

HOME SWEET HOME  
HOW MONEY LAUNDERING POLLUTES THE REAL ESTATE MARKET:  
AN AGENT BASED MODEL

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Abstract

The aim of the paper is to analyze the role of real estate market as dirty money laundering channel for organized crime in Italy. We contribute to the economic literature on house price determinants, providing an agent based model to simulate the price determinants in Italian provincial capitak. Properties' prices typically move in tandem with the economy, but not always it happens. An unforeseeable event as Covid-Sars19 pandemic seems not to have influenced the real estate price trend, mainly in house market. As reported by a latest article of the Economist, American house prices rose by 11% in the year to January, the fastest pace for 15 years. Those in Britain increased by 8% last year and in Germany by 9%. In particular, it happens in suburban areas. Some of the rationale for this sudden rise in prices may be the loose monetary policy and governmental measures including support for household incomes, as well as mortgage moratorium, suspension of stamp duty.

In this paper, we wonder if the presence of organized crime in a country can influence the price trend for different mortgage interest rate.

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## **1. Introduction**

Several illegal activities such as illegal arms sales, smuggling, drug trafficking, corruption, embezzlement, insider trading, bribery, computer fraud schemes and so on, can generate huge amounts of profits.

Money laundering is an economic activity that enables the criminal to enjoy these profits disguising their illegal origin (Masciandaro, 1993; 1999).

Abuse of the real estate sector has long been described as one of the oldest known ways to launder ill-gotten gains (European Parliament, 2019). Such role has been suggested by anecdotal, while the international organizations (such as OECD, 2007; FATF, 2007; Financial Crimes Enforcement Network\_FinCEN, 2008; ESAAMLG, 2013) and national governments (Australian Government\_AUSTRAC, 2015) implemented special measures to fight the crime.

European Parliament reported examples of money laundering through real estate in several European Union Countries based on information collected from press and reports (European Parliament, 2019). This is the case of Czech Republic, France, Finland, Germany, Greece, Portugal and Netherland.

In Italy, the real estate market is the final destination of several illicit funds as reported by the law enforcement (La Gala, 2000). During the period 1984-2015 are 6.9% of total the real estate companies confiscated from mafia-type OC (Savona and Riccardi, 2017, p. 74).

In the United Kingdom (UK), the real estate market is widely considered to be an attractiveness factor for both legal and illicit financial flows. With reference to the second type of funds, it seems that more than £90bn were laundered illegally through the UK property market each year. Illicit funds help sustain Britain's inflated property market through the purchase of homes that are frequently left unoccupied, emptying the wealthier parts of London of residents (Norton, 2019). Moreover, criminals are targeting property in university towns across the UK to launder dirty money. As reported by Chapman in his newspaper, "Mark Hayward, chief executive of NAEA Property mark, said that investment in University towns is secure because it protect against any price downward" (Chapman, 2018).

In US the use to pay all cash for luxury residential real properties make the real estate market a good way to launder large amounts of money. Such purchases rain down in Manhattan, Miami, Florida, California, New York, Texas and so on. The Canada Revenue Agency suggested the risk of money laundering though real estate in several countries as Toronto, Vancouver, Quebec. The study done by the federal government also identified charitable industries as possible target of organized crime (Press, 2016).

In light of the spread of the phenomenon, international organizations take over projects to develop more information on this issue. Moreover, they show the techniques of money laundering by real estate activity (FATF, 2007).

In spite of it, thus far economic literature has neglected the role of real estate in money laundering.

Just some researches focused on the topic, but they are mainly qualitative analysis and not properly supported by a theoretical model.

In this paper, we propose for the first time an agent based model (ABM) to estimate the role of crime fixing the price of the Italian housing market.

## **2. Money laundering through the real estate sector: the state of art**

The literature also recognized that the real estate sector plays a major role in money laundering, but these studies are mainly qualitative analysis and not properly supported by a theoretical model.

To the best of our knowledge, this is the first contribution on the relationship between money laundering and real estate sector analyzed by a principal agent model.

For instance, Schneider (2004) examined how organized crime invested illegal proceeds in the Canadian real estate market. Data for the analysis were collected between January 2000 and May 2002, from the Royal Canadian Mounted Police (RCMP) proceeds of crime (POC) case files. The final sample of POC files included 149 cases. The survey of RCMP cases indicates that real estate is one of the four most frequent destinations for the proceeds of crime in Canada (the others are: deposit institutions, the insurance industry and motor vehicles). Real estate sector has been identified in 83 cases (55.7%); 60 of 83 cases (72.3%) involved the purchase of single-family residential properties which were generally used as own family home or to grow marijuana. According to the police cases, the most common forms in which the proceeds of crime enter the real estate market involved mortgages (in 65 of the 83 cases, i.e. 78.3%) and cash which was used as a deposit, a down payment, or a mortgage payment (in 64 cases, i.e. 77.1%). The primary technique exploited to launder criminal proceeds through real estate sector was the use of nominee owners (it's happen in 51 of 83 cases, 61.4%).

In some cases, police also show that criminal offenders used shell companies and trust accounts to facilitate the laundering process. Moreover, purchasing of income-generating property, flipping real property and under-invoicing were other techniques used to laundering money through real estate sector. Schneider (2004) highlighted also the role of lawyers in several money laundering operations. However, the author acknowledged that certain factors limit the reliability of the data.

Some years later Maloney, Somerville and Unger (2019) provided a report for the Ministry of Finance on Money laundering in BC Real Estate, which included some recommendations to improve regulatory measures enhancing the government response to money laundering in real estate in British Columbia.

Van Duyne and Soudijn (2009) analyzed the real estate confiscation database of the Dutch Prosecution Asset Recovery Agency (PARA) from 2000 onwards. The database covered almost 15 years of confiscation activities. During their analysis, the authors adjusted the database in order to overtake some caveats. The results of their study showed that, based on the available knowledge, the relationship between money laundering and the purchase of real estate property remained indeterminable.

Anyway, as also the authors observed there are criminals that purchase houses, sometimes big villas and a few of them have income-generating property and this small financial criminal elite may be widely spread over time and space.

Unger et al. (2011) undertook a study focused on the relationship between money laundering and Dutch real estate sector. The authors used an “outlier mining” to identify criminal investment in the real estate market in Maastricht and Utrecht. To the purpose, they developed a list of characteristics that are associated with criminal investments (“red flags”). They identified 17 unusual characteristics among that mentioned in literature (OECD, 2007; FATF, 2007). In order to operationalize the indicators associated to criminal investments, they produced a data research based on two datasets. The first one included the stock of buildings, parks and parking lots in Utrecht and Maastricht as of 31 December 2006; the second one consisted of all the transactions involving real estate in Utrecht and Maastricht from 2002 up until 2006. Data were collected from the Offices of the Land Registry combined with data from the Tax Administration. The main result of the analysis was that basing on 11895 objects (buildings, parks and parking lots) traded between 2002 and 2006, 150 seemed unusual but, none of the objects, received more than 9 flags. Moreover, the list of 200 objects (the 150 objects that seemed unusual plus 50 served as a control group), was passed to a research group (Ritzen and Nelen, 2011) for a criminological analysis to deduce if these 150 objects could be also identified as conspicuous and used for criminal investment or money laundering. The analysis of Ritzen and Nelen was approached in a top-down approach and a bottom up analysis. According to the results of this criminological analysis, it was not possible to conclude that certainly some of these objects were used for criminal or speculative purposes.

Ritzen (2011) who stressed some shortcomings of the initial model revised the study of Unger et al. (2011).

Naheem (2017) pointed out some of the challenges that international money laundering schemes were posing for the Chinese banking sector, with a focus on money laundering through real estate market. The authors cited some formal cases of money laundering through the real estate sector using Chinese ex-officials. In a case, the local government official of Wenzhou, Ms Yang, was involved in a money-laundering scheme and she was suspected to have taken bribes for almost an amount of \$30m (Saul and Levine, 2015). During her tenure, the ownership of a building previously purchased by a corporation for an undisclosed value was transferred into her name. Sometime later, Ms Yang sold the property to her sister-in-law, for \$550,000 and, in that same year, it was transferred to an apparently unaffiliated group for \$2.4 million. Some other cases reported by Naheem once again involved an official and it's clear that unlikely the large sums of money used for property purchase may originate from the salary of an official. It was apparent that, almost certainly, the officials were straw wo/man used by money launderers for illegal purposes. According to West (2015) the authors also pointed out that Credit Suisse have predicted that between 2015 and 2021 there will be \$60 bn of Chinese investment in Australian property market.

McPherson (2017) drew attention to the spread of money laundering activities in Miami, whose magnitude is comparable to the "Cocaine Cowboys" era of 1980's Miami. The lax regulation attitude towards accepting large sum of cash joined with anonymity fostered the diffusion of money laundering through real estate transaction in Miami. The anti-money laundering authorities undertook measures to fight against the pollution of real estate sector, but it seems that they have not been very effective.

Boles (2017) investigated money-laundering activities through real estate market in South Africa. He underlined the fact that being South Africa a cash based market and the intensive use of shell companies, it is exposed to money laundering operations. The luxury real estate market in the Western Cape Province in particular provides money-laundering opportunities. In spite of the implementation of several measures launched by anti-money laundering authorities to thwart the money laundering activities, in South Africa there are several tricks that allow to circumvent the law.

Teichmann (2018) analyzed real estate money laundering in Austria, Germany, Switzerland and Liechtenstein, confirming that in those countries the real estate sector is extraordinarily suitable for laundering money. He interviewed 58 experts (money launderers and prevention experts). The results of the interview were used to form three hypotheses, which explain the survey administrated to 184 compliance officers. Assuming that the real estate sector plays a key role in money laundering, compliance officers rarely faced cases of money laundering through real estate property; often they are unable to detect such money-laundering scheme.

The first hypothesis was confirmed. In fact, 75.0 per cent of compliance officers asserted that the real estate sector is particularly relevant for money laundering; 83.7 per cent of the interviewed reported that they rarely faced cases of money laundering in the real estate sector; 79.9 per cent of the interviewed compliance officers believed that, in most cases, they were unable to detect money laundering activities carried out in the real estate sector. Therefore, all the three hypothesis were confirmed.

### **3. The methodology: the Agent Based Models**

As Richard Bookstaber (2017) pointed out, the ABM models may be superior respect to the traditional economic analysis model dealing with crises. At least four factors prove their strengths: 1) Computational irreducibility: economy is not a symple system, so we can't use mathematical methods to predict its future behaviour. Therefore, we should use methods that are more robust, and ABM could be a step in the right direction. 2) Emergence: emergent phenomena occur when the overall effect of individuals' actions is qualitatively different from what each of the individuals are doing. The reason is likely to be that the large system will show properties its individual members do not have. 3) Non-ergodicity: the mechanical processes that drive of our physical world and many biological processes are ergodic. In this processes the past doesn't matter to predict the future. But the past matters in social processes and you cannot simply extrapolate it to know the future. So Similarly, the dynamics of a financial crisis are not reflected in the pre-crisis period, so the future may look nothing like the past. 4) "Knightian" uncertainty (Knight, 1921): there are events that are unanticipated and we can't calculate the odds that it will happen. The pandemic that overwhelmed us may be an example, but in general, the reality of humanity means that a mechanistic approach to economics will fail, as stressed by Bookstaber.

Despite the advantages, a pitfall of the ABMs may be the high degree of freedom in the design phase that may pose serious challenge to less experienced modelers (see Klügl and Bazzan, 2012).

However, as we can observe, in the last years there has been a flowering of economic ABMs. For a summing up of the most recent european contribution you can see Russo (2017). Moreover, Dosi and Roventini (2017) proposed a very interesting paper discussing the three new generations of macroeconomic agent based model: the K+S (The Keynes + Schumpeter evolutionary models), CATS and EURACE. These ABMs consider the economy as a complex evolving system.

Notwithstanding, to the best of our knowledge, no contribution has been focused on money laundering and crimes trough real estate sector.

In our contribution we would like to evaluate the impact of money laundering and usury on Italian residential house market prices. To the purpose we will write a code by Python.

## 4. The model

### 4.1 BUYERS

In our economy, we have  $N$  heterogeneous people. Each person may be honest or criminal. The probability " $p$ " that potential criminal purchaser populates a country depends on several factors: we will consider the crime rate for each country. Moreover, we consider the number of confiscated real estate mafia.

People own a personal wealth " $W_i(t)$ " and a legal income " $R_i(t)$ ", plus a shadow income " $S_i(t)$ ", which will be different from 0 mainly for criminal people.

It may range between zero and a maximum level  $\bar{S}$ .

$$E(I_{it}) = W_i(t) + R_i(t) + pS_i(t)$$

At time  $t$ , each person have to decide to buy or not to buy a house. The choice will depend on several factors and it will be different between the two types of buyers. First, the potential buyer compare the market price  $P_i$  of a house that fit his/her needs with own resources. Two are the possible scenario. If  $P_i \leq I_{it}$ , the buyer will be able to satisfy the purchase plan, otherwise, if  $P_i > I_{it}$  the buyer needs credit. However if  $P_i \leq I_{it}$ , the potential buyer can always finance the purchase with a loan (see subsection 4.3 to analyze the bank behavior).

Assuming that the consumer has the possibility to finance her/his purchase (drawing on his savings or buying on credit), the choice whether or not to buy a property will depend on own preferences. We assume that the buyers have a reserve price for the property that meet their needs. We will consider in the following the determinant of the reserve price.

- The return on investment. The assessment of this value will be different if the buyer is "honest" or "criminal". An honest person will evaluate the yield of this property by considering the return that he could obtain if s/he rent out the house<sup>1</sup>. Moreover, we

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<sup>1</sup> See Engsted and Pedersen (2015) for predicting returns and rent growth in the housing market using the rent-price ratio.

adjust the return on investment for the different propensity ( $\alpha$ ) to buy of each consumer.

$$\alpha \left( \frac{\text{rent}}{\text{price}} \right) = \begin{cases} \alpha \left( \frac{\text{rent}}{\text{price}} \right) & \text{with } \alpha < 1 \text{ if the buyer is a stingy person} \\ \alpha \left( \frac{\text{rent}}{\text{price}} \right) & \text{with } \alpha > 1 \text{ if the buyer is a spendthrift person} \end{cases}$$

Otherwise, if the buyer will be a criminal s/he may use the real estate sector for money laundering purposes or with the aim to conduct criminal activities like drugs production. A British Columbian drug trafficker admitted that he owned 23 homes that he used as lab for the marijuana grow operation (see Schneider, 2004). For sure, in this case it will be  $\alpha > 1$ .

- The tourism density index composed of three elementary indexes:
  - Accommodation facilities (the supply side): total number of beds per 1000 people; number of beds in 4-5 star hotels per 1000 people; number of beds in other accommodations per 1000 people; total number of beds per km<sup>2</sup>; total number of provincial bed/total number of bed in Italy.
  - The total tourist presences (the demand side): total tourist presences per inhabitant; international tourist presences per inhabitant; national tourist presences per inhabitant; presences/total number of bed\*365; total presences/total arrivals; the coefficient of variation of the monthly presences of tourists; provincial presences/ presences in Italy (%); total presences per km<sup>2</sup>; museum and similar institutions visitors per inhabitant.
  - Economic activities related to tourism sector: provincial employment in the tourist sector; added value of tourism per capita; the ratio of localization of employers in tourism sector; provincial employment in the cultural tourism; added value of cultural sector per capita: the ratio of localization of employers in cultural tourism.
- Types of tourism: potential tourist vocation of the municipality based on geographical (proximity to the sea, altitude, and so on) and anthropic (large urban municipalities) criteria. According to the Demoskopika (2021) study there are six regional tourism systems that present the highest risks of criminal infiltration: Campania, Sicily, Lazio, Calabria, Lombardy, Puglia.
- University cities: as pointed out by anecdotal, criminals are targeting property in university towns to launder dirty money. There are several reasons that justify this preference. First, properties in University City are a secure investment, bucking any downwards trend in property prices. Second, they are easily rentable even in case of price increase (Chapman, 2018).



## 4.2 HOUSES: THE REAL ESTATE MARKET IN ITALY

In Italy, the real estate market is splitted in three main categories: residential, non-residential properties and other categories. The earlier includes luxury property; residential building; economic houses; low-income houses; very low income houses; cottages; semidetached houses; detached house (villa); castles and mansions; traditional regional houses<sup>2</sup>. The following real estate annexes also belong to this category: warehouses and storages (up to 30 sqm); cattleshed, stables, carports, private parking lots (up to 50 sqm); awnings (up to 50 sqm)<sup>3</sup>.

The non-residential category comprises: 1) Tertiary and commercial sector. 2) Manufacturing sector; 3) Agriculture manufacturing. These three sub-categories consist of, respectively:

1) offices and private practices; public offices; stores and workshops; warehouses and storages (more than 30 sqm), arts and crafts labs; cattleshed, stables, carports, private parking lots (more than 50 sqm); awnings (more than 50 sqm) hotels and boarding houses; banks, exchange offices and insurances (if not comparable with the reference units); buildings intended for a particular commercial activity. 2) Factories; buildings intended for a particular industrial activity. 3) Buildings intended for agricultural activities.

The last category “Others” includes units intended for collective use (except for public offices); gyms; beach resorts and thermal baths; theatres, movies theatres, concert halls; floating houses, private toll bridges; units aimed to particular end (lighthouses, traffic light, churches and so on); urban entities. In this paper, we will focus on residential buildings, leaving out the item “*pertinenze*”.

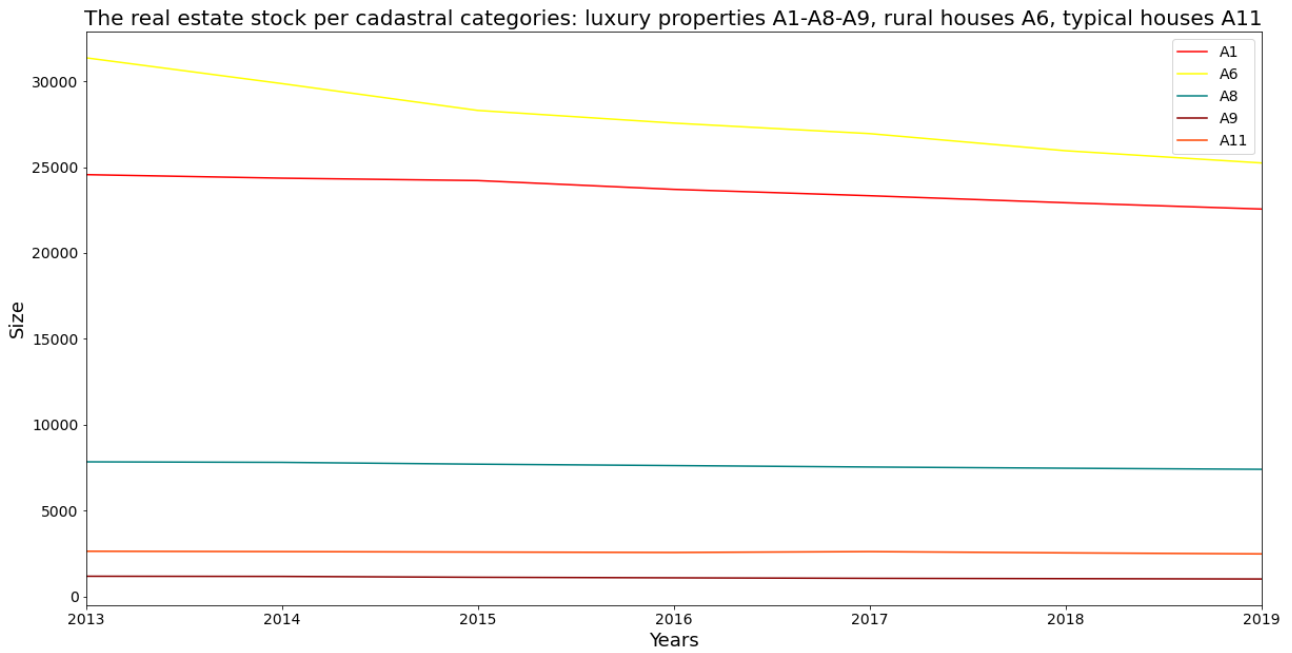
As we can see in the following plots (figures 1-3), the stock of real estate properties per cadastral categories essentially is constant. Therefore, we will consider the real estate supply a constant function.

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<sup>2</sup> According to the Italian land registry these residential buldings correspond to: *abitazioni di tipo signorile* (A1); *abitazioni di tipo civile* (A2); *abitazioni di tipo economico* (A3); *abitazioni di tipo popolare* (A4); *abitazioni di tipo ultrapopolare* (A5); *abitazioni di tipo rurale* (A6); *abitazioni in villini* (A7); *abitazioni in ville* (A8); *castelli, palazzi di eminenti pregi artistici o storici* (A9); *Abitazioni ed alloggi tipici dei luoghi* (A11).

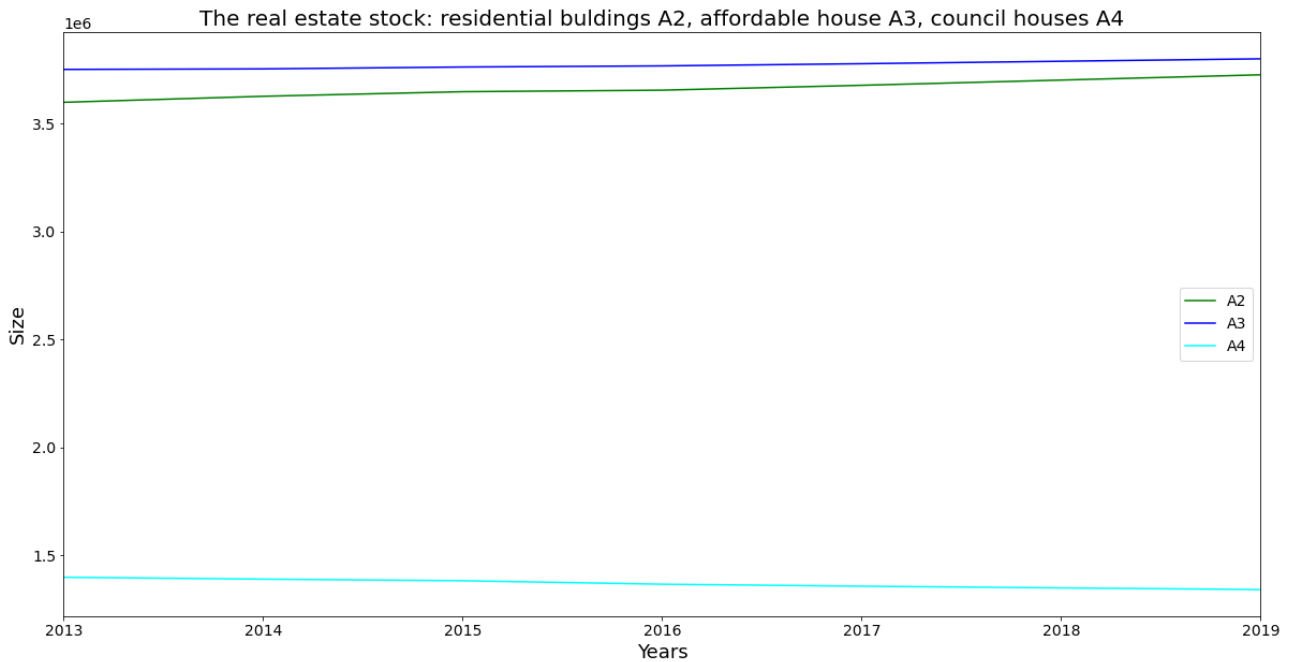
<sup>3</sup> This type of residential buldings is named “*pertinenze*” and include: “*Magazzini e locali di deposito*” up to 30 sqm (C2); *stalle, scuderie, rimesse e autorimesse* up to 50 sqm (C6); *Tettoie chiuse e aperte* up to 50 sqm (C7).

**Figure 1:** The real estate stock per cadastral categories (A1-A6-A8-A9-A11)



Source: Own elaboration on Italian Revenue Agency data (Agenzia delle Entrate, Osservatorio del Mercato Immobiliare – OMI)

**Figure 2:** The real estate stock per cadastral categories (A2, A3, A4)



Source: Own elaboration on Italian Revenue Agency data (Agenzia delle Entrate, Osservatorio del Mercato Immobiliare – OMI)

**Figure 3:** The real estate stock per cadastral categories (A5, A7)



Source: Own elaboration on Italian Revenue Agency data (Agenzia delle Entrate, Osservatorio del Mercato Immobiliare – OMI)

#### 4.3 BANKS

In our economic system, there are national and foreign banks. Credit supply depend on the buyers' affordability index. According to Italian Banking Association (ABI) we calculated the index in the following way:

$$\text{Affordability index} = 30\% - \text{Mortgage payment/available income}$$

The mortgage payment is computed on the 80% of the property value, according to a French repayment plan. It should be equal to 30% of the disposable income. Therefore if:

$$\begin{cases} \text{Affordability index} > 0 \Rightarrow \text{A person is able to buy an house at the average market price} \\ \text{Affordability index} < 0 \Rightarrow \text{A person is not able to buy an house at the average market price} \end{cases}$$

The bank sets the fixed interest rate on loans by applying a spread on the interest rate swap Eurirs  $r$ :

$$r_L(t) = r(t)(1 + \varepsilon_t)$$

## 5. Data

Data on real estate properties were mainly collected from “Estimate and Observatory on the Real Estate” of the Italian Revenue Agency<sup>4</sup>. We considered:

- The prices of real estate properties for each capital city of the provinces for the period 2006-2020. For each city, we took into account the average minimum and maximum market value/square meter for both rent and buy. We followed this procedure for each property category (luxury property; residential building; economic houses; low-income houses and so on) and for each status (good or bad) of the house.
- The stock of real estate properties for the period 2013-2019 for each property category and condition (good or bad condition). As plotted in section 4.2 the stock of real estate properties is constant per almost all cadastral categories.
- The sales of properties in the residential sector in terms of the number of normalized transactions (NTN). In other words if a property is sold in share, for example 50% of the property, it is counted as 0.5. The data are provided in a quarterly series and with provincial and regional details, starting from the first quarter of 2011 until to 2019. After summing the quarterly data I calculated the annual average.

The potential purchaser of the previous buildings, whose numerosity has been set proportionally with the observed frequency for each province tax payers collected from Istat for the period 2012-2018, may be honest or criminal. In order to frame this distinction in a sound way I defined a crime index multiplying a free model parameter that identifies the share of polluted population with a compound index of the crime rate for each province and the number of confiscated real estate mafia properties. The crime rate is collected from Istat considering the number of crimes reported by the police forces to the judicial authorities (values per 100.000 inhabitants) during the period 2010-2019<sup>5</sup>.

Data on confiscated real estate mafia assets were collected from the “National Agency for the management and use of the assets seized and confiscated to the organized crime”<sup>6</sup>. The dataset clarifies whether it is a villa, detached house or apartment. Investments in real estate may be made not just for money laundering purposes but also for profit maximization, control of the territory, social

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<sup>4</sup> Agenzia delle Entrate- Osservatorio del mercato immobiliare.

<sup>5</sup> <http://dati.istat.it/Index.aspx?QueryId=3853#>

<sup>6</sup> Associazione Nazionale per l'amministrazione e la destinazione dei beni sequestrati e confiscati alla criminalità organizzata (ANBSC). [openregio.anbsc.it/statistiche/visualizza/beni\\_destinati/immobili](http://openregio.anbsc.it/statistiche/visualizza/beni_destinati/immobili)

consensus and cultural/personal reasons. Therefore, members of OC groups may buy houses in expensive areas or city centres (Riccardi, 2014; Dugato, Favarin and Giommoni, 2015).

Moreover, organized crime groups and individuals linked to them can take advantage of tourist resorts to commit crimes (Norio, 2021) and are also targeting property in university towns to launder dirty money (Chapman, 2018). We considered a tourism index and the share of university students as a determinant of the choice whether or not to buy a property, collected from Istat.

## **6. Residential real estate market and money laundering risk: results**

The first step was to make the data usable for the purposes of the analysis. We therefore collected all the data on the number of properties per province reported by the real estate observatory of the revenue agency. Since the data on property prices did not contain direct information on the cadastral category to which they belong (A1, A2, A3 etc.), but they were divided by OMI category (economic house, residential house, luxury house, typical house, villa and small villas), we made the two datasets comparable by transforming the cadastral categories into OMI categories. Once the two data sets have been made comparable, we calculated the frequency of the properties for each cadastral category, each province and state of conservation (the frequency was determined as the ratio between the number of properties with the previously reported characteristics and the total number of properties in the nation).

Given approximately 9.4 million residential national properties nationwide, this number has been divided into 531 categories (i.e. 531 combinations of province, OMI category and property status). For some provinces, the data relating to cadastral data has not been recorded or the prices are not available because it is assumed that no sales have been registered. Therefore, these cases were ignored.

Once I cleaned the dataset, I enriched it with the characteristics of each province in relation to: the possibility or not that a given provincial was a tourist destination, the crime rate of the area and whether or not it is a university site. To this end we have assigned to each province a weight between zero and 1 for the three characteristics (the weight is higher the greater the significance of that characteristic).

Potential buyers, who may be criminals or honest (the likelihood that the buyer will be criminal depends on the product of a free parameter – which represents the maximum possible percentage of

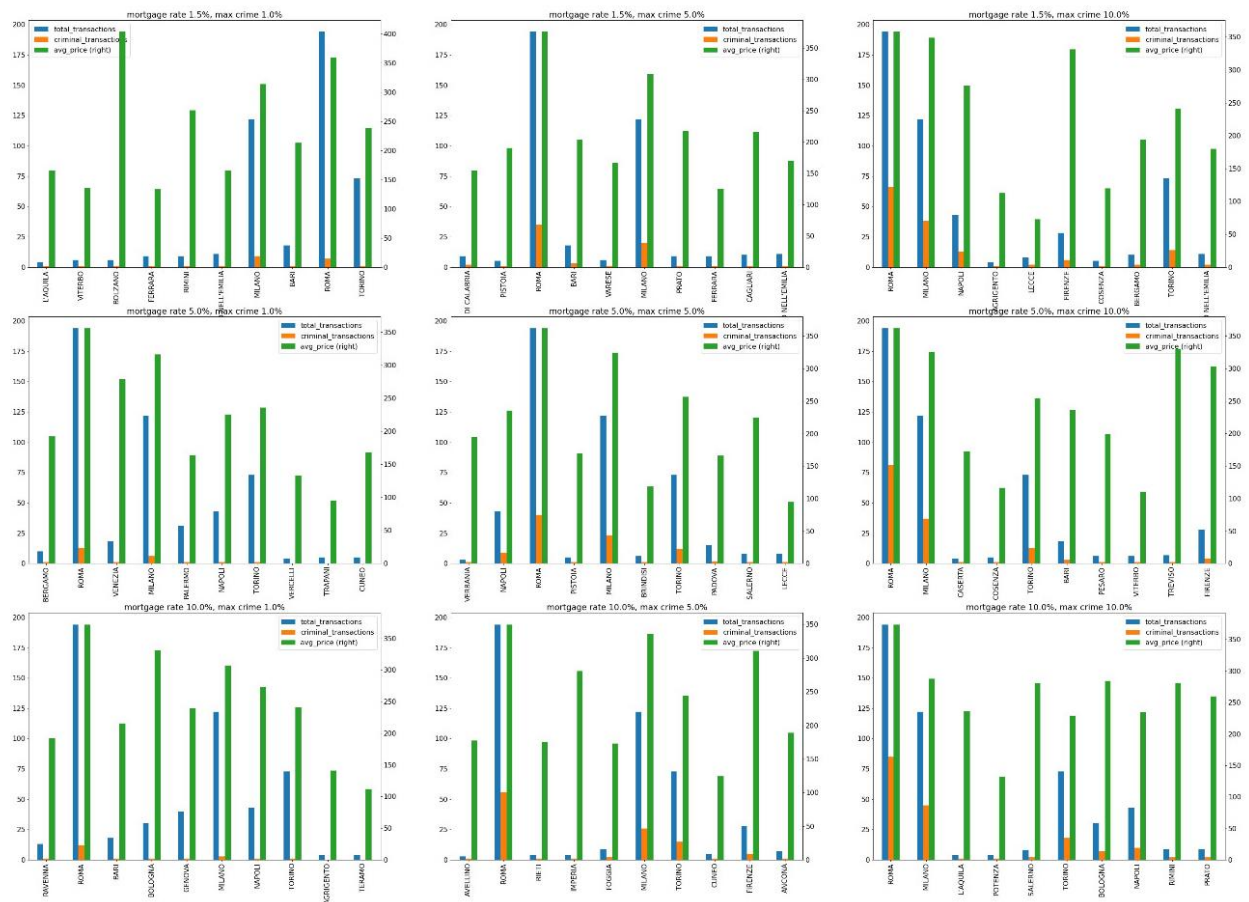
criminals in the population – and the criminal pollution rate of the province obtained through the crime index), are divided by income bracket. Specifically, according to data collected from Istat, I identified five income brackets: [€0-€26,000]; [€26,000-€55,000]; [€55,000-€75,000]; [€75,000-€120,000]; [ $>$ €120.0000]. The starting wealth of each potential buyer is calculated by randomly extracting a multiplication factor that oscillates between 0 and  $f(R)$ , according to a uniform distribution. The multiplication factor is a function of the income bracket the buyers belong to (in the income bracket [0-26,000] I randomly extracts a value between [0-2.5]; in the income range [26,000-55,000] the extracted value will be between [0-4]; in the income range [55,000-75,000] it will be between [0-6]; in the income bracket [75,000-120,000] it will be between [0-8]; in the income bracket [ $>$  120.0000 [it will be between [0-10]).

Hence, we realized the model. In order to build the model I relied on an existing framework for agent based modelling: AgentPy (Foramitti, 2021). The model consists of two agents: the actors (potential buyers and sellers) and the properties. These agents interact randomly according to the Italian market real estate purchase frequencies (I considered the number of real estate business for each province divided by the total national transactions). I run the model for different level of the mortgage interest rate and different share of criminal buyers. The interest rate range between 1,5% and a maximum level of 10% (this values reflect the 10 years mortgage rates during the period 1995-2020).

The results of the model, (see Figure 4), showed that as the number of criminal buyers increases, the total amount of transactions is almost constant, while the percentage of criminal on the total transactions is higher for the following provinces: Rome, Milan, Naples, Akragas, Lecce, Florence, Cosenza, Bergamo, Turin and Reggio nell'Emilia (considering a mortgage rate closer to the last rate of 1,5%).

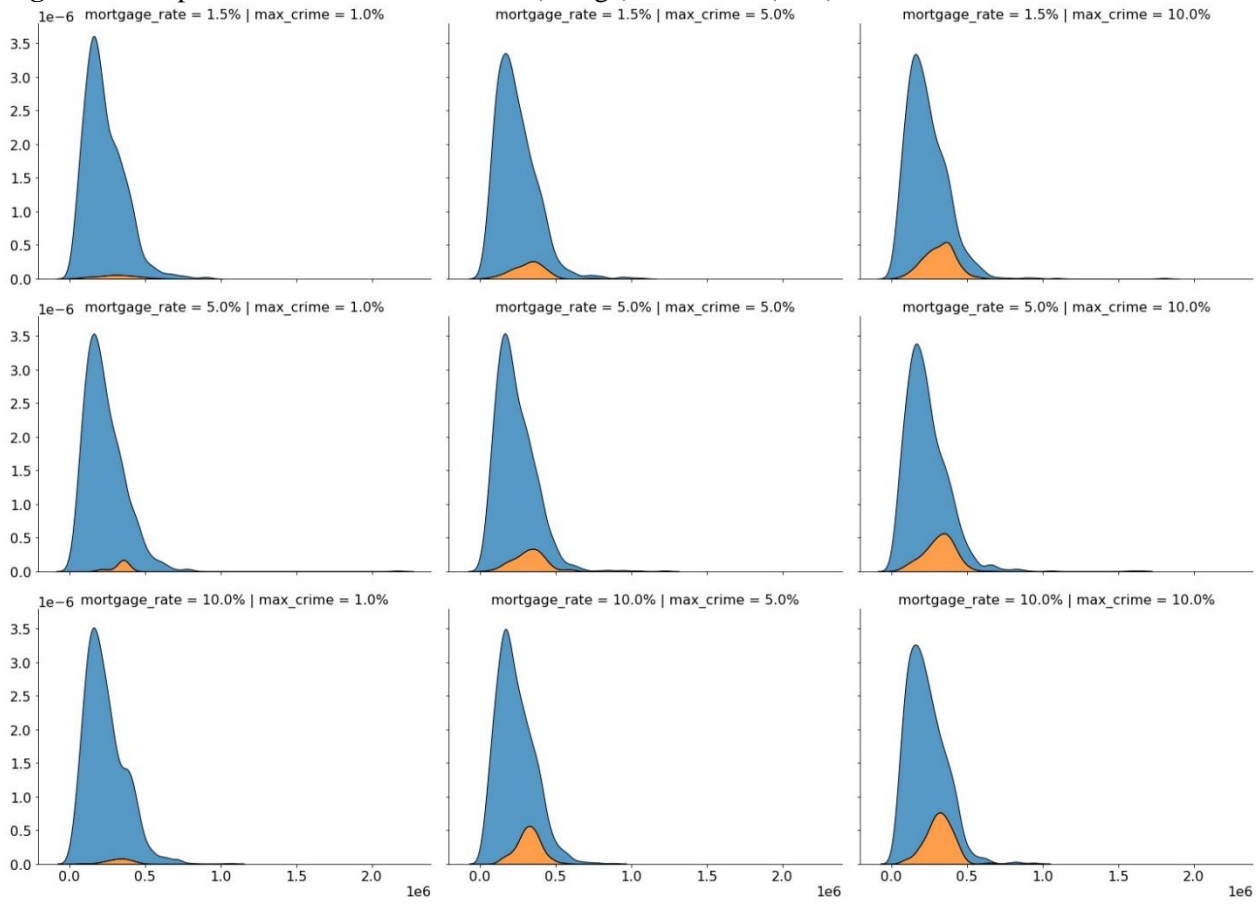
In Figure 5, I plotted the prices distribution for sound transactions (figure in blue) and criminal transaction (figure in orange). The average price is higher for criminal transactions with a growing trend as the number of criminals increases. This result shows how the criminal pollution make possible that homeownership became out of reach for many would-be buyers. In table 1 I show the average price for criminal and sound transactions for both different mortgage rate level and criminal pollution.

**Figure 4:** The top ten provinces based on the percentage of criminal transactions on the total number of transactions



Source: results of the model

**Figure 5:** The price distribution for criminal (orange) and sound (blue) transactions



Source: result of the model

**Table 1:** The average price for criminal or sound transaction

		Mortgage rate								
		1,50%			5,00%			10%		
		Non criminal price (Pnc)	Criminal price (Pc)	(Pc-Pnc)/Pnc	Non criminal price (Pnc)	Criminal price (Pc)	(Pc-Pnc)/Pnc	Non criminal price (Pnc)	Criminal price (Pc)	(Pc-Pnc)/Pnc
Criminal pollution rate	1%	231242	309969	0,34	232339	337067	0,45	234881	321473	0,37
	5%	233372	317791	0,36	226456	321707	0,42	222070	318908	0,44
	10%	222645	316499	0,42	219666	324368	0,48	214049	319386	0,49

## 7. Conclusions



In this paper I provided an agent based model to simulate the impact of organized crime on the real estate market for the Italian provincial capital. Data on real estate properties were mainly collected from “Estimate and Observatory on the Real Estate” of the Italian Revenue Agency.

Honest or criminal people may buy the real estate properties. We wonder if the presence of organized crime in a country can influence the price trend for different mortgage interest rate. The probability that potential criminal purchaser populates a country depends on several factors such as the number of confiscated real estate mafia and the crime rate of each provinces. People own a personal wealth “ $W_i(t)$ ” and a legal income “ $R_i(t)$ ”, plus a shadow income “ $S_i(t)$ ”, which will be different from 0 mainly for criminal people. Some of these people needs a loan to buy a property. Getting a loan will depend on the personal affordability index.

The main result of the model showed that as the number of criminal buyers increases, the total amount of transactions is almost constant, while the percentage of criminal on the total transactions is higher for the following provinces: Rome, Milan, Naples, Akragas, Lecce, Florence, Cosenza, Bergamo, Turin and Reggio nell’Emilia.

As result from the price distribution for sound and criminal transactions, the average price is higher for criminal transactions with a growing trend, as the number of criminals increases. This result shows how the criminal pollution make possible that homeownership became out of reach for many would-be buyers.

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