Environmental and Security Risk Factors behind Mortgage Arrears in Israel, 2010-2011

Abstract

If a mortgage borrower misses three or more payments, the loan moves into the mortgage arrear (MA) category. This study examines MA events in Israel focusing on the effect of several environmental and security risk factors, including air pollution, proximity to the Lebanon-Syria and Gaza strip borders and location outside the 1949 armistice (aka "green") line. The analysis examines MA incidents during the period of 2010-2011 using logistic regressions applied to 91,537 individual records drawn from a nation-wide mortgage database. In the analysis, environmental variables, individual characteristics of the borrowers and property-specific attributes served as predictors for MA events. The analysis revealed statistically significant associations between the incidence of MA and most of the environmental variables. We conjecture that these associations reflect the fact that prolonged exposure to air pollution may elevate morbidity and weaken the ability of borrowers to make the regular loan repayments. In addition, security risks may limit the attractiveness of high-risk areas to developers and investors, thus restricting employment opportunities locally available. Air pollution and security risks may also decrease the asset value by lowering housing demand due to out-migration of more affluent residents. The present analysis is a pioneer individual level study that investigates the effect of air pollution and proximity to conflict zones on MA incidence.

Keywords: Mortgage arrears, security risks, air-pollution, Israel.

1. Introduction

In most developed countries, mortgages are offered to the borrowers directly by financial institutions (Aalbers, 2009). Prior to the 2008 economic crisis, average loan-to-value (LTV) ratio for mortgages in the USA was about 85% (Duca et al., 2012), payback period was up to 30 years (Miles, 2004), and the interest rate was similar to that in Europe, linked to the interbank interest rate (Aron et al., 2012). The 2008 economic crisis triggered a mass credit default, attributed to liquidity issues and negative asset values (Schwartz, 2009). The damage that incurred to the US economy due to the 2008/09 housing slump is estimated at US$14 trillion (Erkens et al., 2012). The 2008 economic crisis in Europe was also accompanied by high unemployment and a decline in the repayment ability of mortgage borrowers. According to Kempson (2015), in the countries of the European Union, household mortgage arrear rate in the aftermath of the crisis increased from 4.5 percent in 2007 to 12.0 percent in 2013.

According to the Bank of Israel's (BOI) estimates, the total amount of mortgages in Israel since 2009 has risen by about 10% each year. However, despite a substantial increase in total mortgage debt, since 2010 only 1% of mortgages defaulted annually. This is a substantial decrease compared to 2003-2006, when mortgage default rate was about 6% per annum (Benchetrit et al., 2010).

Clearly, not every incident of mortgage arrear ends up as a mortgage default leading to a loss of property by the borrower. This may explain the fact that studies of factors affecting mortgage arrears (MA) are essentially scarce and mainly limited to large economies, such as the US, and OECD countries. In one such study, Carmon (2006) found that the main reasons for MA are high loan-to-value (LTV) ratios, negative housing equity, large monthly repayments incompatible with a borrower's income, and unexpected life events, such as divorce, illnesses, natural disasters, and unemployment.

In a separate study, Gerardi et al. (2013) investigated factors behind negative equity in Britain, caused by a decline of the housing value below the initial purchase price. Under these circumstances, selling the house does not cover mortgage liabilities. According to the study's findings, disadvantaged borrowers are the main group that suffers from the price slump: As low-income borrowers stuck to their assets, a cyclical process causes economic fears, and alters the spending behavior, which is crucial for a sustained economic growth. Foote et al. (2008), investigated changes in the housing market in Massachusetts between 1990 and 2007, and also found that negative equity was most frequent in zip codes areas with low-to-moderate income residents.

Additional factors, which may influence the MA incidence, include housing maintenance and locational attributes. Maintaining and improving properties may make the real estate more valuable to the owner, who will do his best to make the regular mortgage payments. As Portnov et al.'s (2005) study revealed, upgrading a property and improving the neighborhood environment by introducing housing changes and modifications, increases the property value, and helps to maintain a positive housing price dynamics.

Although several studies analyzed the effect of environment factors on *home values* (see, *inter alia*, Gibson et al., 2007, Conway et al., 2008, Sayag, 2012; Cuerri et al., 2015), there have been no studies that examine the *effect of environmental characteristics and security risk of the property on mortgage survival rate.* The present study attempts to fill this gap.

As we hypothesize, in addition to individual characteristics of the borrowers (such as age, income, employment status, etc.), and property and loan attributes (i.e., loan-to value ratio (LTV), size of monthly payments), several environmental and security risk factors may increase the risk of MA. These factors expectedly include prolonged exposure to air pollution, local security threats and proximity to high-risk areas (Figure 1).

<<<Figure 1 about here>>>

Prolonged exposure to air pollution may elevate morbidity. High incidence of health problems may cause property owners, who are employees, to loose work days and income and hence weaken their ability to continue to make the monthly payments on mortgage loans. We therefore conjecture that high incidence of mortgage arrears is associated with high pollution in the areas of residence of borrowers. These environmental risk factors are *not* included in conventional MA risk assessment models (Sullivan, 2016).

Security risks may hinder the attractiveness of high-risk areas to developers and industrial investors, thus restricting employment opportunities locally available. Areas of high security risk may therefore have limited business and employment opportunities. Residents of high-risk areas may thus find it difficult to find alternative jobs when their current place of employment suffers economically and has to lay off some of its employees. Hence, one may expect higher incidence of mortgage arrears in high-risk areas.

In addition, air pollution and security risks inversely affecting the quality of life may cause departure of economically successful residents. Their departure is associated with sale of their residential units that may negatively affect the market value of real estate in the area as a whole. Such a negative price dynamic may trigger arrears in mortgage payments by residents remaining in the area.

To investigate these potential associations between MA incidence and environmental risk factors, we analyzed individual records obtained from a countrywide mortgage database maintained by Israel's leading commercial bank. The database contains more than 90,000 mortgage transactions recorded between 2010 and 2011. We merged these records with air pollution data, obtained from local air quality monitoring stations, and locational attributes of individual properties, and then analyzed the combined records using multi-variate analysis tools.

3. Factors potentially affecting MAs

3.1. Previous studies of MA risk factors

According to Guiso et al. (2013), one of the main factors behind MAs in the USA during the subprime crisis was the practice of *nonrecourse* mortgage contracts. In the case of a serious delinquency, the lender can foreclose the home but has no protection in the case of a negative asset value. If the loan is nonrecourse, the lender may repossess and sell the property, but the lender may remain with an unpaid residual debt. Several studies investigated mortgage borrowers' financial survival, mainly focusing on *socioeconomic* aspects, such as the failure to pay back the mortgage due to unemployment (Ronald, 2008), loan characteristics (Min, 2009), or changes in the borrower's income (Benita, 2013).

In an early study, Quercia et al. (1992) emphasized two main causes of MA: loan characteristics and home equity. According to the study findings, the main cause of MA is decline in the property value, which may increase the risk of a mortgage failure. Other factors analyzed by the study, such as size of monthly paybacks, characteristics of the interest rate (either variable or fixed), and transaction costs, were found to be insignificant. In a more recent study, Ronald (2008) investigated factors behind the housing market collapse in 2008, and concluded that the main reason for the high default rates in the USA during that period was limited repayment ability of the borrowers. According to the study, in order to stimulate the loan demand, many financial agencies (both public and private) acted aggressively in the mortgage market, opening the market to many low-income borrowers. The tactic led to a sharp increase in the purchase of homes where the ownership of homes climbed from 64% in 1995 to 69% in 2007. In a separate study, Min (2009) investigated the effect of loan conditions on chances of mortgage survival and determined that the most important determinants of MA were the price of the asset and loan to value (LTV) ratio.

According to another study by Benita (2013), the main risk factors behind MAs are high payment-to-income (PTI) ratio, and size of monthly paybacks. However, as the author of this study concludes, PTI is an important determinant of the MA risk only for borrowers who pay up to 30% of their income, while for other borrowers; the main cause of MA was unexpected unemployment.

3.2 The effect of environmental factors on housing prices and MA risk

As well established in empirical literature, prolonged exposure to air pollution is significantly associated with respiratory and cardio-vascular morbidity (Veremchuk et al., 2016, Delfino et al., 2014, Greenberg et al., 2015, Portnov et al., 2011, Kelly et al., 2015). Economic and social costs of such morbidity include decreased productivity, loss of working hours, and increased hospitalization (Dudek et al., 2015).

Several early studies (see, *inter alia*, Freeman, 1974; Robert, 1971; Harrison et al., 1978) revealed a strong correlation between housing prices and air pollution levels. More recent studies (Bleich et al., 2003; Sullivan, 2015) also showed that people living in neighborhoods with high air pollution levels suffer from high morbidity rates, which decrease productivity (Graff et al. 2012), and may, in turn, affect their loan repayment ability. Studies by Manguez (2013) and Chasco (2013) also revealed a strong association between air pollution (either measured or perceived), noise, and housing prices.

As Nevo (1999) concludes, environmental risk factors, such as security risks, may have a direct impact on home prices, resulting in a negative home equity. Several other environmental factors are also found to be associated with home prices, including proximity to environmental hazards and high-risk areas. Thus, in a recent study, Xu and Xu (2017) found that one of the lenders' considerations regarding mortgage approval in Texas is the distance of the house from gas and oil pipelines. According to the authors, the inclusion of the oil pipeline proximity factor into the list of mortgage-lending considerations is justified by a possibility that pipeline related incidents (such as leaks and spills) may cause fatalities, injuries, decrease prices of nearby houses, and thus decrease the value of the house as a collateral for loans.

In a separate study, Wilhelmsson (2000) found that traffic noise might reduce home prices by up to 30%. Yet, Genesove et al. (2016), who examined the effect of proximity to cellular phone antennas on home prices in Israel, found that the effect was small and insignificant, thus implying that potential homebuyers do not seem to consider this particular environmental risk factor as critical in their housing decision.

3.3 Housing mortgage practice and MA rates in Israel

All residential mortgages in Israel are *recourse* loans. The borrower's home is collateral to the lender, and the loan imposes personal liability on the borrower. Over the past decades, the mortgage market in Israel has undergone several changes. Until the 1990's, the local mortgage market was dominated by the State, which offered subsidized mortgages which were provided through commercial banks and governmental housing companies.

In 1989-1992, the country experienced a major wave of immigration from the former Soviet Union, when about one million of new immigrants arrived, increasing the country's population by nearly 10% in just four years (ICBS, 2017). During this period, the government instituted the policy of "direct absorption", according to which the immigrants received the so called "absorption basket" that included a small amount of cash and several long-term economic benefits, including a possibility to apply for a state-subsidized mortgage.

As mass immigration raised housing demand and prices, government-subsidized mortgages became insufficient for immigrants to purchase a home (Raijman et al, 2010). As a result, commercial banks started offering additional mortgages, leading to another increase in housing prices and even to more demand for housing loans.

Between 2010 and 2012, the total amount of mortgages in Israel increased by about 10% per year, reaching some NIS240 billion (US$68 billion) by the end of 2012. About 1.7% of this amount (or NIS4 billion) were in deep arrears, treated by active collection methods (ICBS, 2012).

Although since 2010 home prices in Israel have been on the rise, according to BOI's (2016) estimates, in the past decade, the MA rate in Israel has been actually declining. This trend can be explained by relatively low interest rates, low unemployment (about 4.3% on the average) and a relatively stable economic environment that helped the borrowers comply with the terms of the mortgage payments. Yet, to reduce the risk from MAs to the national financial system even further, BOI issued restrictive regulations on mortgage lending, setting the permissible LTV rate to up to 75%, and limiting the share of the variable interest part of the mortgage loan by up to 33%.

In the past years, the central government also introduced several regulatory measures that affected the local housing market. The first measure, introduced in 2010, was to increase the purchase tax rate on the second apartment or more. The second measure was the "price to the dweller" (*mehir le'mishtaken*) policy, introduced in 2015. Under this policy, the state started to subsidize the price of land and grant preferential construction rights to developers who committed to selling housing units at the lowest price (GoI, 2015). However, despite these measures, house prices in the country are still on the rise, although some home price stabilization has been recently reported (ICBS, 2017).

3.4 Studies of environmental and security risk factors affecting home prices in Israel

There have been only a handful of studies, investigating home price dynamics in Israel, and, *no* study investigated risk factors behind MAs, environmental or otherwise. Thus, Czamanski et al. (2008) examined the relationship between environmental parameters and immigration and housing prices in the Haifa metropolitan area. The study found a positive correlation between housing prices and net migration. However, the relationship in question was found to weaken over time, eventually leading to a price stabilization.

In a separate study, Sage (2011) analyzed house prices in different geographic areas of Israel. The study focused on 64 cities and towns with at least 5,000 housing units, and assessed differences between the localities in respect to environmental conditions and apartment quality. Environmental conditions included road accessibility, socioeconomic level of the community, and proximity to the 1949 armistice (*aka* “green”) line. In addition, indicators of apartment quality included the floor area of the apartment, number of rooms, age of the building, number of floors, apartment status (i.e., newly built or second-hand) and the type of the apartment (a standard apartment in a multi-floor building, penthouse, or a cottage). As the study revealed, environment parameters and apartment quality were the most important factors affecting house prices. Concurrently, security risks, associated with properties’ location in towns near the Lebanon and Gaza strip borders, were found to have only a limited effect on the prices. Air pollution variables were not covered by the analysis.

In a separate study, Hazan and Felsenstein (2007) investigated the effect of violence in different residential neighborhoods in Jerusalem. They found that the number of recorded terror events was associated with lower housing prices and rents. In another recent study, Zussman et al. (2015) examined housing prices during and after a massive missile attack by Hezbollah on northern Israel in 2006, and found that housing prices declined by about 7% during the two years after the event, compared to other areas in the north that did not suffer direct missile hits. However, neither Hazan and Felsenstein (2007) nor Zussman et al. (2015) examined factors affecting MA. These studies referred to only two areas of the country, the city of Jerusalem and on the north of the country, respectively.

4. Research method

The main goal of the present study was to determine whether environmental attributes of individual residential properties and proximity of the properties to high security risk areas affect the incidence of MA, thus helping to improve the MA models' predictive potential, as opposed to models based on individual attributes of the borrowers and loan characteristics only.

4.1 Mortgage records

The mortgage data were obtained from a nationwide database maintained by the country's leading commercial bank, which finances about 30% of all mortgages in Israel (BOI, 2013). The individual mortgage records available to the researchers covered the 2-year period between 2010 and 2011. In particular, 91,537 records were retrieved from the database, 46,633 records for the year 2010 and 44,904 records for 2011 (see Table 1).

The database analyzed in the study was retrieved in June 2016 and includes all the MA events since the issuance of a mortgage. In other words, the duration of the period during which the MA events (or a lack thereof) are considered is 2010-2016 for mortgages issued in 2010, and 2011-2016 for mortgages issued in 2011. For each study year, the time span over which MA events are recorded thus covers a considerably long period of 5-6 years, which minimizes the probability of a potential censoring problem in the data selection.

<<<Table 1 about here>>>

The records contained information on the geographic location of individual properties for which mortgages were received (referenced by seven-digit ZIP-codes), loan characteristics (i.e., the total mortgage amount and LTV ratio[1]), and several socioeconomic attributes of the borrowers, including age of the main borrower, education, income, the total number of persons in the family. If the mortgage borrower was in arrear for 3 months or more during the study period, the value of the MA variable was set to 1 and to *zero* otherwise.

4.2 Air pollution data

Air pollution data for the study were collected from the national air quality monitoring network, which consists of 140 monitoring stations spread all over the country, from the town of *Carmiel* in the north to *Eilat* in the south (see Figure 2). The information on five routinely monitored air pollutants – nitrogen oxides (NO_x), sulfur dioxide (SO_2), ozone (O_3), and particulate matter ($PM_{2.5}$ and PM_{10}), – where collected as annual averages in parts per billion (ppb) in the year of interest and linked to the geographic locations of individual properties by the nearest monitor method (Kioumourtzoglou et al, 2014).

<<<Figure 2 about here>>>

For each individual residential property in the database, we calculated its aerial proximity to the nearby main road (D_road), considering it as a proxy for routinely unmeasured air pollutants, such as volatile and semi-volatile organic compounds, often associated with motor vehicles (Klelly, 2011). The data linkages were performed in the ArcGIS™10.x software (ESRI, 2014).[2]

[1] LTV information is available only for the time of the mortgage's issuance, because, according to the current mortgage practice, the bank makes the LTV assessment only once, *before* the mortgage is approved.

[2] Depending on specific measurement equipment installed, air quality monitoring stations measure different combinations of air pollutants. In particular, there were 129 stations recording all five pollutants, and 11 stations recording NO_x, $PM_{2.5}$, and PM_{10} only.

4.3 Additional locational attributes

The northern border of Israel with Lebanon and the border with the Gaza strip in the south (Figure 2) are sources of continuous armed conflicts and security risks.[3] In addition, about 85,000 Israeli homes are currently located outside the 1949 Armistice (*aka* "green") line, in the territories controlled by Israel and known as Judea and Samaria or, alternatively, as the Jordan river's West Bank (CBS, 2017). These areas are disputed by Israel and the Palestinian Authority (PA), and international sanctions are imposed on industries and products manufactured there (Botta, 2010). Location in such areas may affect the loan repayment ability of the borrowers due to unstable job and salaries, loss of working hours during road closures, security unrests, etc.

To account for these potential effects, we added three additional variables as explanatory factors for the MA risk: areal distances to the Northern or to the Gaza strip borders (D_north, and D_Gaza, respectively), and whether the location of the property is in the Palestinian autonomous areas (PA). The former two variables were calculated in km (ln), while the latter variable received binary values, with its value set to zero if a property is located outside the Green line, and 1 for all properties located *inside* it. We also added the socio-economic status (SES) of the neighborhood as an additional explanatory variable, considering that probability of MA may be affected by neighborhood's socio-economic status, not only by individual welfare of the mortgage borrower. The calculations were performed using its "spatial join" tool in the ArcGIS™10.x software, applied to the layers (maps) obtained from the National Survey of Israel (SOI, 2016) and Israel Central Bureau of Statistics (CBS, 2012).

4.4 Statistical analysis

To identify and measure the effect of different factors on the MA incidence, we used two binary logistic models. The first, "Model 1", only contains socio-economic characteristics of the loans and borrowers as explanatory variables.

$$logit_{MAi} = \mathrm{b}_0 + \mathrm{b}_1 \boldsymbol{IND}_i + \mathrm{b}_2 \boldsymbol{PROP}_i + \varepsilon \qquad (1)$$

[3] The list of recent armed conflicts and incidents originating from these areas include (in addition to intermittent clashes and security incidents): the 2nd Lebanon War (July-August 2006), the operation "Cast Lead" in Gaza (December 2008-January 2009), the operation "Pillar of Cloud" (November, 2012), and the operation "Protective Edge" (July-September 2014).

The second, "Model 2," contains the same socio and economic characteristics, and in addition it contains five environmental and location characteristics of each loan:

$$logit_{MAi} = \mathrm{b}_0 + \mathrm{b}_1\boldsymbol{IND}_i + \mathrm{b}_2\boldsymbol{PROP}_i + \mathrm{b}_3\boldsymbol{POL}i + \mathrm{b}_4 PA_i + \mathrm{b}_5 Roads + \mathrm{b}_6\boldsymbol{BORD}_i + \varepsilon \quad (2)$$

In these models:

$logit_{(MAi)}$ is probability of arrear for property i;

***IND**$_i$* is a vector of individual attributes of the borrower, including age, education (academic, associate, high school, or elementary), net monthly income of the family in NIS (ln), and family size (persons);

***PROP**$_i$* is a vector of mortgage-related attributes, including the total mortgage amount in NIS (ln) and LTV (%);

***POL**$_i$* is a vector of air pollution estimates for NO_x, O_3, PM_{10}, $PM_{2.5}$, and SO_2 air pollutants (in ppb);

PA is a dummy variable reflecting location inside the Green line (yes/no);

$Roads_i$ is the aerial distance from the property to the nearest main road (km);

***BORD**$_i$* is a vector of the aerial distances from the Northern or from the Gaza strip borders in km (D_north (ln) and D_gaza (ln), respectively), ε = random error term.

We also added a binary variable for the year 2011 to the models in which mortgage records for both years were pooled together.

5. Results

5.1 General trends

Table 1 reports selected descriptive statistics of the research variables. In 2010, out of a total number of 46,633 transactions examined, 6,304 transactions (11.8%) were in arrears. In 2011, out of the total number of 44,904 transactions, 4,868 mortgages (or 10.8%) were in the MA category, with regular payments delayed by 3 months or more. The majority of the borrowers (i.e., 56.5% in 2010, and 59.8% in 2011) had academic education. Such borrowers normally have higher incomes and more secured jobs compared to borrowers with lower levels of educational attainment. This usually affects the bank's decisions on mortgages.

As Table 1 also shows, the average net monthly income of the borrowers was 13,766 NIS in 2010 and 14,764 NIS in 2011, which are close to the average family income in Israel during that period -- NIS12,150 or US$3,492 (CBS, 2012). Notably, the average loan-to-value (LTV) ratio in both 2010 and 2011 was well below the 75% threshold instituted by Bank of Israel: 55% in 2010 to 53% in 2011. Such relatively low LTV ratios reflect a reasonable reaction of the lender to recent economic crises (such as the 2008 subprime crisis in the USA and European debt crisis in 2010), apparently aimed to reduce loan associated risks.

The mean estimates of air pollution exposures for individual properties appear to be, in general, well below the local air pollutions standards, which currently stand at 38 ppb for NOx, 66 ppb for O_3, 60 ppb for PM_{10}, 25 ppb for $PM_{2.5}$, and 23 ppb for SO_2 (IMEP, 2011). However, relatively large variations in the pollution levels, estimated for individual properties are also recorded: 5.6-94.0 ppb for NOx; 50.8-103.4 ppb for O_3, 44.0-74.0 ppb for PM_{10}, 19.0-29.0 ppb for $PM_{2.5}$, and 1.1-8.3 ppb for SO_2. This indicates that at least some properties in our sample are located in areas with very high levels of ambient air pollution.

5.2 Differences in the MA rates

Table 2 reports MA rates calculated for geographic areas with different levels of air pollution. For the analysis, the observed air pollution levels were grouped into three categories – low, medium, and high, – using Jenks' natural breaks method (ESRI, 2014).

<<<Table 2 about here>>>

As Table 2 shows, there appear to be significant differences in average MA rates in areas with different concentrations of most air pollutants analyzed. In particular, in the combined dataset (Y2010-2011), the average rate of MA in localities with low NO_x levels is 11.8%, while such a rate is 13.4% in localities with high concentrations of this air pollutant (X^2=11.297, p<0.01). Similar trends are observed for other air pollutants as well: 10.7% of MA for low concentrations of PM_{10} vs. 14.0% of MA for high concentrations (X^2=128.97, p<0.01); 10.0% of MA for low concentrations of $PM_{2.5}$ vs. 13.8% of MA for high concentrations (X^2=120.81, p<0.01), and 10.9% of MA for low concentrations of SO_2 *vs.* 12.8% for high concentrations of this air pollutant (X^2=25.75, $p<0.01$).

5.4 Regression analysis

The aforementioned association between air pollution exposure estimates and MA incidence might be attributed, at least in theory, to the concentration of low-income borrowers in highly polluted areas, rather than to the exposure to air pollution *per se*. To investigate such a possibility, we performed a multi-variate regression analysis of factors potentially affecting the MA incidence, in which environmental exposure variables were controlled for individual attributes of the borrowers, neighborhood SES, and loan characteristics.

The results of the analysis are reported in Tables 3, 4 and 5. The models in these tables are presented separately for years 2010 and 2011 (Tables 3 and 4) and for the two years combined (Table 5). In Table 3, the results refer to Model 1, where only socio-economic characteristics of the borrowers are the explanatory variables. In Table 4, the regression results of Model 2 are reported. In this model, the air pollution characteristics of the area of residence as well as the security risk characteristics are added to the list of explanatory variables. Table 5 displays the results of the combined two years, 2010 and 2011, both for Model 1 and Model 2.

Many air pollutants often come from the same pollution sources, such as e.g., industries and motor traffic. As a result, a strong correlation between air pollution measurements is observed, as confirmed by correlation coefficients reported in Appendix 1. Due to the presence of such correlation, we estimated separately models in which different air pollution variables are introduced into regressions separately. Tables 6-7 report the results of such singe-pollutant modelling.

<<<Tables 3-7 about here>>>

As Table 3 shows, in the year 2010, the following factors emerged as statically significant predictors for MA: the borrower's age (b=0.04; $p<0.05$); academic education (b=-0.596, $p<0.01$), associate education (b=-0.259, $p<0.01$), mortgage amount, NIS (ln) (b=-0.111, $p<0.01$), LTV ratio (b=0.005, $p<0.01$), and family size (b=0.025, $p<0.01$). Concurrently, in the year 2011 model, the significant predictors of MA incidence were: the borrower's age (b=0.05; $p<0.05$); academic education (b=-

0.311, $p<0.05$), mortgage amount, NIS (ln) ($b=-0.091$, $p<0.01$), LTV ratio ($b=0.005$, $p<0.01$), and family size ($b=0.031$, $p<0.01$).

In the *bi*-annual Model 1 (see Table 5, the first 4 columns), the following socio-demographic and property related attributes emerged as statistically significant: age of the main borrower ($b=0.004$, $p<0.01$), mortgage amount ($b=-0.102$, $p<0.01$), LTV ratio ($b=0.005$, $p<0.01$), family size ($b=0.028$, $p<0.01$), and Y2011 dummy variable ($b=-0.211$, $p<0.01$). All these variables exhibit the expected sign, indicating that the MA incidence tends to increase with the age of the borrower, LTV ratio and family size, while such incidence appears to decrease with educational attainment, being lower for borrowers with academic education than for less educated ones.

Notably, the regression fit improves after the environmental variables are added to the set of predictors, as indicated by the Hosmer-Lemeshow (H-L) goodness-of-fit test, as well as AIC, and SBC tests (Archer, 2006). In particular, for the year 2010, the values of the H-L X^2 drops from 16.733 in the model without environmental variables (Table 3) to 13.481 in the model incorporating them (Table 4), thus indicating that the inclusion of environmental variables improves the model estimates. The AIC and SBC tests, which smaller values indicates that differences from the "true" model are minimized (Beal, 2007), show similar results, pointing out that the models improve after incorporating environmental variables. A similar improvement in the model fit is observed in the year 2011 models after adding environmental and security risk variables (Model 1 vs. Model 2), and in the models estimated for *bi*-annual data (see Table 5), as confirmed by H-L, AIC and SBC tests.

As Table 4 shows, the following environmental variables emerged statistically significant in the year 2010 model: NO_x ($b=0.004$, $p<0.01$); $PM_{2.5}$ ($b=0.049$, $p<0.01$), SO_2 ($b=0.046$, $p<0.01$), and location inside the "green" line (PA: $b=0.186$, $p<0.01$) (see Table 4). All these variables exhibit the expected signs. Only one variable (D_gaza) emerged with an unexpected (positive) sign ($b=0.109$, $p<0.05$), implying that other things being equal, the MA risk tends to rise as distances to this enclave increase. We shall try to explain this unexpected finding in the discussion section.

Concurrently, in the year 2011 model, the following two environmental variables emerged statistically significant: PM_{10} ($b=0.014$, $p<0.01$), and SO_2 ($b=0.055$, $p<0.01$), while all five air pollution variables analyzed emerged statistically significant in the pooled model, exhibiting the expected positive signs: NO_x (b=0.003, $p<0.01$); O_3 (b=0.007, $p<0.01$); PM_{10} (b=0.007, $p<0.01$), $PM_{2.5}$ (b=0.027, $p<0.01$), and SO_2 (b=0.046, $p<0.01$) (see Table 5).

The results of single-pollutant modeling, reported in Tables 6-7, in which most air pollutants emerged as statistically significant predictors of the MA events are consistent with the results of multi-pollutant modelling.

5.3 Sensitivity test

Figure 3 reports the result of a sensitivity test of the MA risk estimate to plausible changes in the levels of air pollutions variables. The test was performed using the regression coefficients of the *bi*-annual model (see Table 5). As Figure 3 shows, the estimated relative risk (RR) of MA increases from 1.02 to 1.36 for the low-to-high change in the recorded NOx levels, from 1.30 to 1.92 for the low-to-high change in O_3, from 1.32 to 1.70 for PM_{10}, from 1.66 to 2.17 for $PM_{2.5}$, and from 1.05 to 1.54 for $SO_{2.}$

<<<Figure 3 about here>>>

6. Discussion and conclusions

The present study examined socio-demographic, environmental and security risk factors behind MAs in Israel during the 2010-2011 period. Individual mortgage records for the analysis were obtained from the nationwide mortgage database maintained by a leading commercial bank and geographically referenced by 7-digit zip codes. For each property, several environmental and geographic attributes were estimated, including annual air pollution averages, proximity to main roads and proximity to high security risk areas, such as border with Lebanon in the North and border with the Gaza strip in the south. Using these data, multiple logistic models were then ran, to identify factors significantly affecting the MA risk. In these models, environmental and security risk attributes of individual properties were controlled for individual attributes of the borrowers and basic loan characteristics.

As the analysis found, the incidence of MA appear to increase in line with age of the main borrower, LTV ratio and family size, and decrease with education attainment of the borrowers. Most air pollution variables analyzed (i.e., SO_2, O3, $PM_{2.5,}$ PM_{10}, and NO_X) also emerged as statistically significant predictors of the incidence of MA

(P<0.01). In addition, proximity to the Gaza strip border emerged significant in the 2010 model but not in the 2011 model. A possible explanation for this change might be related to the introduction of new security measures that effectively reduced the risk of property damage and injuries to the residents of the border areas, such as the Iron Dome tactical defense system that became operational at the first quarter of 2010. As a result of the installation of this system, the number of rockets that were launched from Gaza and reached Israel was sharply reduced, from more than 400 in 2009, to less than 100 rockets and projectiles in 2010 (ISA, 2012).

Most variables in the MA models emerged with expected signs, showing that the MA risk tends to increase, *ceteris paribus,* in line with an increase in the level of air pollution to which residents of a geographic area are exposed. In particular, according to our estimates, the relative risk of MA in most polluted areas was, on the average, 27-74% higher than in the least polluted areas. We attribute such an increase to potential health complications and reduction in work productivity associated with prolonged exposure to air pollution. Another possible explanation for this phenomenon is the departure of affluent people from environmentally disadvantageous areas (Ding et al, 2010). Private entrepreneurs and real estate developers may also opt to build in the areas where they have a chance to make profit, not in distressed areas. Owners of advanced companies may also prefer to establish their factories in environmentally favorable and non-polluted areas, where there is a better chance to find high quality and educated manpower, not in the areas in distress. Hence, *a-priori* highly polluted areas and areas with high security risk are likely to have residents that are greatly affected by even small changes in the economic conditions and have difficulties making regular mortgage payments.

Our results are in line with findings of other studies that revealed statistically significant associations between mortgage survival and several individual level factors and loan attributes, including LTV rate, age and income (cf., *inter alia,* Ronald, 2008, Min, 2009, Benita, 2013). The study is novel in that it examined the effect of environmental variables (specifically, exposure to air pollution and proximity to security risk areas) on MA incidence. In this respect, the findings of this study are of practical importance, potentially helping borrowers and lenders to make informed real estate decisions. In particular, knowledge about additional risks associated with buying a property in a polluted area can help borrower to redirect their investment. From a standpoint of the lender, a correct assessment of the MA risk can help determine more precisely the risk premium for each mortgage, and provide the borrower with an appropriate mortgage interest quote. The results of the study may also help the government to prioritize environmental and security issues and to deal with these issues more effectively by understanding better their multifaceted effects on the economy.

The relative strength of the present study is the use of individual level data, controlling for both individual-level and regional confounders, and a relatively large number of individual transactions covered (more than 90,000 mortgage records), which helped to improve the robustness of the estimates.

Several limitations of the study are ought to be mentioned. First, due to data availability considerations, the study covered a relatively short period between 2010 and 2011 and used data obtained from one mortgage lending bank. All mortgage lenders in Israel have to comply with regulations issued by the country's central bank, and therefore, no substantial bias can potentially occur in the MA risk estimates. Nevertheless, future studies should attempt to expand the period of the analysis and incorporate data from other banks and lending institutions, to verify the generality and time-invariability of our findings. Studies in other countries, using the same (or similar) methodologies, may also be beneficial for estimating the importance of incorporating environmental variables into mortgage risk assessment models.

According to several empirical studies, localities characterized by unfavorable environmental conditions often experience out-migration of well-to-do residents, stagnant housing prices or even price depreciation (see e.g., Crowder, 2010). In Israel, districts located in the country's core areas exhibit relatively high levels of traffic-related air pollution and often tend to exhibit outmigration, except for the Central district, adjacent to Tel Aviv, which absorbs many migrants and has shown, in recent years, robust price increases of about 37% (MC&H, 2018).

It should also be noted that the database, the results of which analysis are reported in this study, is an individual-level cross-sectional database, which does not allow to investigate dynamic events such as migration, changes in air pollution in particular localities and links between them. The conjecture between these variables may present a legitimate topic of future studies, focusing on the links between the price behavior, air pollution and security dynamics. Further studies may also use hazard type models for predicting MA events should the duration-to-event information for individual mortgages become available.

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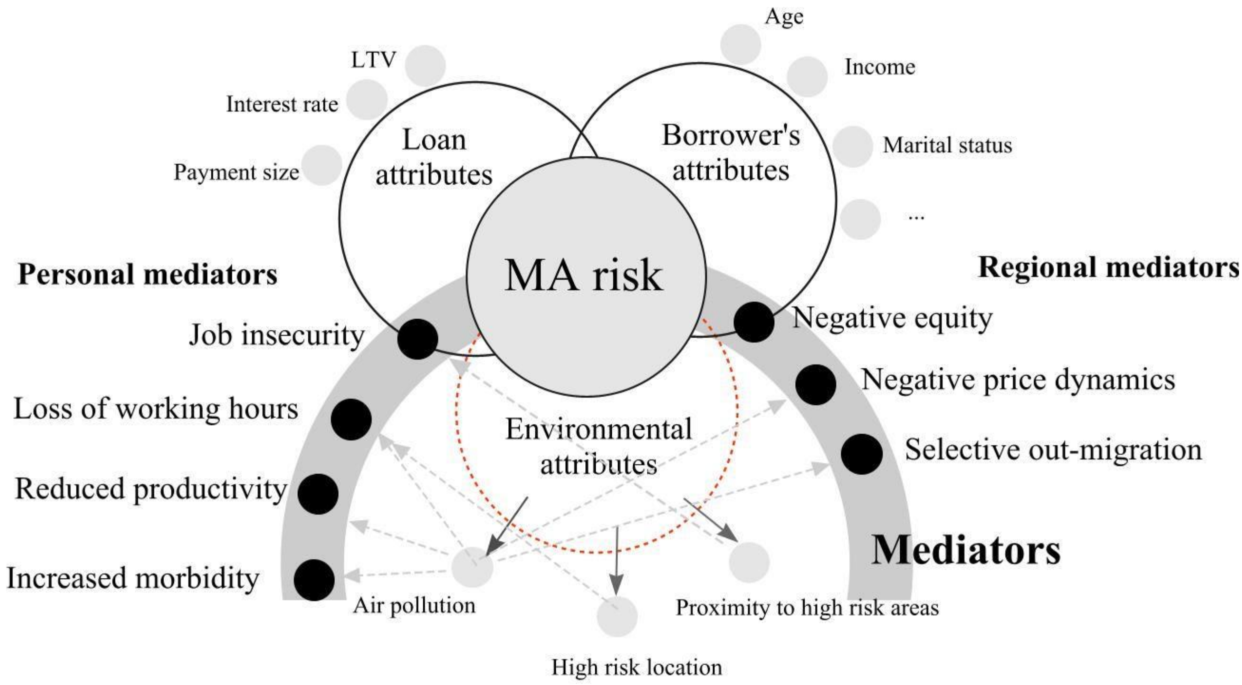

Figure 1: Conceptual model of the factors potentially affecting MA events

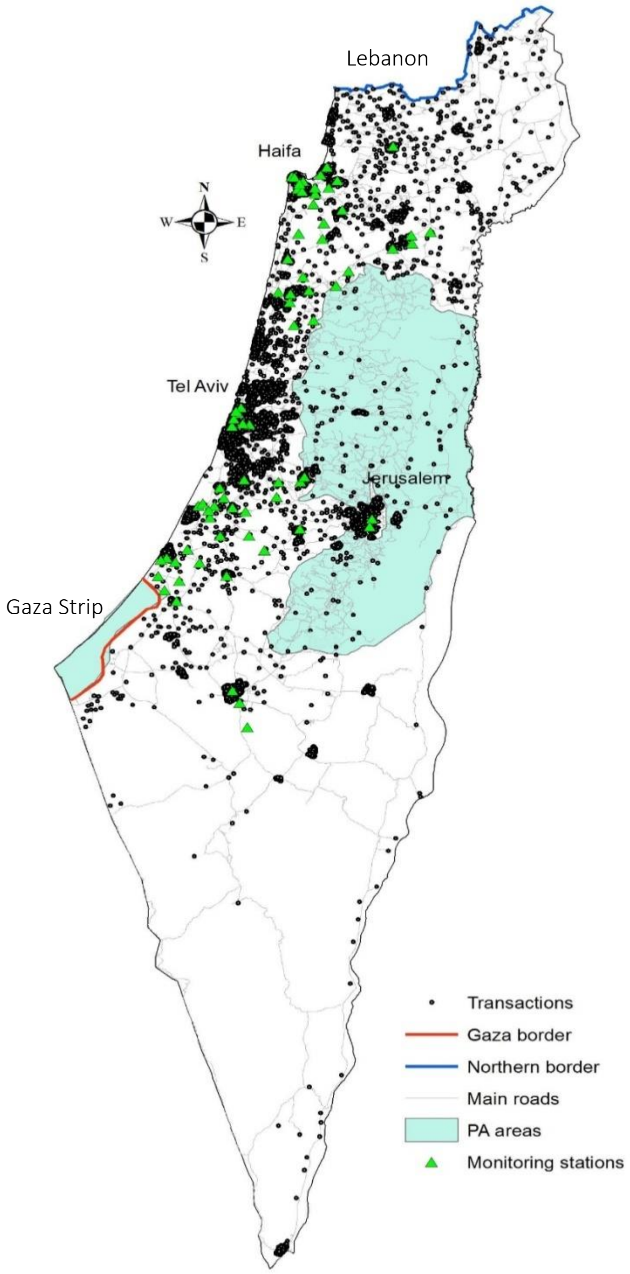

Figure 2: Map of the study area showing the location of residential properties under study and relevant geographic attributes – main cities, borders, roads, etc.

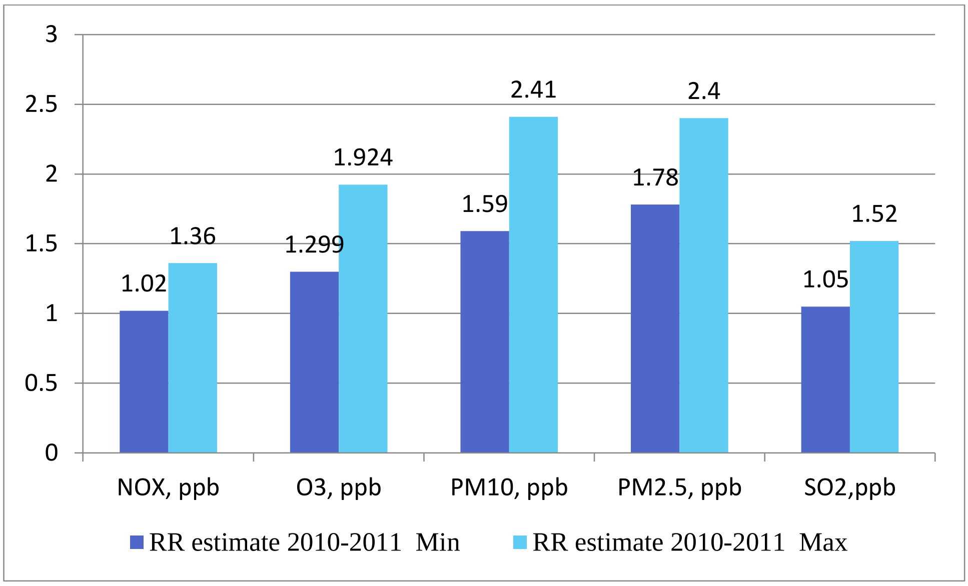

Figure 3: Sensitivity tests of the MA relative risk (RR) to plausible changes in air pollution levels (see text for explanations)

Note: Based on Table 5 (Y2010-2011). The values of all variables (except for air pollution) are set to their averages in the given time period.

Table 1: Descriptive statistics of the research variables

Variable	Min	Max	Mean	Std. Dev.	Count (%)	Min	Max	Mean	Std. Dev.	Count (%)
	2010					2011				
MA event:										
• Yes (%)	-	-	-	-	6304 (11.8%)	-	-	-	-	4868 (10.8%)
• No (%)	-	-	-	-	47044 (88.2%)	-	-	-	-	40036 (89.2%)
Age of the main borrower (years)	18	70	47.52	11.09	-	18	70	46.81	10.91	-
Education:										
• academic	-	-	-	-	56.50%	-	-	-	-	59.80%
• associate	-	-	-	-	32.20%	-	-	-	-	31.50%
• high school	-	-	-	-	9.10%	-	-	-	-	6.90%
• elementary	-	-	-	-	2.20%	-	-	-	-	1.80%
Net monthly income, NIS (ln)	0	14.22	9.53	0.57		0	15.42	9.60	0.54	-
Mortgage amount, NIS (ln)	3.91	16.45	12.40	1.07	-	5.23	16.77	12.39	1.11	-
Loan-to-value ratio (%)	0.1	1.00	0.55	0.19	-	0.1	1.23	0.53	0.18	-
Family size, persons	1.00	16.00	3.81	2.02	-	1.00	17.00	3.85	2.11	-
Air pollution estimates (annual averages in ppb):										
• NOx	5.64	94.00	38.27	21.27	-	3.00	80.00	31.17	15.40	-
• O_3	50.76	103.40	66.15	12.27	-	41.55	96.00	67.84	9.62	-
• PM_{10}	44.00	74.00	61.80	8.14	-	36.00	63.00	50.62	6.68	-
• $PM_{2.5}$	19.00	29.00	23.52	2.52	-	14.00	26.00	22.17	2.39	-
• SO_2	1.13	8.27	3.49	1.36	-	1.00	10.48	4.02	1.53	-
D_road, m	0.00	4324.49	110.17	131.81	-	0.00	4324.49	110.00	134.08	-
PA areas	-	-	-	-		-	-	-	-	
• yes	-	-	-	-	8%	-	-	-	-	8.3%
• no	-	-	-	-	92%	-	-	-	-	91.7%
D_north, km (ln)	3.35	12.88	11.48	0.76		3.35	12.88	11.48	0.76	
D_gaza, km (ln)	7.20	12.31	11.11	0.57		7.20	12.31	11.10	0.58	
Valid N (listwise)	46,633					44,904				

Table 2: Number of default cases and default rates (%) in locations characterized by different air pollution levels

Air pollution Level[1]	NOx			O_3			PM_{10}			$PM_{2.5}$			SO_2		
	Count	%	X^2	Count	%	X^2	Count	%	X^2	Count	%	X^2	Count	%	X^2
Y2010															
Low	2575	13.10	0.89	2588	12.20	44.08**	625	12.60	18.87**	2728	11.90	79.21**	5689	13.30	16.22**
Medium	3189	13.30		3385	14.10		2599	12.70		3422	14.70		230	10.80	
High	428	13.70		219	16.10		2968	14.00		42	10.50		273	15.10	
Y**2011**															
Low	2969	11.15	7.20*	10	8.00	1.75	80	7.11	28.25**	54	10.47	5.75	4618	10.86	1.10
Medium	1776	10.34		4000	10.89		2417	10.45		434	9.78		148	9.99	
High	36	10.32		771	10.56		2284	11.48		4293	10.95		15	10.87	
Y2010/11															
Low	4661	11.8	11.297**	10	8.0	2.914	3113	10.7	128.97*	227	10.0	120.81**	1787	10.9	25.75**
Medium	5834	12.3		9696	12.1		4878	12.1		6606	11.3		8735	12.3	
High	463	13.4		1252	12.4		2967	14.0		4125	13.8		436	12.8	

[1]Air pollution levels: SO_2: Low - <4ppb, Medium – 4-6, High - >6 ppb; PM2.5: Low - <19, Medium – 25-27, High - >28 ppb;PM10: Low - <47, Medium – 58-64, High - >74 ppb; O3: Low - <62, Medium – 66-86, High - >103 ppb; NOX : Low - <1, Medium – 31-64, High - >94 ppb.

Notes: Indicates a 0.05 significance level; ** indicates a 0.01 significance level (two-tailed).

Table 3: Factors affecting mortgage defaults in 2010 and 2011 (**Model 1:** Socio-economic factors as explanatory variables only; method: binary logistic regression; dependent variable: mortgage default - Yes=1, No = 0)

Variable	**Y2010**[d]				**Y2011**[d]			
	B	Exp(B)	95% CI		B	Exp(B)	95% CI	
			Lower	Upper			Lower	Upper
(Constant)	-0.632	0.531	-	-	-1.720	0.179	-	-
Age (years)	0.004*	1.004	1.001	1.007	0.005*	1.005	1.001	1.008
Education:								
• academic	-0.596**	0.551	0.467	0.650	-0.311*	0.733	0.589	0.912
• associate	-0.259**	0.772	0.654	0.910	0.067	1.069	0.858	1.331
• high school	-0.153	0.858	0.718	1.025	0.073	1.076	0.847	1.366
Net monthly income, NIS (ln)	-0.007	0.993	0.940	1.050	0.024	1.024	0.959	1.093
Mortgage amount, NIS (ln)	-0.111**	0.895	0.871	0.919	-0.091**	0.913	0.887	0.940
Loan-to-value ratio (LTV, %)	0.005**	1.005	1.004	1.007	0.005**	1.006	1.004	1.007
Family size, persons	0.025**	1.026	1.011	1.041	0.031**	1.032	1.016	1.049
Neighborhood SES	0.001	1.000	0.995	1.006	0.001	1.001	0.995	1.007
No of cases	47,324				44,027			
H-L X^{2a}	16.733*				23.470*			
AIC[b]	101650.115				101603.850			
SBC[c]	101571.352				101534.447			
-2 Log likelihood	36006.120				29307.172			

*Indicates a 0.05 significance level; ** indicates a 0.01 significance level (two-tailed). [a] Hosmer–Lemeshow test is for the goodness-of-fit [b] Akaike information criterion (Notes: smaller values of the index indicate models, which minimize differences from the "true" model (Beal, 2007); [c] Schwarz Bayesian criterion (the criterion helps to select between a finite set of models; the model with the lowest BIC is preferred (*ibid.*)); [d]mortgage issuance year, from which on all the MA events are counted till the database retrieval in June, 2016).

Table 4: Factors affecting mortgage defaults in 2010 and 2011 (**Model 2:** Environmental and locational variables added; Method: binary logistic regression; dependent variable: mortgage default event (Yes=1, No = 0))

	Y2010[d]				**Y2011**[d]			
	B	Exp(B)	95% CI		B	Exp (B)	95% CI	
Variable			Lower	Upper			Lower	Upper
Constant	-4.271	0.014	-	-	-3.243	0.039	-	-
Socio-economic variables:								
Age (years)	0.004*	1.004	1.002	1.007	0.005*	1.005	1.001	1.008
Education:								
• academic	-0.549**	0.577	0.489	0.682	-0.292**	0.0747	0.600	0.930
• associate	-0.234*	0.792	0.670	0.935	0.084	1.088	0.874	1.355
• high school	-0.112	0.894	0.747	1.070	0.101	1.106	0.871	1.405
Net monthly income, NIS (ln)	-0.007	0.993	0.939	1.050	0.015	1.015	0.951	1.084
Mortgage amount NIS (ln)	-0.112**	0.894	0.870	0.918	-0.095**	0.909	0.883	0.936
Loan-to-value ratio (LTV, %)	0.006**	1.006	1.004	1.007	0.006**	1.006	1.004	1.008
Family size, persons	0.018	1.018	1.003	1.034	0.027**	1.027	1.011	1.044
Neighborhood SES	0.000	1.000	0.994	1.005	0.001	1.001	0.995	1.007
Environmental and locational variables:								
NOx ,ppb	0.004**	1.004	1.002	1.006	0.001	1.001	0.998	1.003
O_3,ppb	0.004	1.001	1.004	1.001	1.008	1.005	1.001	1.010
PM_{10},ppb	0.005	1.005	1.000	1.010	0.014**	1.014	1.008	1.020
$PM_{2.5}$,ppb	0.049**	1.050	1.036	1.064	0.005	1.005	0.991	1.020
SO_2,ppb	0.046**	1.047	1.024	1.071	0.055**	1.056	1.031	1.082
D_road, m	0.000	1.000	1.000	1.000	0.000	1.000	1.000	1.000
PA (yes/no)	0.055**	1.213	1.090	1.090	-0.090	0.914	0.810	1.032
D_north, km (ln)	0.033	1.033	0.974	1.096	0.017	1.017	0.953	1.085
D_gaza, km (ln)	0.109*	1.115	1.033	1.204	-0.001	0.999	0.922	1.081
No of cases	47,324				44,028			
H-L X^{2a}	13.481				14.982			
X^2 Sig.	0.096				0.060			
AIC[b]	-100071.662				-101680.447			
SBC[c]	-99914.423				-101532.967			
-2 Log likelihood	35347.435				29210.904			

See footnotes to Table 3

Table 5: Factors affecting mortgage defaults in Y2010-2011 (**Models 1&2**: Dependent variable: mortgage default: Yes=1, No = 0)

Variable	Y2010-2011[d]				Y2010-2011[d]			
	B	Exp (B)	95% CI Lower	95% CI Upper	B	Exp (B)	95% CI Lower	95% CI Upper
Constant	-0.984	0.374			-3.321	0.036		
Socio-economic variables:								
Age (years)	0.004**	1.004	1.002	1.007	0.005**	1.005	1.007	1.007
Education:								
• academic	-0.489**	0.613	0.538	0.699	-0.454**	0.635	0.557	0.725
• associate	-0.134	0.874	0.767	0.997	-0.111	0.895	0.784	1.021
• high school	-0.068	0.934	0.811	1.077	-0.033	0.967	0.838	1.116
Net monthly income, NIS (ln)	0.004	1.004	0.963	1.048	0.002	1.022	0.960	1.046
Mortgage amount NIS (ln)	-0.102**	0.903	0.886	0.921	-0.104**	0.901	0.883	0.919
Loan-to-value ratio (LTV, %)	0.005**	1.006	1.004	1.007	0.006**	1.006	1.004	1.007
Family size, persons	0.028**	1.029	1.018	1.040	0.022**	1.022	1.011	1.033
Neighborhood SES	0.001	1.001	0.997	1.005	0.000	1.000	0.996	1.004
Year 2011	-0.211**	0.810	0.778	0.844	-0.113**	0.893	0.842	0.947
Environmental variables:								
NOx ,ppb	-	-	-	-	0.003**	1.003	1.001	1.004
O_3,ppb	-	-	-	-	0.007**	1.007	1.004	1.009
PM_{10},ppb	-	-	-	-	0.007**	1.007	1.003	1.011
$PM_{2.5}$,ppb	-	-	-	-	0.027**	1.027	1.018	1.037
SO_2,ppb	-	-	-	-	0.046**	1.047	1.031	1.064
D_road, m	-	-	-	-	0.000	1.000	1.000	1.000
PA (yes/no)	-	-	-	-	0.061	1.063	0.982	1.151
D_north, km (ln)	-	-	-	-	0.020	1.020	0.978	1.065
D_gaza, km (ln)	-	-	-	-	0.029	1.030	0.976	1.086
No of cases	91,350				91,350			
H-L X^{2}[a]	31.099				12.107			
AIC[b]	202826.186				201383.776			
SBC[c]	202750.928				201223.993			
-2 Log likelihood	65322.311[a]				64607.974[a]			

See footnotes to Table 3

Table 6: Factors affecting mortgage defaults in 2010 and 2011 (**Model 3:** environmental and locational variables added, air pollution variables introduced separately); Method: binary logistic regression; dependent variable: mortgage default (Yes=1, No = 0))

Variable	**Y2010**[d]					**Y2011**[d]				
	Model w/ NOx	Model w/ O_3	Model w/ PM_{10}	Model w/ $PM_{2.5}$	Model w/ SO_2	Model w/ NOx	Model w/ O_3	Model w/ PM_{10}	Model w/ $PM_{2.5}$	Model w/ SO_2
(Constant)	-1.611	-1.818	-1.674	-2.798	-2.315	-2.466	-2.832	-2.227	-2.343	-3.448
Socio-economic variables:										
Age (years)	0.005*	0.005*	0.005*	0.004*	0.005*	0.005	0.005*	0.005*	0.005*	0.005
Education:										
• academic	-0.579**	-0.577**	-0.583**	-0.574**	-0.573**	-0.299	-0.299	-0.301	-0.297	-0.292
• associate	-0.251*	-0.250*	-0.251*	-0.249*	-0.252*	0.078	0.075	0.084	0.080	0.077
• high school	-0.127	-0.133	-0.113	-0.142	-0.121	0.092	0.093	0.101	0.089	0.091
Net monthly income, NIS (ln)	-0.007	-0.001	-0.010	-0.001	-0.006	0.020	0.023	0.007	0.021	0.026
Mortgage amount, NIS (ln)	-0.113**	-0.110**	-0.114**	-0.110**	-0.112**	-0.96	-0.094**	-0.097**	-0.095**	-0.094**
Loan-to-value ratio (%)	0.006**	0.006**	0.006**	0.006**	0.006**	0.006**	0.006**	0.006**	0.006**	0.006**
Family size, persons	0.020	0.018	0.021	0.019	0.019	0.029**	0.026*	0.031**	0.029*	0.025*
SES	-0.01E-02	-0.0325E2	-0.0318E	-0.0436E	-0.0287E	0.001	0.001	0.001	0.001	0.001
Environmental variables:										
NOx ,ppb	0.001	-	-	-	-	0.0147E-3	-	-	-	-
O_3,ppb	-	0.005**	-	-	-	-	0.008**	-	-	-
PM_{10},ppb	-	-	0.008*	-	-	-	-	0.016**	-	-
$PM_{2.5}$,ppb	-	-	-	0.042**	-	-	-	-	0.012	-
SO_2,ppb	-	-	-	-	0.035*	-	-	-	-	0.067**
D_road, m	0.108E-03	0.102E-03	0.011E-3	0.011E-3	0.010E-3	0.014E-3	0.012E-3	0.013E-3	0.014E-3	0.014E-3
PA (yes/no)	0.260**	0.158*	0.227**	0.233**	0.0242**	0.029	-0.044	-0.057	0.031	0.022*
D_north, km (ln)	0.063*	0.079*	0.019	0.057	0.077*	0.088	0.099*	0.016	0.066	0.086
D_gaza, km (ln)	0.021	-0.017	0.032	0.038	0.056	-0.020	-0.048	-0.028	-0.035	0.040
H-L X^{2a}	31.862	30.598	19.513	24.101	32.624	14.786	22.820	15.079	16.763	23.653
AIC[b]	-99981.476	-99998.753	-99989.51	-100032.273	-99990.780	-101620.301	-101658.813	-101648.294	-101522.78	-101639.455
SBC[b]	-99867.111	-99883.123	-99875.95	-99918.65	-99877.002	-101624.872	-101563.385	-101552.886	-101527.549	-101544.021
-2 Log likelihood	64846.546[a]	64825.137[a]	64736.458[a]	64769.147[a]	64834.721[a]	29282.243[a]	29264.035[a]	29251.683[a]	29251.683[a]	29244.975[a]

See footnotes to Table 3

Table 7: Factors affecting mortgage defaults in 2010-2011 (**Model 3:** environmental and locational variables added, air pollution variables introduced separately); Method: binary logistic regression; dependent variable: mortgage default (Yes=1, No = 0))

Variable	Model w/ NOx	Model w/ O_3	Model w/ PM_{10}	Model w/ $PM_{2.5}$	Model w/ SO_2
(Constant)	-1.831	-2.128	-1.871	-2.225	-2.728
Socio-economic variables:					
Age (years)	0.005**	0.005**	0.005**	0.005**	-0.005**
Education:					
• academic	-0.474**	-0.0472**	-0.047**	-0.470**	-0.0466**
• associate	-0.124	-0.123	-0.121	-0.121	-0.124
• high school	-0.044	-0.047	-0.043	-0.053	-0.038
Net monthly income, NIS (ln)	0.003	0.008	-0.003	0.006	0.005
Mortgage amount, NIS (ln)	-0.105**	-0.102**	-0.106**	-0.104**	-0.104**
Loan-to-value ratio (%)	0.006**	0.006**	0.006**	0.006**	0.006**
Family size, persons	0.024**	0.022**	0.025**	0.024**	0.022**
Neighborhood SES	0.038E-03	0.031E-03	0.030E-03	0.025E-03	0.036E-03
Year 2011	-0.208**	-0.222**	-0.103**	-0.172**	-0.238**
Environmental variables:					
NOx ,ppb	0.046E-03	-	-	-	-
O_3,ppb	-	-0.007**	-	-	-
PM_{10},ppb	-	-	0.010**	-	-
$PM_{2.5}$,ppb	-	-	-	0.030**	-
SO_2,ppb	-	-	-	-	0.050**
D_road, m	0.012E-03	0.012E-03	0.013E-03	0.011E-03	0.011E-03
PA (yes/no)	0.159**	0.064	0.115*	0.151**	0.145**
D_north, km (ln)	0.073**	0.000	0.024	0.050	0.083**
D_gaza, km (ln)	-0.001	-0.033	0.008	-0.006	0.052
H-L X^{2a}	70.544	45.036	35.796	48.211	76.281
AIC[b]	-201170.366	-201215.311	-201194.230	-201218.13	-201214.623
SBC[c]	-201148.562	-201093.102	-201072.506	-201085.826	-201092.146
-2 Log likelihood	64905.955[a]	64868.107 [a]	64788.582[a]	64826.833[a]	64886.879[a]

See footnotes to Table 3

Appendix 1: Correlation matrix of Pearson correlation coefficients for the Y2010-2011 pooled data

A. Air pollution variables

Air pollutant	O_3,ppb	PM_{10},ppb	$PM_{2.5}$,ppb	SO_2,ppb
NOx ,ppb	-0.611	0.313	-0.129	0.163
O_3,ppb		-0.122	0.192	-0.012
PM_{10},ppb				0.130
$PM_{2.5}$,ppb				-0.054

B. Socio-economic variables

Variable	Education	Net monthly income, NIS (ln)	Mortgage amount, NIS (ln)	Loan-to-value ratio (%)	Family size, persons	Neighborhood SES[a]
Borrowers' age (years)	0.039	0.156	-0.169	-0.275	-0.291	0.016
Education		-0.250	-0.149	-0.060	0.020	0.007
Net monthly income, NIS (ln)			0.255	0.042	0.140	0.001
Mortgage amount, NIS (ln)				0.223	0.021	0.003
Loan-to-value ratio (%)					0.059	0.002
Family size, persons						-0.009

[a] A continuous scale, ranging from 1 (low SES) to 20 (high SES) (CBS, 2012).