zones were selected to reproduce the synthetic control for Legnaia[13], which exhibits a close fit (Table 2).

The effect of the tram line introduction on house prices is positive, as expected, even if small, in the order of 3 per cent (about 85 euros per square meter). This low magnitude could be related, from one side, to the smaller intensity of the treatment, given the modest time gain related to the usage of the tramline; from the other side, it could be due to the strong heterogeneity in the quality of buildings in the area, which could lead to different dynamics in the real estate markets within the same area, thus perturbing the analysis. We observe, finally, in the period just after the treatment, a significant divergence between the actual price level in Legnaia (and also in Isolotto, as will be shown later) its synthetic counterpart. In particular the former, in the first semester after the treatment, increase much less then the latter. This divergence could be related to the severe congestion problems faced by these suburbs at the early stage of the works. This kind of effect, as expected, is much higher in the congested zones at the heart of the tramline route, such as Legnaia and Isolotto, than in the terminus zone of Scandicci.

The evolution of the average house prices in Isolotto (Figure 7) and its synthetic counterpart for the same time period does not demonstrate any price change in the area. The synthetic control for Isolotto is mainly composed of the suburb of Novoli (Table 3), which, in turn, has been involved in the construction of the second tramline of Florence (while the announcement of the third line occurred in 2014, out of our sample). This fact could lead to a downward bias of our estimates, due to the potential increase in prices in Novoli from the work starting of the T2 tramline and the consequent positive shift of the synthetic control for Isolotto. However, the construction of the T2 tram line was announced in 2011, 6 years after the treatment date under analysis. In this period of time the effect on Isolotto was initially slightly negative (might be due to the beginning of the construction works - related congestion shock observed also in Legnaia), remaining stable for the next 4 years, even after the entry into service of the tramline, at a level close to zero. At the beginning of 2011 we observe a slight increase in the synthetic control, possibly related to the T2 announcement, that unfortunately we can

[13] The suburbs of Dalmazia and Bandino, displaying very similar characteristics in terms of income and social structure, accounted for the three quarters of the weight. The remaining weight is mostly related to the suburb of Cupolina, which is close to Legnaia but displays a lower level of income and density and a much higher ratio of immigrants.

Figure 6: Evolution of property values: Legnaia vs synthetic Legnaia

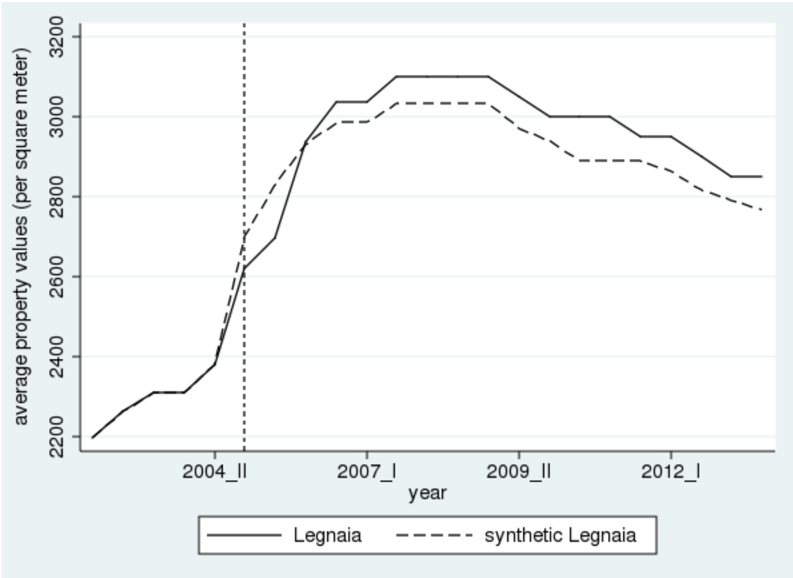
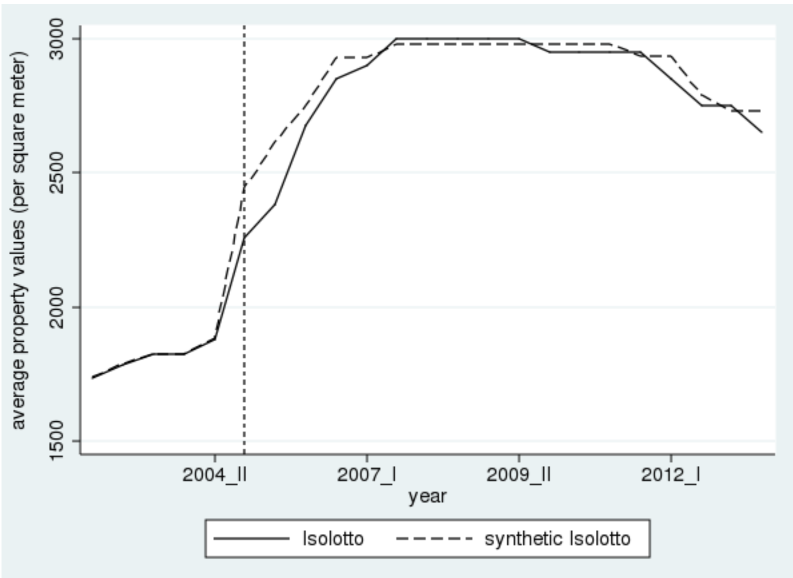


Figure 7: Evolution of property values: Isolotto vs synthetic Isolotto



not follow after 2013 due to a structural break in the data. From the observation of the results, though, the absence of a positive effect for Isolotto appears undisputed and not affected by the T2 effect on Novoli.

For the suburb of Isolotto the treatment is supposed to be very weak due to the much smaller distance to the city center. Moreover, the zone is crossed

Table 2: Property values predictor means in Legnaia

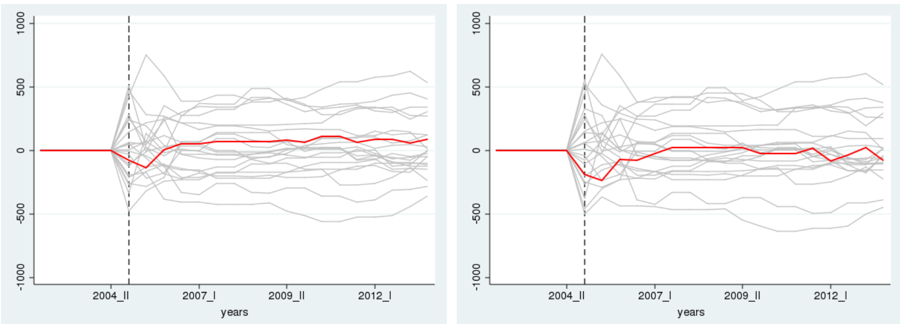
Variables*	**Treated area**	**Synthetic area †**	**Sample average**
housing prices(2003-II)	2310	2309.735	2369.857
housing prices(2004-II)	2380	2379.825	2441.085
pop. density	71.42275	68.02001	70.95665
human capital	0.0860586	0.097676	0.1446846
house concentration	30.30097	30.64539	31.81129
per capita income	17659.74	18034.57	21505.91
share of elderly	0.2508166	0.252998	0.2637407

* Units of measurement: housing prices – €/m^2, population density – inhabitants/hectare, human capital is the share of residents in possession of a university degree, house concentration is the share of dwellings occupied by at least one resident per total surface of the area (in hectares), per capita income – €/inhabitant, share of elderly is the proportion of senior citizens (older than 65) in the population of the area. Population density, human capital, house concentration and the share of elderly are related to the census of 2001 and are thus kept constant over time; while the per capita income is available for 2003, 2004, 2005 and 2013 (where the first three years represent the pre-treatment period while the post-intervention is characterized by the last year). Source: Statistical Service of the Municipality of Florence.

† The synthetic control weights are allocated in the following way: Dalmazia (0.5), Bandino (0.238), Cupolina (0.247), Cascine (0.015).

only marginally by the tramway, with a large part of the area located too far from the stops to exploit the tram line benefits. The covariates exhibit a less precise fit compared to Legnaia (Table 3).

Figure 8: Property values gaps between the real and synthetic counterparts in Legnaia and Isolotto (discards zones with pre-RMSPE five times higher than of the treated area)



The pre-treatment RMSPE, which is the average of the squared discrepancies between the treated area and its synthetic counterpart before the intervention, is satisfactory in Legnaia (a bit higher than one), while it is twice higher in Isolotto. As before, we then conduct a falsification test in

Table 3: Property values predictor means in Isolotto

Variables*	Treated area	Synthetic area †	Sample average
housing prices(2003-II)	1825	1824.44	2369.857
housing prices(2004-II)	1880	1882.04	2441.085
pop. density	108.4333	59.36002	70.95665
human capital	0.0725909	0.1024186	0.1446846
house concentration	47.56549	26.08339	31.81129
per capita income	16060.79	17561.09	21505.91
share of elderly	0.2718984	0.2532454	0.2637407

* Units of measurement: housing prices – €/m^2, population density – inhabitants/hectare, human capital is the share of residents in possession of a university degree, house concentration is the share of dwellings occupied by at least one resident per total surface of the area (in hectares), per capita income – €/inhabitant, share of elderly is the proportion of senior citizens (older than 65) in the population of the area. Population density, human capital, house concentration and the share of elderly are related to the census of 2001 and are thus kept constant over time; while the per capita income is available for 2003, 2004, 2005 and 2013 (where the first three years represent the pre-treatment period while the post-intervention is characterized by the last year). Source: Statistical Service of the Municipality of Florence.

† The synthetic control weights are allocated in the following way: Novoli (0.896), Le Cure (0.104).

space where we reassign artificially the intervention to each unit which have not received the treatment, to assess if the effect estimated for the treated area is large relative to the distribution of the effects for the non treated areas. The placebo tests (Figure 8) show that the increase in prices is not statistical significant at 10 per cent neither in Legnaia (Figure 8, left) nor in Isolotto (Figure 8, right).

3 Robustness check: micro analysis

The synthetic control is a powerful tool which permits the comparison between a treated area and a set of counterfactual units in small sample analysis. However, it presents a drawback in the sense that OMI zones served by the facility are, in general, too wide to permit a valuable access to the tram line. This way, a certain percentage of buildings belonging to the treated areas can not be considered as treated, since they are not located at a walking distance from a tram stop: our estimates could therefore present a downward bias. Moreover, it is not possible to charge different levels of treatment to buildings located at different distance to the stops.

To corroborate our baseline results we perform a robustness analysis by looking at property prices from a different perspective. We estimate an hedonic pricing model using micro data, the standard approach adopted in the literature to evaluate the effect of infrastructure in urban economics[14]. This

[14]For example, Brandt and Maennig (2012) show that railway stations in Hamburg

approach is based on a sample of micro-data on house prices taken from the biggest Italian real estate website, *immobiliare.it*. The dataset is a cross-section composed of 483 geo-referenced selling offers of private apartments in Florence on November 7, 2016, each containing the price and some basic property characteristics of the apartment[15].

This method allows us a more accurate focus on the neighbourhood of the tram line, identifying more precisely the area of treatment. On the other hand, given the absence of a temporal dimension, the analysis suffers of an inherent fragility related to the presence of omitted variables: since it is impossible to control for all the factors influencing property values, if the tram stops were built in strategic locations, more beautiful or characterized by a higher number of amenities, the higher level of prices could be related to this choice and not to the tramline construction. The control variables, indeed, describe perfectly the properties themselves (number of rooms, bathrooms, state of conservation, etc.) but the data could contain an unintended heterogeneity in the external context: there is no way to distinguish between an economic 10 floor building or a fancy 3-floor one and it is hard to control for the attractiveness of particular areas of the sample.

For this reason, we operate a series of exclusions in our sample in order to rule out the most important source of heterogeneity. First of all, we select in our sample only the advertisements related to apartments, removing those about villas or chalet. Secondly, we include in the analysis only dwellings located within 1000 metres from the tram stops. Florence is a very ancient city presenting, even in the same suburb, economic buildings and ancient more fashion premises, blocks located in the hills etc. Choosing advertisements in a wider range around the stops, we would face the risk to compare dis-homogeneous dwellings which would lead to biased results. The distance of 1000 metres, on the contrary, seems reasonable even by on-the-spot visits, confirming that in a similar diameter, all the offers of the sample describe

increase the prices of neighbouring condominiums; Hess and Almeida (2007) find a positive impact of the light rail transit stations on property values in Buffalo, New York; Billings (2011) suggests that the light rail-transit system in Charlotte, North Carolina increases the house values of condominiums to the higher extent than single-family properties; Lewis-Workman and Brod (1997) demonstrate that property values grow nearby the rail stations in several states of the US; Nelson (1992) suggests that in Atlanta, Georgia, transit stations have a positive impact on property values only in lower-income neighbourhoods. Gatzlaff and Smith (1993), on the opposite, demonstrate that there is a very weak evidence of appreciation in real estate values close to the metro rail in the City of Miami.

[15]the dataset is not composed by selling prices but is relative to bids. Following Loberto, Luciani and Pangallo (2017) comparison between the OMI data and the immobiliare.it database, selling prices are similar to bids, less than a 12 per cent average drop that can be interpreted as a discount.

comparable houses[16]. For a similar reason we exclude three of the eleven tram stops used in the previous analysis: one is the Scandicci terminus, due to its proximity to the highway, which reduces the attractiveness of buildings so potentially biasing the results; the other two are stops located closely to the Arno river, characterized by expensive houses and villas very different from the urban context of Legnaia and Isolotto. Finally, we include in the analyses some variables, not available for the the whole sample[17], related to the proximity to parks, schools and supermarkets, in order to partially control for quality heterogeneity linked to the distance from the amenities in the area.

To identify the effect of proximity to the tramline stop, we evaluate around each stop the impact of distance on property values using ten 100-meter-radius circles up to one kilometer. This way a house i, if located between 0 and 100 metres from the nearest stop, will be assigned the distance 100 and so on[18].

To compute the impact of the facility we estimate a diff-in-diff equation by using a standard hedonic model:

$$P_i = \alpha DISTANCE_i + \beta X_i + \gamma TTS + \epsilon_i \tag{3}$$

where P_i is the selling price of the housing unit i, $DISTANCE_i$ is the distance from the property to the closest tram stop (used alternatively with the dummy $living\_far$), TTS (time to Scandicci) measures the time needed to reach the Scandicci terminus from the closest stop, X_i is a vector of structural characteristics of the property i, and ϵ_i is the error term for property i. To ensure a better comparison with the synthetic control estimations we also split our sample into the three OMI areas previously analyzed (Isolotto, Legnaia and Scandicci Center). In the regression we control for the following structural characteristics: surface, number of bathrooms, number of rooms and the property conditions (which is a categorical variable of four states of

[16]To increase the homogeneity of the sample, we also exclude from the analysis a historical suburb in the Isolotto area, built in the fifties and exhibiting a different quality with respect to standard buildings of the area, built in the seventies and eighties. We also discard the part of Scandicci south of *via di Scandicci*, characterized by small houses in the hills, not comparable with the standard buildings of the central part.

[17]These variables are available only for the observations with a complete set of information about the address.

[18]The use of 100 meter circles is motivated by the impossibility to assign to each dwelling the exact distance from the stop, given that we have not houses coordinated for each advertisement; the only way to assign a distance to a house is to extract all the real estate offers within a pre-defined range (the circles) assigning to all the advertisements in that set the same distance. Each advertisement has a serial number too, so we were able to avoid duplicates.

a property[19]). Finally, we include in the estimates the variable TTS (time to Scandicci), measuring to number of minutes the tram takes to reach the Scandicci terminus: this variable, which is invariant to tram stops, permits to estimate differences in house prices related to tram stop position, which in turn is related to the intensity of the treatment.

In addition to the specification containing the linear (measure of distance, we estimate also the model introducing a dummy variable measuring the impossibility to reach the tram walking; it is called $living\_far$, and it is equal to one if the house is located at more than 600 meters to the closest tram stop and zero otherwise[20].

Table 4: Estimation results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All sample	All sample	Scandicci	Scandicci	Legnaia	Legnaia	Isolotto	Isolotto
	price/m^2	price/m^2	price/m^2	price/m^2	price/m^2	price/m^2	price/m^2	price/m^2
distance	-0.259***		-0.702***		-0.320*		-0.00159	
	(0.0957)		(0.168)		(0.173)		(0.138)	
$living\_far$		-145.5***		-341.8***		-100.4		-5.264
		(48.40)		(87.72)		(74.26)		(83.32)
TTS	0.665	2.058	-3.492	-9.761	51.52***	57.02***	-57.51	-58.02
	(5.875)	(5.739)	(43.73)	(48.08)	(18.00)	(17.59)	(65.63)	(64.51)
size	-9.449***	-9.296***	-12.81***	-13.15***	-5.123**	-5.107**	-13.28***	-13.27***
	(1.727)	(1.716)	(3.383)	(3.400)	(2.372)	(2.371)	(2.902)	(2.883)
bathrooms	334.8***	327.8***	248.3**	260.2**	274.1***	257.4***	353.6***	353.7***
	(56.46)	(56.70)	(103.2)	(106.3)	(75.77)	(78.20)	(87.62)	(88.25)
rooms	42.56	43.30	125.7**	125.9**	-14.59	-9.564	152.9**	152.4**
	(39.98)	(39.31)	(51.68)	(50.67)	(63.72)	(62.95)	(72.53)	(73.26)
condition_good	317.0***	316.3***	299.1***	339.9***	406.0***	373.7***	222.4**	222.2**
	(68.43)	(69.26)	(103.7)	(108.6)	(133.8)	(131.3)	(87.01)	(87.04)
condition_perfect	502.0***	498.7***	518.8***	522.1***	536.0***	504.5***	479.3***	478.0***
	(65.13)	(65.92)	(109.3)	(116.4)	(131.2)	(127.9)	(91.62)	(90.14)
condition_new	1111.2***	1094.5***	1291.2***	1256.0***	1142.1***	1115.3***	991.4***	990.4***
	(98.20)	(97.98)	(166.3)	(168.4)	(165.7)	(164.0)	(156.0)	(156.1)
Observations	483	483	133	133	223	223	127	127
Adjusted R^2	0.363	0.365	0.477	0.476	0.299	0.293	0.347	0.347

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4 shows the results for private apartments for the total sample and for the each single OMI area considered in the previous macro approach. The average effect across the whole sample amounts to an increase of 26 euros per square meter for every 100 metres nearer to the tram stop. The results concerning the OMI areas are in line with our previous findings: the average

[19]The categorical variable divides the properties that need to be restored, those habitable, in excellent conditions and new.

[20]600 metres is the distance covered in 10 minutes by walking at a moderate speed of 4 km/h (since we can assign only the distance every 100 metres); we experimented with various "proximity" combinations (within 500 metres and 700 metres) and they produce very similar result.

Table 5: Estimation results

	(1) price/m^2	(2) price/m^2	(3) price/m^2	(4) price/m^2	(5) price/m^2	(6) price/m^2
distance		-0.974***		-0.385***		-0.928***
		(0.184)		(0.115)		(0.221)
$living\_far$	-390.5***		-168.1***		-301.4**	
	(86.86)		(59.08)		(120.8)	
TTS	-9.247	-50.73***			-36.26**	-72.96***
	(6.892)	(13.36)			(15.85)	(17.09)
TTS_{far}	40.31***				22.09	
	(12.15)				(14.90)	
$TTS_{distance}$		0.101***				0.0827***
		(0.0220)				(0.0276)
size	-9.471***	-9.439***	-8.939***	-9.034***	-9.120***	-9.323***
	(1.694)	(1.704)	(1.863)	(1.847)	(1.884)	(1.869)
bathrooms	331.0***	334.9***	282.1***	293.3***	284.9***	294.6***
	(56.22)	(54.89)	(65.23)	(64.91)	(65.47)	(64.38)
rooms	52.88	51.34	63.79*	59.69	67.07*	67.41*
	(37.75)	(38.41)	(37.31)	(38.21)	(37.15)	(37.97)
condition_good	316.1***	317.8***	228.4***	232.5***	233.3***	242.1***
	(67.90)	(66.42)	(78.12)	(77.08)	(77.73)	(75.43)
condition_perfect	508.3***	523.0***	448.5***	446.2***	460.4***	476.8***
	(64.39)	(63.22)	(77.47)	(76.64)	(77.19)	(75.46)
condition_new	1104.8***	1138.6***	1074.1***	1091.1***	1089.3***	1122.5***
	(95.04)	(94.87)	(119.8)	(119.3)	(119.6)	(118.6)
dist_school			-2.221	-2.024	-2.144	-2.128
			(1.878)	(1.831)	(1.885)	(1.838)
dist_supermarket			0.768	1.182	0.502	0.416
			(1.223)	(1.242)	(1.229)	(1.270)
dist_park			-1.478***	-1.805***	-1.214*	-1.162*
			(0.560)	(0.546)	(0.628)	(0.615)
Observations	483	483	355	355	355	355
Adjusted R^2	0.378	0.386	0.395	0.399	0.397	0.410

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

effect of an increase of the distance from the tram stop by 100 meters is a drop of 70 euros per square meter in the area of Scandicci Center. This effect is sizable also in Legnaia (32 euros, borderline significant) while it is negligible in Isolotto.

Looking at the overall effect of living beyond the walking distance (more than 600 metres from the tram stop) we observe a drop in prices of 146 euros per square meter in contrast to those who live within 600 metres from the tram. In Scandicci this value reaches 342 euros per square metre. Again, Legnaia presents a smaller price premium, equal to 100 euros (not significantly different from zero at the 5 per cent) while Isolotto demonstrates stability in property values with respect to the presence of the tram line.

Our findings are quite robust to different specifications. Analyzing houses located within 500 and 700 meters from the stop produces very similar results.

Even including the dis-homogeneous areas in the sample, namely analyzing properties without excluding hilly more expensive districts, leads to results that are qualitatively unchanged but present smaller coefficients, since the sample comprises houses contextually very different from the average properties in the area.

In order to exploit the information we have about the total commuting journey, i.e. the distance from the house to the stop plus the time to get by tram to the centre of Florence, we estimate also the following equation:

$$P_i = \alpha DISTANCE_i + \beta X_i + \gamma TTS + \delta TTS\_DISTANCE_i + \epsilon_i \qquad (4)$$

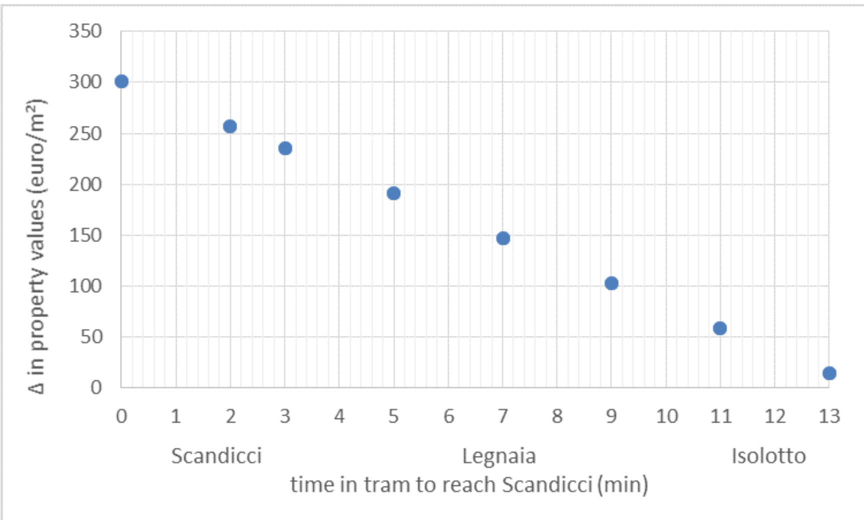
where the variables TTS_{far} and $TTS_{distance}$ (inserted respectively in columns 1 and 2) represent the interaction of the variable TTS with the $DISTANCE$ and the $living\_far$ variables, estimating the presence of a decreasing effect of distance on prices. We include the interaction together with the TTS variable, accounting for structural differences in each stop area. The results, presented in Table 5, show that staying far from the tram stop (700-1000 meters) decreases on average the value of a house by almost 400 euros per square meter in the Scandicci terminus, with a decrease in absolute value of the effect 40 euros for each minute of tram journey toward the centre. This result supports the macro analysis findings, confirming that the effect on prices of the tramline is maximum for the areas that experiment an harder treatment (close to the Scandicci terminus and far from the centre); the premium associated with the access to the public transit is then declining the closer we get to the city centre, because the time saved due to the tramline is smaller.

This relation is presented in Figure 9: the first three values are related to Scandicci (zero is associated with houses in proximity to the last stop analyzed – De Andrè, 2 and 3 with the two following stops), the following three represent property values in Legnaia and the last two (11 minutes and 13 minutes from the terminus) describe the time needed to reach from the Scandicci terminus the two stops located in Isolotto. One can notice, with the approximation given by the use of a linear relation, the clear tendency of the price premium related to the tram line proximity to decrease when moving towards the city center. The fifth column of Table 5 supports this pattern.

In the last four columns of table 5 we propose the same analysis with the inclusion of three variables related to the proximity of each building from the closest school, supermarket and park. Given that we need exact information on the building address to compute these variables, the analysis has to be restricted to the three quarter of the sample, thus lowering the significance of the estimation and hindering the splitting analysis in the three OMI zones. However, including these variables we are able to partially control for the heterogeneity in the attractiveness of the zones along the way of the tramline, mitigating the potential bias due to omitted variables. The results highlight that house prices are inversely related to the distance from schools and, especially, from parks. Once we control for these characteristics, the quality of the results remains unchanged, thus confirming the robustness of the analysis.

Summing up, we conclude that the results from the micro estimations highlighted in this paragraph, although derived by an extremely different approach (in terms of time span, methodology, house locations) present results that are qualitatively identical to those of the previous analysis: the price effect does exists and its magnitude follows the intensity of the treatment. Moreover, the micro estimates seem to operate a correction of the downward bias of the previous approach, by exhibiting in all areas price effects higher in magnitude. Finally, the micro analysis uncovers the presence of a sizable price effect even in Legnaia, whose results, in the previous analysis, were probably affected by the wideness of the zone.

Figure 9: Change in housing prices (per square meter) with respect to journey time from the Scandicci terminus



3.1 An estimate of the return on investment

As mentioned before, the total expense for the tram line amounted to 264.9 million of euros, financed by national and regional funds, and by the municipalities interested in the transit. It thus might be useful to verify how the investment of the government was absorbed as a private surplus. It has to be noticed that the increase in property prices should account for the overall increase in utility of the infrastructure, included the benefits in terms of pollution and decrease in probability to have accidents, but the rise in housing prices does not include the positive externalities of these benefits on the rest of population in Florence and contiguous districts.

If we compute the jump in the value of the properties considering only the price increase of Scandicci (the one area exhibiting a significant effect in the macro approach), the total rise due to the tramline construction reaches 264.5 million of euros[21]. Adding also the effect on Legnaia, which appears to be significant in the micro analysis, the overall private effect rises at 320 million euros, with a surplus of about 20 per cent of the construction costs. Using the results from the micro analysis, the private benefits are not so different, equal to 275 million of euros[22]. Thus, the average private benefits appear to be in line with the amount of funds spent.

Since the tramline redistributes the public funds to the residents of Scandicci and Legnaia, the results could be relevant in the discussion on the reform of the cadastral values for Italian properties, in the way of a redistribution of benefits by an increase in the property taxes in the treated area.

4 Public externalities

Apart from the private benefits induced by the jump of real estate values, the positive shock in the public transportation capacity is expected to produce important positive public externalities. Tramways and railroads, indeed, are considered to have favorable environmental characteristics and this is the reason why many governments and local authorities subsidize public transit[23]. Given these premises, after the launch of the tramway we expect areas

[21] Calculated as number of residential houses in Scandicci Center area multiplied by average surface (both taken from census data, 2001) and by the price increase of a properties (average from second semester of 2005 till 2013).

[22] First the proportion of Scandicci Center and Legnaia surface covered by the 600m-radius circles is calculated and is then multiplied by number of residential houses, by average surface and by the price increase of each area, summed up afterwards.

[23] For instance, Lalive et al. (2013) demonstrate a strong decrease in severe road accidents as the German regional passenger railway service increases. Green et al. (2014)

in proximity to the new transit to experience a reduction in car and bus circulation, leading to an increase in safety and to a favorable evolution of environmental quality.

4.1 Car accidents

Data on motor vehicle accident counts are obtained from the municipality of Florence, producing statistics on the number of accidents for each street of the city in the period 2009-2011. We restrict our sample to the streets which counted at least 10 car accidents in 2009 (111 streets), thus focusing on high risk areas. The dataset refers to total yearly accidents regardless of their severity (accidents which caused no damages or injuries are also included in the study). For each street exhibiting an accident occurrence we consider its central point and we then compute the average distance to the nearest tram stop. The streets are considered "treated" (or "in proximity") if they are situated within the area delimited by the two principal roads leading to the city center from west (Figure 10)[24]. Since the tram was launched in February 2010 we conduct a fixed effect regression on a panel of streets excluding 2010 and just considering 2009 and 2011. The effect of the tram line on car accidents is identified using the following estimation:

$$prox_i = 1\big[\text{street i in proximity of tram}\big] \tag{5}$$

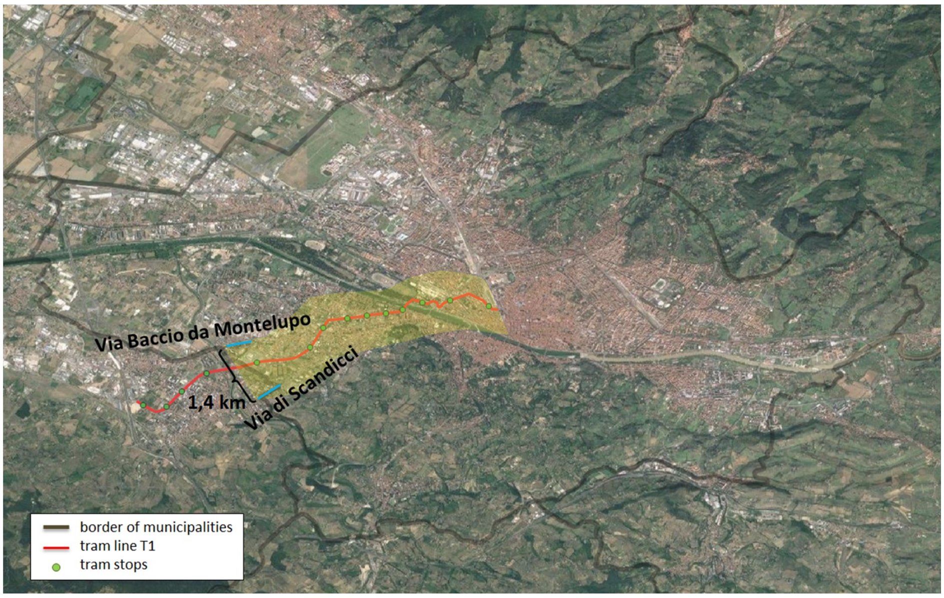
$$acc_{it} = \alpha_i + \beta_1 1\big[year = 2011\big]_{it} + \beta_2 1\big[year = 2011\big]_{it} * prox_i + \epsilon_{it} \tag{6}$$

where acc_{it} is number of accidents on street i at time t and $prox_i$ is a dummy equal to one if the street i lies in the proximity of the tram line. The equation

evaluate the impact of central London congestion charges on traffic accidents using the synthetic control method. A growing body of literature has attempted to evaluate the effect of public transit on air quality as well. Lalive et al. (2013) show an increase in air quality related to the development of the German railway service. Chen and Whalley (2012) demonstrate that the introduction of a new metro system in Taipei in 1996 led to a significant reduction of CO emissions. Goel and Gupta (2013) find that the Delhi Metro reduced the carbon monoxide emissions by one third in the treated period. Bel and Holst (2015) find a significant reduction of the majority of pollutants as a consequence of the introduction of bus rapid transit in Mexico City.

[24]The area under analysis could be covered by the area between the two principal roads parallel to the tramline, via di Scandicci and via Baccio da Montelupo; however, this area tends to narrow going towards the city center, becoming negligible after about 3 kilometers; for this reason we obtain the area of interest by projecting towards the city center the distance measured between these two streets in the western border of the Florence district, where it is equal to 1.4 kilometers; therefore, we compute a 700 meters range around the tramway to account for the treatment. Experiments with other "proximity" combinations produce similar results.

Figure 10: Treated streets of the municipality of Florence



can be further simplified and estimated:

$$acc_{it} = \beta_0 + \beta_1 prox_i + \beta_2 1\left[year = 2011\right]_{it} + \beta_3 1\left[year = 2011\right]_{it} * prox_i + \epsilon_{it} \quad (7)$$

Table 6 shows that, after the new tram line started operating, one can observe an average reduction of car accidents in the surrounding streets by 3 accidents, which is statistically significant and accounts for a bit less than 1/6 of total accidents of 2011.

4.2 Air quality

Air quality in Toscany is recorded by the regional agency of environmental protection (ARPAT). Established in 1996, ARPAT monitors stations distributed throughout the region. Concerning air quality, the network reports hourly and daily measurements of the main pollutants. Due to the character and the availability of the data we focus our analysis on the particulate matter (PM_{10}), indicated by several publications as one of the principal causes of respiratory diseases due to its ability to penetrate deep into human body with the air[25]. The pollutant annual average limit values based on the EU

[25] Arceo-Gomez et al. (2012) demonstrate that a 1 $\mu g/m^3$ (1.5 percent) increase in particulate matter (PM_{10}) is associated with 0.24 more infant deaths per 100,000 births. Guttikunda and Goel (2013) find that particulate matter present in Delhi in 2010 caused from 7,350 to 16,200 premature deaths per year and around 6 million asthma attacks per year.

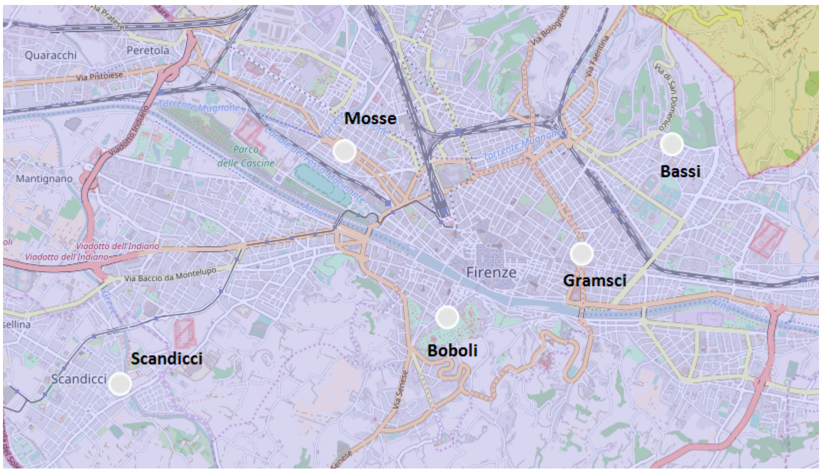
Table 6: Estimation results

	(1) accidents
streets in proximity	-3.151**
	(1.539)
year 2011	-3.284***
	(0.700)
constant	22.78***
	(0.441)
Observations	222
Groups	111

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Air Quality Directive (2008/50/EC) should not exceed 40 μg/m^3, while the recommendations of the World Health Organization[26] is to keep the limit value around 20 μg/m^3.

Figure 11: ARPAT monitoring stations of Florence and Scandicci



The ARPAT has five monitoring stations located in the municipalities of Florence and Scandicci (Figure 11) which allow us to compare the results of the "treated" Scandicci station with the remaining four control stations, not affected by the tramway route. To analyse the impact of the infrastructure

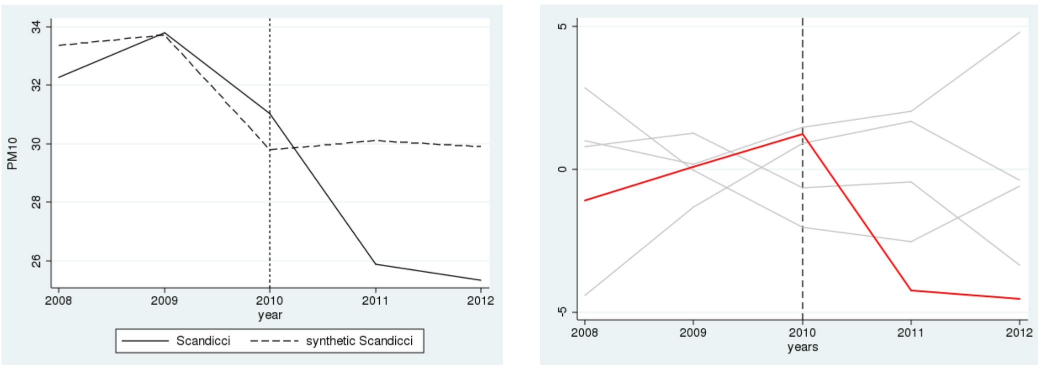
[26] *Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide. Global update 2005. Summary of risk assessment.*, World Health Organization, 2005.

on the particulate matter emissions we apply again the synthetic control method. Although there are several works on the environmental effects of various events and policies[27], to our knowledge, this tool has not been yet applied to the pollution studies related to public transport.

To perform the synthetic control method we use as predictors the lagged PM_{10} 2009 level and the values of NO_2. Even though the PM_{10} pollutant is measured daily and the values of NO_2 are measured every hour, we average the data to annual basis for seasonality reasons. Both variables are averaged across the whole pre-treatment period. The period 2008-2012 is analysed (2 years prior to the introduction of the tram line and 2 years afterwards). To avoid the strong seasonality in pollution indexes the data was converted to the annual basis.

The synthetic control algorithm assigned positive weights to the stations of Boboli (0.43) and Mosse (0.57) which are the closest to the Scandicci monitoring station. Figure 12 (a) demonstrates the evolution of PM_{10} values in Scandicci and its synthetic counterpart. One can notice that from the year 2011 the area of Scandicci registers a reduction of the particulate matter of 10% (by 4.4 μg $/m^3$) compared to its synthetic counterpart. Figure 12 (b) reflects the PM_{10} gaps between the real and synthetic area in both Scandicci and the four placebo control stations of Florence. The "in-space" placebo test shows that the PM_{10} values of Scandicci are the lowest compared to the distribution of placebo estimates in the donor pool.

Figure 12: Synthetic control estimations of the air quality



(a) (b)

[27]Zhang et al. (2016) applied the synthetic control method to evaluate the impact of the 2008 Olympic Games on Beijing's air quality. Percoco (2015) uses a similar approach to estimate the impact of road pricing enforcement in Milan on the traffic flows.

5 Conclusion

This paper analyses the existence of private and public benefits related to the implementation of a new tram line in Florence in 2010. In our empirical analysis we apply two different approaches, each with strengths and critical points, in order to achieve an all-round investigation of the phenomenon. Our baseline estimation apply the synthetic control methodology to a sample of house prices related to micro-zones situated in the municipalities of interest; as a robustness test we estimate an hedonic pricing model using data on individual apartment price bids downloaded from one of the top estate agencies in Italy. In our macro estimation we observe, in the areas crossed by the tram line, a significant increase in house prices starting from 2005, the year when the construction process started. The jump in prices, as expected, is graduated as a function of the intensity of the tram line treatment: it is maximum in Scandicci (about 200 euro per square meter, the 8 per cent of the synthetic control value), far from the city center terminus, where the benefits of the time saved due to the infrastructure are higher; the effect decreases and becomes less significant approaching the city center, and vanishes completely close to the Arno river, where the gain of using the tram line is negligible. Findings from the micro estimation corroborates these results, with some minor differences in the magnitude of the effect.

The study also analyses the entity of public externalities associated with the introduction of the tram line, namely the decreased number of car accidents and the increased air quality. According to our findings, after the T1 tram line started operating we observe an average reduction of car accidents of one sixth in the surrounding streets; other results suggest that, starting from 2011, in the area of Scandicci there was a decline of the particulate matter (PM_{10}) pollutant of 10%.

The results of the study are especially important for the city of Florence for a couple of reasons: firstly, the peculiarity and the artistic constraints of a city like Florence, the reduced mobility of people and the stickiness of prices made it not obvious a significant economic impact of the facility, in terms of private benefits resumed by house price increase. Moreover, the relevance of these results is amplified by the fact that the T1 tramline is only the first step of a more ambitious project aiming at enhancing the public transport facilities in the Florence area.

References

[1] Abadie A. and Gardeazabal J., *The economic costs of conflict: a case study of the Basque country*, The American Economic Review 93(1), pp. 113-132, 2003.

[2] Abadie A., Diamond A. and Hainmueller J., *Synthetic control methods for comparative case studies: estimating the effect of California's Tobacco control program*, Journal of the American Statistical Association 105 (490), pp. 493-505, 2010.

[3] Abadie A., Diamond A. and Hainmueller J., *Comparative politics and the synthetic control method*, American Journal of Political Science 59(2), pp. 495-510, 2015.

[4] Agostini C.A. and Palmucci G. A., *The anticipated capitalisation effect of a new metro line on housing prices*, Fiscal studies 29(2), pp. 233-256, 2008.

[5] Allegretto S. A., Dube A., Reich M. and Zipperer B. *Credible Research Designs for Minimum Wage Studies: A Response to Neumark, Salas and Wascher* ILR Review 70(3), pp. 559-592, 2017.

[6] Ando M., *Dreams of urbanization: quantitative case studies on the local impacts of nuclear power facilities using the synthetic control method*, Journal of Urban Economics 85, pp. 68-85, 2015.

[7] Arceo-Gomez E. O., Hanna R., Oliva P., *Does the effect of pollution on infant mortality differ between developing and developed countries? Evidence from Mexico City*, National Bureau of Economic Research, Working Paper n.18349, 2012.

[8] Bae C., Jun M. and Park H., *The impact of Seoul's subway line 5 on residential property values*, Transport Policy 10 (2), pp. 85-94, 2003.

[9] Bel G. and Holst M., *Evaluation of the impact of bus rapid transit on air pollution*, Research Institute of Applied Economics, Working paper 2015/19, 1/43, 2015.

[10] Billings S. B., *Estimating the value of a new transit option*, Regional Science and Urban Economics 41, pp. 525-536, 2011.

[11] Brandt S. and Maennig W., *The impact of rail access on condominium prices in Hamburg*, Transportation 39, pp. 997-1017, 2012.

[12] Carling K. and Li Y., *The power of the synthetic control method*, Working papers in transport, tourism, information technology and microdata analysis, 2016.

[13] Chen, Y., and Whalley, A., *Green infrastructure: the effects of urban rail transit on air quality*, American Economic Journal: Economic Policy 4(1), pp. 58-97, 2012.

[14] Coffman, C. and Gregson, M. E., *Railroad development and land value*, The journal of real estate finance and economics, 16(2), pp. 191-204, 1998.

[15] Combes, P.F. Duranton, G., Gobillon, L., Puga, D. and Sbastien, R., *The Productivity Advantages of Large Cities: Distinguishing Agglomeration From Firm Selection*, Econometrica, 80(6), pp. 2543-94, 2012.

[16] Debrezion, G., Pels, E., Rietveld, P., *The impact of railway stations on residential and commercial property value: a meta-analysis.*, The Journal of Real Estate Finance and Economics 35(2), pp. 161-180, 2007.

[17] Ganesan S., So H.M. and Tse R.Y.C., *Estimating the influence of transport on house prices: evidence from Hong Kong*, Journal of Property Valuation and Investment 15(1), pp. 40-47, 1997.

[18] Gatzlaff D. H. and Smith M. T., *The impact of the Miami Metrorail on the value of residences near station locations*, Land Economics 69(1), pp. 54-66, 1993.

[19] Goel D. and Gupta S., *The effect of metro rail on air pollution in Delhi*, Centre for Development Economics, Department of Economics, Delhi School of Economics, Working paper n.229, 2013.

[20] Green C. P., Heywood J. S. and Navarro M., *Traffic accidents and the London congestion charge*, Lancaster University Economics Working Paper series, 2014/015, 2014.

[21] Guttikunda, S. K. and Goel R., *Health impacts of particulate pollution in a mega-city — Delhi, India*, Environmental Development 6, pp. 8-20, 2013.

[22] Hennebery J., *Transport investment and house prices*, Journal of Property Valuation and Investment 16(2), pp. 144-158, 1998.

[23] Hess D. B., and Almeida T. M., *Impact of proximity to light rail rapid transit on station-area property values in Buffalo, New York*, Urban Studies 44(5/6), pp. 1041-1068, 2007.

[24] Hsieh, C.T. and Moretti, E., *Why Do Cities Matter? Local Growth and Aggregate Growth*, National Bureau of Economic Research, Working Paper n.21154, 2015.

[25] Kohlhase J. E., *The impact of toxic waste sites on housing values*, Journal of Urban Economics 30, pp. 1-26, 1991.

[26] Lalive R., Luechinger S. and Schmutzler A., *Does supporting passenger railways reduce road traffic externalities?*, University of Zurich, Working Paper No. 110, 2013.

[27] Lewis-Workman S. and Brod D., *Measuring the neighborhood benefits of rail transit accessibility*, Transportation Research Record Journal 1576(1), pp. 147-153, 1997.

[28] Loberto M., Luciani A. and Pangallo M., *The potential of big housing data: an application to the Italian real-estate market*, Banca d'Italia, mimeo, 2017.

[29] McDonald J.F. and Osuji C.I., *The effect of anticipated transportation improvement on residential land values*, Regional Science and Urban Economics 25, pp. 261-278, 1995.

[30] Munasib A. and Rickman D. S., *Regional economic impacts of the shale gas and tight oil boom: a synthetic control analysis*, Regional Science and Urban Economics 50, pp. 1-17, 2015.

[31] Nelson A. C., *Effects of elevated heavy rail transit stations on house prices with respect to neighborhood income*, Transportation Research Record 1359, pp. 127-132, 1992.

[32] Percoco, M., *Heterogeneity in the reaction of traffic flows to road pricing: a synthetic control approach applied to Milan*, Transportation 42(6), pp. 1063-1079, 2015.

[33] Wadu M. J., Lam T.I. and Chong M.I., *The impact of anticipated transport improvement on property prices: a case study in Hong Kong*, Habitat International 49, pp. 148-156, 2015.

[34] Yan S., Delmelle, E. and Duncan, M., *The impact of a new light rail system on single-family property values in Charlotte, North Carolina*, Journal of Transport and Land Use 5(2), pp. 60-67, 2012.

[35] Yiu C.Y. and Wong S.K., *The effects of expected transport improvements on housing prices*, Urban Studies 42(1), pp. 113-125, 2005.

[36] Zhang, J., Zhong, C. and Yi, M., *Did Olympic Games improve air quality in Beijing? Based on the synthetic control method.*, Environmental Economics and Policy Studies 18(1), pp. 21-39, 2016.

[37] Zhao Q., Simons R. A., Li-jun F. and Fen Z., *The effect of the Nengda incineration plant on residential property values in Hangzhou, China*, Journal of Real Estate Literature 24(1), pp. 85-102, 2016.

RECENTLY PUBLISHED "TEMI" (*)

N. 1139 – *Credit misallocation during the European financial crisis*, by Fabiano Schivardi, Enrico Sette and Guido Tabellini (September 2017).

N. 1140 – *Natural rates across the Atlantic*, by Andrea Gerali and Stefano Neri (September 2017).

N. 1141 – *A quantitative analysis of risk premia in the corporate bond market*, by Sara Cecchetti (October 2017).

N. 1142 – *Monetary policy in times of debt*, by Mario Pietrunti and Federico M. Signoretti (October 2017).

N. 1143 – *Capital misallocation and financial development: a sector-level analysis*, by Daniela Marconi and Christian Upper (October 2017).

N. 1144 – *Leaving your mamma: why so late in Italy?*, by Enrica Di Stefano (October 2017).

N. 1145 – *A Financial Conditions Index for the CEE economies*, by Simone Auer (October 2017).

N. 1146 – *Internal capital markets in times of crisis: the benefit of group affiliation in Italy*, by Raffaele Santioni, Fabio Schiantarelli and Philip E. Strahan (October 2017).

N. 1147 – *Consistent inference in fixed-effects stochastic frontier models*, by Federico Belotti and Giuseppe Ilardi (October 2017).

N. 1148 – *Investment decisions by European firms and financing constraints*, by Andrea Mercatanti, Taneli Mäkinen and Andrea Silvestrini (October 2017).

N. 1149 – *Looking behind the financial cycle: the neglected role of demographics*, by Alessandro Ferrari (December 2017).

N. 1150 – *Public investment and monetary policy stance in the euro area*, by Lorenzo Burlon, Alberto Locarno, Alessandro Notarpietro and Massimiliano Pisani (December 2017).

N. 1151 – *Fiscal policy uncertainty and the business cycle: time series evidence from Italy*, by Alessio Anzuini, Luca Rossi and Pietro Tommasino (December 2017).

N. 1152 – *International financial flows and the risk-taking channel*, by Pietro Cova and Filippo Natoli (December 2017).

N. 1153 – *Systemic risk and systemic importance measures during the crisis*, by Sergio Masciantonio and Andrea Zaghini (December 2017).

N. 1154 – *Capital controls, macroprudential measures and monetary policy interactions in an emerging economy*, by Valerio Nispi Landi (December 2017).

N. 1155 – *Optimal monetary policy and fiscal policy interaction in a non-Ricardian economy*, by Massimiliano Rigon and Francesco Zanetti (December 2017).

N. 1156 – *Secular stagnation, R&D, public investment and monetary policy: a global-model perspective*, by Pietro Cova, Patrizio Pagano, Alessandro Notarpietro and Massimiliano Pisani (December 2017).

N. 1157 – *The CSPP at work: yield heterogeneity and the portfolio rebalancing channel*, by Andrea Zaghini (December 2017).

N. 1158 – *Targeting policy-compliers with machine learning: an application to a tax rebate programme in Italy*, by Monica Andini, Emanuele Ciani, Guido de Blasio, Alessio D'Ignazio and Viola Salvestrini (December 2017).

N. 1159 – *Banks' maturity transformation: risk, reward, and policy*, by Pierluigi Bologna (December 2017).

N. 1160 – *Pairwise trading in the money market during the European sovereign debt crisis*, by Edoardo Rainone (December 2017).

(*) Requests for copies should be sent to:
Banca d'Italia – Servizio Studi di struttura economica e finanziaria – Divisione Biblioteca e Archivio storico – Via Nazionale, 91 – 00184 Rome – (fax 0039 06 47922059). They are available on the Internet www.bancaditalia.it.

2015

AABERGE R. and A. BRANDOLINI, *Multidimensional poverty and inequality,* in A. B. Atkinson and F. Bourguignon (eds.), Handbook of Income Distribution, Volume 2A, Amsterdam, Elsevier, **TD No. 976 (October 2014).**

ALBERTAZZI U., G. ERAMO, L. GAMBACORTA and C. SALLEO, *Asymmetric information in securitization: an empirical assessment*, Journal of Monetary Economics, v. 71, pp. 33-49, **TD No. 796 (February 2011).**

ALESSANDRI P. and B. NELSON, *Simple banking: profitability and the yield curve,* Journal of Money, Credit and Banking, v. 47, 1, pp. 143-175, **TD No. 945 (January 2014).**

ANTONIETTI R., R. BRONZINI and G. CAINELLI, *Inward greenfield FDI and innovation,* Economia e Politica Industriale, v. 42, 1, pp. 93-116, **TD No. 1006 (March 2015).**

BARONE G. and G. NARCISO, *Organized crime and business subsidies: Where does the money go?,* Journal of Urban Economics, v. 86, pp. 98-110, **TD No. 916 (June 2013).**

BRONZINI R., *The effects of extensive and intensive margins of FDI on domestic employment: microeconomic evidence from Italy*, B.E. Journal of Economic Analysis & Policy, v. 15, 4, pp. 2079-2109, **TD No. 769 (July 2010).**

BUGAMELLI M., S. FABIANI and E. SETTE, *The age of the dragon: the effect of imports from China on firm-level prices*, Journal of Money, Credit and Banking, v. 47, 6, pp. 1091-1118, **TD No. 737 (January 2010).**

BULLIGAN G., M. MARCELLINO and F. VENDITTI, *Forecasting economic activity with targeted predictors,* International Journal of Forecasting, v. 31, 1, pp. 188-206, **TD No. 847 (February 2012).**

BUSETTI F., *On detecting end-of-sample instabilities,* in S.J. Koopman, N. Shepard (eds.), Unobserved Components and Time Series Econometrics, Oxford, Oxford University Press, **TD No. 881 (September 2012).**

CESARONI T., *Procyclicality of credit rating systems: how to manage it,* Journal of Economics and Business, v. 82. pp. 62-83, **TD No. 1034 (October 2015).**

CIARLONE A., *House price cycles in emerging economies,* Studies in Economics and Finance, v. 32, 1, **TD No. 863 (May 2012).**

CUCINIELLO V. and F. M. SIGNORETTI, *Large bank, loan rate markup and monetary policy,* International Journal of Central Banking, v. 11, 3, pp. 141-177, **TD No. 987 (November 2014).**

DE BLASIO G., D. FANTINO and G. PELLEGRINI, *Evaluating the impact of innovation incentives: evidence from an unexpected shortage of funds,* Industrial and Corporate Change, v. 24, 6, pp. 1285-1314, **TD No. 792 (February 2011).**

DEPALO D., R. GIORDANO and E. PAPAPETROU, *Public-private wage differentials in euro area countries: evidence from quantile decomposition analysis,* Empirical Economics, v. 49, 3, pp. 985-1115, **TD No. 907 (April 2013).**

DI CESARE A., A. P. STORK and C. DE VRIES, *Risk measures for autocorrelated hedge fund returns,* Journal of Financial Econometrics, v. 13, 4, pp. 868-895, **TD No. 831 (October 2011).**

FANTINO D., A. MORI and D. SCALISE, *Collaboration between firms and universities in Italy: the role of a firm's proximity to top-rated departments,* Rivista Italiana degli economisti, v. 1, 2, pp. 219-251, **TD No. 884 (October 2012).**

FRATZSCHER M., D. RIMEC, L. SARNOB and G. ZINNA, *The scapegoat theory of exchange rates: the first tests,* Journal of Monetary Economics, v. 70, 1, pp. 1-21, **TD No. 991 (November 2014).**

NOTARPIETRO A. and S. SIVIERO, *Optimal monetary policy rules and house prices: the role of financial frictions,* Journal of Money, Credit and Banking, v. 47, S1, pp. 383-410, **TD No. 993 (November 2014).**

RIGGI M. and F. VENDITTI, *The time varying effect of oil price shocks on euro-area exports,* Journal of Economic Dynamics and Control, v. 59, pp. 75-94, **TD No. 1035 (October 2015).**

TANELI M. and B. OHL, *Information acquisition and learning from prices over the business cycle,* Journal of Economic Theory, 158 B, pp. 585–633, **TD No. 946 (January 2014).**

2016

ALBANESE G., G. DE BLASIO and P. SESTITO, *My parents taught me. evidence on the family transmission of values,* Journal of Population Economics, v. 29, 2, pp. 571-592, **TD No. 955 (March 2014).**

ANDINI M. and G. DE BLASIO, *Local development that money cannot buy: Italy's Contratti di Programma,* Journal of Economic Geography, v. 16, 2, pp. 365-393, **TD No. 915 (June 2013).**

BARONE G. and S. MOCETTI, *Inequality and trust: new evidence from panel data,* Economic Inquiry, v. 54, pp. 794-809, **TD No. 973 (October 2014).**

BELTRATTI A., B. BORTOLOTTI and M. CACCAVAIO, *Stock market efficiency in China: evidence from the split-share reform,* Quarterly Review of Economics and Finance, v. 60, pp. 125-137, **TD No. 969 (October 2014).**

BOLATTO S. and M. SBRACIA, *Deconstructing the gains from trade: selection of industries vs reallocation of workers,* Review of International Economics, v. 24, 2, pp. 344-363, **TD No. 1037 (November 2015).**

BOLTON P., X. FREIXAS, L. GAMBACORTA and P. E. MISTRULLI, *Relationship and transaction lending in a crisis*, Review of Financial Studies, v. 29, 10, pp. 2643-2676, **TD No. 917 (July 2013).**

BONACCORSI DI PATTI E. and E. SETTE, *Did the securitization market freeze affect bank lending during the financial crisis? Evidence from a credit register,* Journal of Financial Intermediation , v. 25, 1, pp. 54-76, **TD No. 848 (February 2012).**

BORIN A. and M. MANCINI, *Foreign direct investment and firm performance: an empirical analysis of Italian firms,* Review of World Economics, v. 152, 4, pp. 705-732, **TD No. 1011 (June 2015).**

BRAGOLI D., M. RIGON and F. ZANETTI, *Optimal inflation weights in the euro area,* International Journal of Central Banking, v. 12, 2, pp. 357-383, **TD No. 1045 (January 2016).**

BRANDOLINI A. and E. VIVIANO, *Behind and beyond the (headcount) employment rate,* Journal of the Royal Statistical Society: Series A, v. 179, 3, pp. 657-681, **TD No. 965 (July 2015).**

BRIPI F., *The role of regulation on entry: evidence from the Italian provinces,* World Bank Economic Review, v. 30, 2, pp. 383-411, **TD No. 932 (September 2013).**

BRONZINI R. and P. PISELLI, *The impact of R&D subsidies on firm innovation,* Research Policy, v. 45, 2, pp. 442-457, **TD No. 960 (April 2014).**

BURLON L. and M. VILALTA-BUFI, *A new look at technical progress and early retirement,* IZA Journal of Labor Policy, v. 5, **TD No. 963 (June 2014).**

BUSETTI F. and M. CAIVANO, *The trend–cycle decomposition of output and the Phillips Curve: bayesian estimates for Italy and the Euro Area,* Empirical Economics, V. 50, 4, pp. 1565-1587, **TD No. 941 (November 2013).**

CAIVANO M. and A. HARVEY, *Time-series models with an EGB2 conditional distribution,* Journal of Time Series Analysis, v. 35, 6, pp. 558-571, **TD No. 947 (January 2014).**

CALZA A. and A. ZAGHINI, *Shoe-leather costs in the euro area and the foreign demand for euro banknotes,* International Journal of Central Banking, v. 12, 1, pp. 231-246, **TD No. 1039 (December 2015).**

CESARONI T. and R. DE SANTIS, *Current account "core-periphery dualism" in the EMU,* The World Economy, v. 39, 10, pp. 1514-1538, **TD No. 996 (December 2014).**

CIANI E., *Retirement, Pension eligibility and home production,* Labour Economics, v. 38, pp. 106-120, **TD No. 1056 (March 2016).**

CIARLONE A. and V. MICELI, *Escaping financial crises? Macro evidence from sovereign wealth funds' investment behaviour,* Emerging Markets Review, v. 27, 2, pp. 169-196, **TD No. 972 (October 2014).**

CORNELI F. and E. TARANTINO, *Sovereign debt and reserves with liquidity and productivity crises,* Journal of International Money and Finance, v. 65, pp. 166-194, **TD No. 1012 (June 2015).**

D'AURIZIO L. and D. DEPALO, *An evaluation of the policies on repayment of government's trade debt in Italy,* Italian Economic Journal, v. 2, 2, pp. 167-196, **TD No. 1061 (April 2016).**

DE BLASIO G., G. MAGIO and C. MENON, *Down and out in Italian towns: measuring the impact of economic downturns on crime,* Economics Letters, 146, pp. 99-102, **TD No. 925 (July 2013).**

DOTTORI D. and M. MANNA, *Strategy and tactics in public debt management,* Journal of Policy Modeling, v. 38, 1, pp. 1-25, **TD No. 1005 (March 2015).**

ESPOSITO L., A. NOBILI and T. ROPELE, *The management of interest rate risk during the crisis: evidence from Italian banks,* Journal of Banking & Finance, v. 59, pp. 486-504, **TD No. 933 (September 2013).**

LIBERATI D., M. MARINUCCI and G. M. TANZI, *Science and technology parks in Italy: main features and analysis of their effects on hosted firms*, Journal of Technology Transfer, v. 41, 4, pp. 694-729, **TD No. 983 (November 2014).**

MARCELLINO M., M. PORQUEDDU and F. VENDITTI, *Short-Term GDP forecasting with a mixed frequency dynamic factor model with stochastic volatility,* Journal of Business & Economic Statistics , v. 34, 1, pp. 118-127, **TD No. 896 (January 2013).**

RODANO G., N. SERRANO-VELARDE and E. TARANTINO, *Bankruptcy law and bank financing,* Journal of Financial Economics, v. 120, 2, pp. 363-382, **TD No. 1013 (June 2015).**

ZINNA G., *Price pressures on UK real rates: an empirical investigation,* Review of Finance,v. 20, 4, pp. 1587-1630, **TD No. 968 (July 2014).**

2017

ADAMOPOULOU A. and G.M. TANZI, *Academic dropout and the great recession,* Journal of Human Capital, V. 11, 1, pp. 35–71, **TD No. 970 (October 2014).**

ALBERTAZZI U., M. BOTTERO and G. SENE, *Information externalities in the credit market and the spell of credit rationing,* Journal of Financial Intermediation, v. 30, pp. 61–70, **TD No. 980 (November 2014).**

ALESSANDRI P. and H. MUMTAZ, *Financial indicators and density forecasts for US output and inflation,* Review of Economic Dynamics, v. 24, pp. 66-78, **TD No. 977 (November 2014).**

BARBIERI G., C. ROSSETTI and P. SESTITO, *Teacher motivation and student learning,* Politica economica/Journal of Economic Policy, v. 33, 1, pp.59-72, **TD No. 761 (June 2010).**

BENTIVOGLI C. and M. LITTERIO, *Foreign ownership and performance: evidence from a panel of Italian firms,* International Journal of the Economics of Business, v. 24, 3, pp. 251-273, **TD No. 1085 (October 2016).**

BRONZINI R. and A. D'IGNAZIO, *Bank internationalisation and firm exports: evidence from matched firm-bank data,* Review of International Economics, v. 25, 3, pp. 476-499 **TD No. 1055 (March 2016).**

BRUCHE M. and A. SEGURA, *Debt maturity and the liquidity of secondary debt markets,* Journal of Financial Economics, v. 124, 3, pp. 599-613, **TD No. 1049 (January 2016).**

BURLON L., *Public expenditure distribution, voting, and growth,* Journal of Public Economic Theory,, v. 19, 4, pp. 789–810, **TD No. 961 (April 2014).**

BURLON L., A. GERALI, A. NOTARPIETRO and M. PISANI, *Macroeconomic effectiveness of non-standard monetary policy and early exit. a model-based evaluation,* International Finance, v. 20, 2, pp.155-173, **TD No. 1074 (July 2016).**

BUSETTI F., *Quantile aggregation of density forecasts,* Oxford Bulletin of Economics and Statistics, v. 79, 4, pp. 495-512, **TD No. 979 (November 2014).**

CESARONI T. and S. IEZZI, *The predictive content of business survey indicators: evidence from SIGE,* Journal of Business Cycle Research, v.13, 1, pp 75–104, **TD No. 1031 (October 2015).**

CONTI P., D. MARELLA and A. NERI, *Statistical matching and uncertainty analysis in combining household income and expenditure data,* Statistical Methods & Applications, v. 26, 3, pp 485–505, **TD No. 1018 (July 2015).**

D'AMURI F. and J. MARCUCCI, *The predictive power of google searches in forecasting unemployment,* International Journal of Forecasting, v. 33, 4, pp. 801-816, **TD No. 891 (November 2012).**

DE BLASIO G. and S. POY, *The impact of local minimum wages on employment: evidence from Italy in the 1950s,* Journal of Regional Science, v. 57, 1, pp. 48-74, **TD No. 953 (March 2014).**

DEL GIOVANE P., A. NOBILI and F. M. SIGNORETTI, *Assessing the sources of credit supply tightening: was the sovereign debt crisis different from Lehman?,* International Journal of Central Banking, v. 13, 2, pp. 197-234, **TD No. 942 (November 2013).**

DELLE MONACHE D. and I. PETRELLA, *Adaptive models and heavy tails with an application to inflation forecasting,* International Journal of Forecasting, v. 33, 2, pp. 482-501, **TD No. 1052 (March 2016).**

DEL PRETE S., M. PAGNINI, P. ROSSI and V. VACCA, *Lending organization and credit supply during the 2008–2009 crisis,* Economic Notes, v. 46, 2, pp. 207–236, **TD No. 1108 (April 2017).**

LOBERTO M. and C. PERRICONE, *Does trend inflation make a difference?,* Economic Modelling, v. 61, pp. 351–375, **TD No. 1033 (October 2015).**

MANCINI A.L., C. MONFARDINI and S. PASQUA, *Is a good example the best sermon? Children's imitation of parental reading,* Review of Economics of the Household, v. 15, 3, pp 965–993, **D No. 958 (April 2014).**

MEEKS R., B. NELSON and P. ALESSANDRI, *Shadow banks and macroeconomic instability,* Journal of Money, Credit and Banking, v. 49, 7, pp. 1483–1516, **TD No. 939 (November 2013).**

MICUCCI G. and P. ROSSI, *Debt restructuring and the role of banks' organizational structure and lending technologies,* Journal of Financial Services Research, v. 51, 3, pp 339–361, **TD No. 763 (June 2010).**

MOCETTI S., M. PAGNINI and E. SETTE, *Information technology and banking organization,* Journal of Journal of Financial Services Research, v. 51, pp. 313-338, **TD No. 752 (March 2010).**

MOCETTI S. and E. VIVIANO, *Looking behind mortgage delinquencies,* Journal of Banking & Finance, v. 75, pp. 53-63, **TD No. 999 (January 2015).**

NOBILI A. and F. ZOLLINO, *A structural model for the housing and credit market in Italy,* Journal of Housing Economics, v. 36, pp. 73-87, **TD No. 887 (October 2012).**

PALAZZO F., *Search costs and the severity of adverse selection,* Research in Economics, v. 71, 1, pp. 171-197, **TD No. 1073 (July 2016).**

PATACCHINI E. and E. RAINONE, *Social ties and the demand for financial services,* Journal of Financial Services Research, v. 52, 1–2, pp 35–88, **TD No. 1115 (June 2017).**

PATACCHINI E., E. RAINONE and Y. ZENOU, *Heterogeneous peer effects in education,* Journal of Economic Behavior & Organization, v. 134, pp. 190–227, **TD No. 1048 (January 2016).**

SBRANA G., A. SILVESTRINI and F. VENDITTI, *Short-term inflation forecasting: the M.E.T.A. approach,* International Journal of Forecasting, v. 33, 4, pp. 1065-1081, **TD No. 1016 (June 2015).**

SEGURA A. and J. SUAREZ, *How excessive is banks' maturity transformation?,* Review of Financial Studies, v. 30, 10, pp. 3538–3580, **TD No. 1065 (April 2016).**

VACCA V., *An unexpected crisis? Looking at pricing effectiveness of heterogeneous banks,* Economic Notes, v. 46, 2, pp. 171–206, **TD No. 814 (July 2011).**

VERGARA CAFFARELI F., *One-way flow networks with decreasing returns to linking,* Dynamic Games and Applications, v. 7, 2, pp. 323-345, **TD No. 734 (November 2009).**

ZAGHINI A., *A Tale of fragmentation: corporate funding in the euro-area bond market,* International Review of Financial Analysis, v. 49, pp. 59-68, **TD No. 1104 (February 2017).**

FORTHCOMING

ADAMOPOULOU A. and E. KAYA, *Young Adults living with their parents and the influence of peers,* Oxford Bulletin of Economics and Statistics, **TD No. 1038 (November 2015).**

ALBANESE G., G. DE BLASIO and P. SESTITO, *Trust, risk and time preferences: evidence from survey data,* International Review of Economics, **TD No. 911 (April 2013).**

BOFONDI M., L. CARPINELLI and E. SETTE, *Credit supply during a sovereign debt crisis,* Journal of the European Economic Association, **TD No. 909 (April 2013).**

CASIRAGHI M., E. GAIOTTI, L. RODANO and A. SECCHI, *A "Reverse Robin Hood"? The distributional implications of non-standard monetary policy for Italian households,* Journal of International Money and Finance, **TD No. 1077 (July 2016).**

D'AMURI F., *Monitoring and disincentives in containing paid sick leave,* Labour Economics, **TD No. 787 (January 2011).**

FEDERICO S. and E. TOSTI, *Exporters and importers of services: firm-level evidence on Italy,* The World Economy, **TD No. 877 (September 2012).**

GIACOMELLI S. and C. MENON, *Does weak contract enforcement affect firm size? Evidence from the neighbour's court,* Journal of Economic Geography, **TD No. 898 (January 2013).**

NATOLI F. and L. SIGALOTTI, *Tail co-movement in inflation expectations as an indicator of anchoring,* International Journal of Central Banking, **TD No. 1025 (July 2015).**

RIGGI M., *Capital destruction, jobless recoveries, and the discipline device role of unemployment,* Macroeconomic Dynamics, **TD No. 871 (July 2012).**

SEGURA A., *Why did sponsor banks rescue their SIVs?,* Review of Finance, **TD No. 1100 (February 2017).**