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European motor insurance demand: a spatial approach of its effects and key determinants

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ABSTRACT

The expansion of the European Union has intensified road traffic from, at least, two perspectives: it increased free mobility of people and goods, along with structural funds available for infrastructure improvement. Consequently, connections between regions/countries have improved, and a spatial diffusion effect is seen in the car transportation behaviour. We study the effect of Human Development Index (HDI) along with other important socio-economic, demographic and institutional factors on the motor insurance market in 31 European countries. Simultaneously, we evaluate if the crucial spatial diffusion effect is present on the European motor insurance market. Findings reveal that HDI, urbanization and car fleet positively impact the motor insurance market, while unemployment and population density exhibit an opposite effect. Overall, results are robust to a set of additional control factors, but sensitive relative to institutional factors and emerging and former communist countries group. Estimations confirm the assumption of spatial diffusion, while the assessment of the direct and indirect effects shows that most of the factors internally impact the dependent variable, and an international effect is at work for the HDI. Our findings may enhance the understanding of the European motor insurance market and provide some valuable insights from a policy perspective.

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1. Introduction

Amongst non-life insurance, motor insurance plays an important role in financial activities, being the dominant line of business, especially in emerging countries. Although there is an extensive strand of the literature studying the drivers of non-life insurance consumption across countries, still, the motor insurance sector is mostly approached at the country level.

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According to Insurance Europe (2021), the motor insurance market in Europe was worth approximately 147 billion euros in 2019 in terms of gross written premiums. Also, Europe's three largest markets (Germany, France and the UK) together accounted for almost half of the total amount (i.e. 72.31.95 billion euros), the largest motor insurance market for gross written premiums in Europe in 2019 being Germany, at a value of 28.55 billion euros. As well, the motor insurance line of business represents around 40% of the non-life insurance sector for the developed European countries. However, if we look only at the European emerging and former communist economies, this percentage rises to roughly 58 (see Figure A1 from Appendix A). Generally, the motor insurance sector includes two components: the motor third party liability insurance, which is mandatory in all EU states, and the voluntary damage coverage for which there are no EU-wide rules. Moreover, turning our attention to the size of the motor insurance market across countries, we can notice that it depends on a range of factors, such as the size of its economy, geography and demography. Accordingly, if we consider the consumption of motor insurance in European countries (expressed as premiums/capita in euros), we can observe a great heterogeneity amongst countries (see Figure A2 from Appendix A).

Given that for developing countries, the motor line of business is dominant as source of premiums, the size of the motor insurance sector may represent a proxy for the development of the insurance market (Habib-Makar, 1981). Still, motor insurance functions within a legal, economic, political and social framework, with constrained intervention options, justifying the consideration of institutional drivers, as well.

Taking stock of the above mentioned, our main motivation in this research steam from the importance and size of the motor insurance market within the non-life insurance sector in Europe, along with the lack of cross-country analyses on the determinants of demand for this line of business. Also, the high interdependencies within the sample states, which are rarely (or not at all) addressed in the related literature via spatial econometrics techniques, allow us to capture the potential neighbouring effects and provide a novel perspective on this fundamental topic.

Consequently, this paper aims to fill the gap in the related literature, by examining the impact of HDI along with other key socio-economic, demographic and institutional factors on the motor insurance demand. In doing so, we employ appropriate spatial panel techniques for a large sample of 31 European countries over the period 2004–2019. HDI is a measure of achievements in three key dimensions of HDI – health and longevity, standard of living and education – which proved to positively influence the life insurance demand (Browne & Kim, 1993; Li et al., 2007; Truett & Truett, 1990). Building on these previous results, we choose to study how the dimensions of the human development index influence the European motor insurance demand, both as a whole and individually, to draw practical policy implications.

Our results are as follows. We find that HDI, urbanization and the size of the car fleet exhibit a significant positive impact on motor insurance density, opposite to population density and unemployment, which seem to display a negative effect. While the findings remain qualitatively unaltered when we control for institutional factors and income distribution, overall, some of these additional variables significantly explain the spending behaviour on motor insurance in European countries.

When we consider individually the three dimensions of HDI, we ascertain that income and the educational index are the main drivers of the motor insurance market, with a positive influence.

Moreover, the impact of both main and control factors on motor insurance density differs between the groups of developed and emerging states. Also, significant contagion and diffusion processes are confirmed on the European motor insurance market, conditioned by the determinants analysed and the emerging status. Likewise, results suggest that additional spatial effects are triggered by the level of human development.

The rest of the paper is organised as follows. Section 2 surveys the related literature, Section 3 describes the data and the model specification, followed by empirical results and their discussion in Section 4, and the concluding remarks in Section 5.

2. Literature review

According to Mossin (1968), insurance increases welfare by transferring uncertainty from risk-averse individuals to risk-neutral insurers, who pool together a wide range of risks for better risk management. On the one hand, theoretical models of non-life insurance demand (Arrow, 1971; Mossin, 1968; Pratt, 1964) forecast increasing demand for higher levels of risk aversion (proxied by education or age structure of the population), probability of loss (proxied by urbanization or population density) and total wealth (proxied by income). On the other hand, scholars who focus on non-life insurance demand, primarily from an empirical perspective, are Millo and Pasini (2010), and Trinh et al. (2020), amongst others. Overall, their models include a wide range of explanatory variables such as economic, socio-demographic, institutional, and/or behavioural factors, while the demand for non-life insurance is expressed mainly through insurance density or penetration. Moreover, the landmark study of Feyen et al. (2013) targets the effect of four categories of explanatory factors (economic, demographic, socio-cultural, and institutional/market structure determinants) on both life and non-life insurance, for a broad sample of 90 countries during the period 2000–2008. More recently, Born and Bujakowski (2021) examine the development of property-casualty and life health insurance markets in 18 post-communist European countries over the period 2008–2017, using the dynamic generalised method of moment (GMM) approach. First, their results show that the factors having the highest impact on motor hull insurance are as follows: GDP, domestic credit, size of the agricultural sector and insurance market concentration. Second, for motor third party liability insurance, the factors with higher impact seem to be education, urbanization, foreign insurance penetration and the size of the agricultural sector.[1]

Regarding the impact of income on non-life insurance demand, the literature overwhelmingly documents a positive and significant one (Beenstock et al., 1988; Browne et al., 2000; Esho et al., 2004; Park & Lemaire, 2012), while authors such as Treerattanapun (2011) argues that non-life insurance becomes more affordable as the GDP per capita increases. Likewise, Treerattanapun (2011) also notes that in emerging markets the motor insurance line of business dominates the non-life insurance sector. Furthermore, one of the earliest studies analysing motor insurance demand

for 359 cities and towns in the state of Massachusetts (Sherden, 1984), concludes that the demand is generally inelastic for three automobile insurance coverages: bodily injury, comprehensive and collision. Put differently, Sherden (1984) shows that for physical damage coverage, an increase in the automobile price generates a decrease in the average price elasticity. Also, considering that the most used proxy for local spatial factors is population density, the author shows that the demand for comprehensive and collision coverage is positively associated with population density. In fact, Sherden (1984) suggests that the perceived risk for motor claims is a function of income threat and locational risk (expressed through population density).

Education, often used in the academic literature as a proxy for risk aversion, is another important determinant of non-life insurance demand. However, unlike the life sector where the results diverge, for the non-life sector the findings converge to a positive influence of education on the non-life insurance consumption (Ćurak et al., 2013; Park & Lemaire, 2012). In this way, Treerattanapun (2011) argues that education makes people more aware of risk and financial threats, generating higher levels of insurance demand. Also, Ofoghi and Farsangi (2013) find a positive and significant influence of risk aversion on the motor insurance demand, considering risk-averse individuals as having more insurance knowledge.

Findings on the importance of life expectancy as a determinant of the insurance market are quite restrictive for the non-life sector compared to the life one, while the life insurance literature provides a fairly wide range of results, namely positive effects (Outreville, 1996), negative effects (Li et al., 2007), insignificant effects (Browne & Kim, 1993), or ambiguous results (Beck & Webb, 2003). Along this line, the results of Feyen et al. (2013) reveal that a higher life expectancy is associated with a lower probability of death and a lower necessity to buy a life insurance policy. In contrast, for the non-life insurance market, Hodula et al. (2020) argue that a lower probability of premature death should stimulate people to insure their property, as they will use it for a longer period of time. Overall, as expected, life expectancy and HDI have received more attention in the life insurance sector compared to the non-life one. With respect to HDI, the literature suggests that countries with higher levels of HDI are expected to have a greater insurance penetration rate (Browne & Kim, 1993; Li et al., 2007, amongst others; Truett & Truett, 1990). Based on our knowledge, there are no studies in the literature that aim to investigate the potential relationship between HDI and car insurance demand. Indeed, by studying the influence of HDI on motor insurance demand we implicitly consider the aggregate influence of its three components, which due to collinearity issues cannot be introduced as independent factors in the same regression.

On the relationship between urbanization and automobile ownership, Melia et al. (2018) conclude that urban areas discourage car use. Thus, people living in urban areas perceive a higher risk of car accidents or theft, generating an increased motor insurance demand (Sherden, 1984). Besides, Browne et al. (2000), using urbanization as a proxy of loss probability, show that an increase of loss probability generates an increase in non-life insurance demand. Esho et al. (2004) associate urbanization with increased delinquency, and conclude that in urban areas additional sources of security are needed (i.e. security that can be obtained through property-casualty demand). As

well, in a study covering data from 82 countries, representing 82.7% of the world's total population, Park and Lemaire (2012) find a positive effect of urbanization on non-life insurance sales.

With respect to population density, the early study of Mills (1967) highlights that in areas with higher population density, people are discouraged to own cars because of a relatively higher price of their use. Likewise, the study of Sanghi (1976) on motor ownership in several US states indicates smaller auto ownership and use of vehicles for higher population density areas. This may be due to the proximity of service, shopping, or leisure activities, but also to a better-developed mass transportation system in highly populated areas. More recently, Oakil et al. (2016) argue that neighbourhood density has a strong effect on car ownership.

The unemployment rate is expected to have a negative effect on the insurance demand, even if some studies in the literature seem to contradict these expectations (Beenstock et al., 1988) – insignificant effect, and Born and Bujakowski (2021) – mixed results). Relatedly, Chitiyo (2017) examines the impact of a series of macroeconomic and social factors on the non-life insurance market for a panel of 28 African countries over the period 1990–2013. The findings indicate a highly significant negative relationship between unemployment rates and non-life insurance products. Also, Born and Bujakowski (2021) find that unemployment and savings are significant in the two-way fixed effects specifications for property-casualty insurance, for 18 post-communist European markets.

Starting from the idea that one of the roles of institutions is to diminish uncertainty (Peng, 2003), the governance indicators may represent important factors influencing insurance consumption choices. The relationship between institutional factors and the non-life insurance market has received great attention in the literature, even though the results vary depending on the sample, period, or research objective. Browne et al. (2000) focus their attention on motor vehicle and general liability insurance for 22 OECD countries for the period 1987–1992. Using panel data techniques, they provide evidence that several factors such as GDP per capita, wealth, the proportion of a country's insurance market controlled by foreign firms, and legal system are important to explain the purchase of motor vehicles and general liability. Contrary, Esho et al. (2004) unveil that the legal system lacks statistical significance after controlling for income and property rights. Besides, Park et al. (2010) show that the common law legal system is strongly associated with bonus-malus system designs in 16 Asian countries. Also, Dragos and Dragos (2013) employ the OLS approach on a sample of 31 European countries during the period 2006–2010 and show that the level of corruption is a key driver for non-life insurance development. Indeed, based on the findings for the non-life insurance consumption previously mentioned, we expect institutional factors to play an important role in explaining the motor insurance demand.

The Gini coefficient, measuring the income inequality across states, is considered as a determinant of non-life insurance consumption in the study of Nakata and Sawada (2007). The authors show that the income elasticity of insurance demand is greater than unity in low-income countries and smaller than unity in upper-income, middle-income and high-income countries. Thus, in low-income countries the non-

life sector is growing in importance, the products being seen as superior (luxury) goods. Similarly, Enz (2000) argues that the income elasticity of insurance is higher in developing markets, and smaller than one in developed ones.

Overall, the literature targeting the determinants of non-life insurance consumption emphasises their different effects in high-income countries compared to emerging ones. Since in emerging countries the main component of non-life insurance is represented by motor insurance, we are particularly interested in the results obtained for these states. Dragos (2014) shows that in 10 emerging CEE countries, over the period 2001–2011, the non-life insurance demand is positively influenced by income, education and urbanization, while it is negatively affected by income distribution. Likewise, Petkovski and Jordan (2014) examine the drivers of the non-life insurance market in 16 countries from Central and South-Eastern Europe over a period of twenty years (i.e. 1992–2011), and find a positive and significant relationship between rule of law, population density, number of passenger cars per 1.000 people, GDP per capita and the non-life insurance demand. Recently, the findings of Trinh et al. (2021) for 27 middle-income countries for the period 1980–2014 reveal that urbanization positively impacts non-life insurance consumption. The authors also point out that, for middle-income states, ensuring an environment promoting low government spending and high security of property rights could be effective in promoting non-life insurance products.

Starting from the current state of research for the non-life insurance demand, we analyse the drivers of the motor insurance demand for developed and developing European countries, along with the potential neighbouring effects.

3. Data and Methodology

3.1. Data

In this study, motor insurance density is considered as proxy for the development of the motor insurance market for 31 European countries,[2] observed annually over the period 2004–2019. As such, we aim to jointly capture the impact of some pivotal economic and demographic features on the motor insurance market, by using HDI and unemployment as key explanatory factors, along with population density and urbanization to control for a potential omitted variable bias. To provide a global assessment of a country's development level from a more subjective point of view, we use HDI rather than GDP in the modelling process, given that it is a comprehensive index that takes into account life expectancy, educational attainment and income. However, for emphasising which component is most salient, and for drawing relevant policy implications, we also consider them individually in the baseline model (see results in Appendix C). As well, bearing in mind that the development of the motor insurance market is also institutionally determined by the domestic regulations of each country, we also introduce in the analysis the World Governance Indicators (WGI) to control for the stability of the baseline findings. Besides, to further ensure the robustness of our results, we include the Gini coefficient as an additional control factor. The variables' description and source, together with the descriptive statistics are provided in Appendix B, Tables B1 and B2.

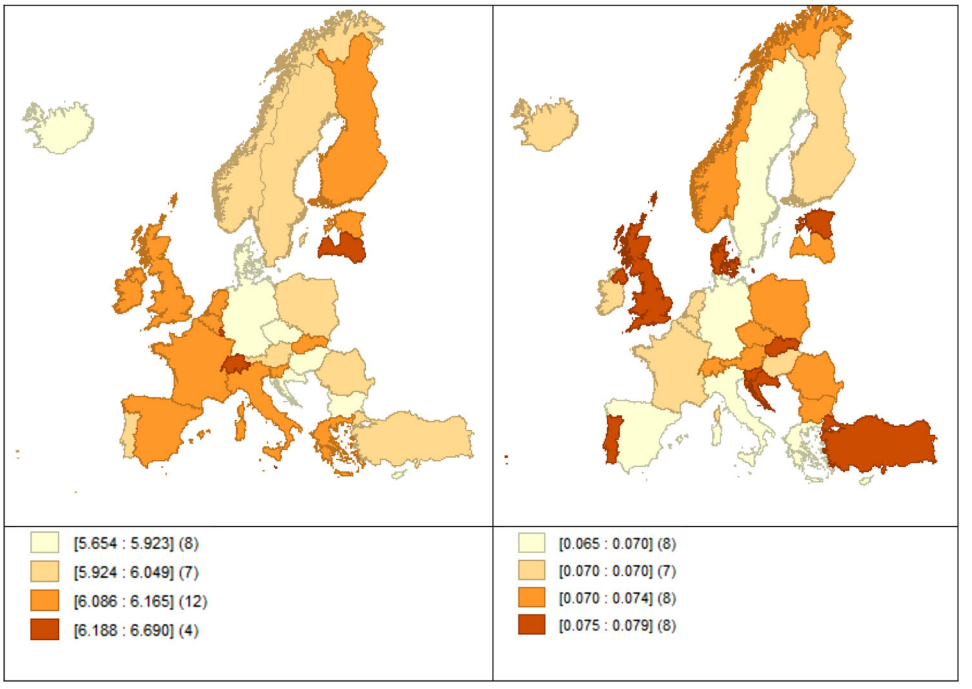

Figure 1. Motor insurance density on HDI (left) and urbanization (right): spatially smoothed rate quartile map (2019).
Source: Own computation.

3.2. Methodology

Given that the countries in our sample are either members of the EU or highly connected with the EU, there is a high interdependence that characterises their economic, social and political conduct. Thus, to properly capture the genuinely neighbouring effects that potentially characterise our sample, we employ spatial panel econometrics techniques.

First, as a preliminary step of the analysis, variables are descriptively assessed and treatments such as logarithmic transformation are applied where needed. Moreover, to better visualise the behaviour of our variables and their spatial features, we construct the associated specific maps. In this manner, on the one hand, we create the spatially smoothed rate maps between the logged value of the motor insurance density in 2019 and the potential influencing factors (HDI and urbanization – Figure 1; population density and unemployment – Figure 2). On the other hand, we use the conditional map with three dimensions to evaluate how the contagion and diffusion processes are conditioned by the explanatory variables. Particularly, the conditional map is constructed based on the median value of the two factors, using the quartile map for the dependent variable. Also, since island countries are included in the sample, the weights matrix is built based on distances rather than contiguity, in the inverse distance mode.

Second, given that we are dealing with European countries that are linked through cross-dependence, we expect fixed effects to be present in our sample. Indeed, this assumption is also confirmed by the result of the Hausman test and the Likelihood

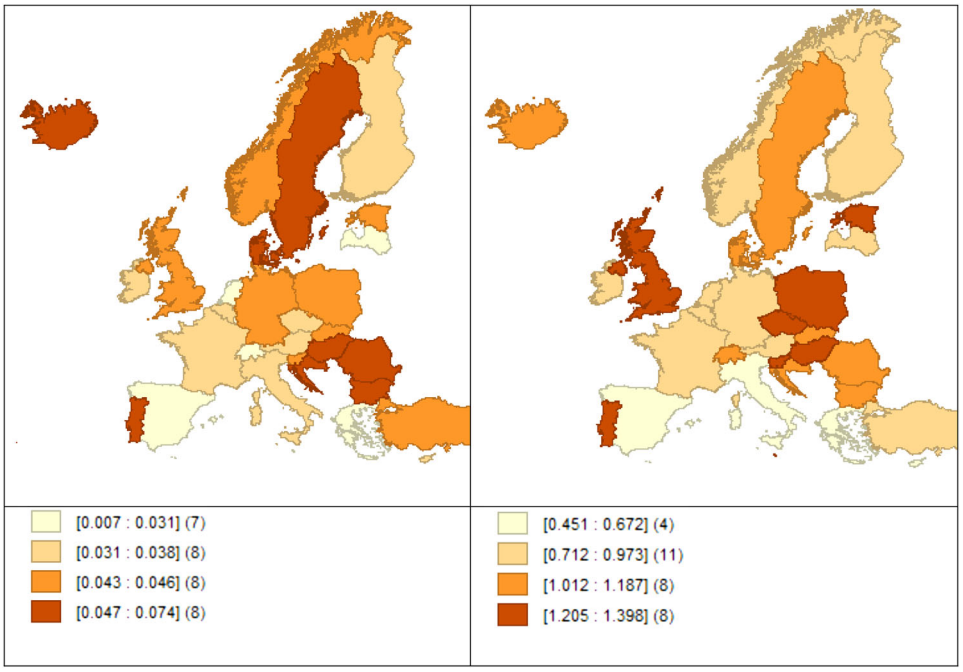

Figure 2. Motor insurance density on population density (left) and unemployment (right): spatially smoothed rate quartile map (2019).
Source: Own computation.

ratio test.[3] Besides, the preparatory estimations performed to identify the best model specification suggest that a SDM (i.e. Spatial Durbin Model) is appropriate, with spatial effects both for the dependent variable and for the HDI (or its components). Thus, the fixed effects spatial panel models are constructed following the equation below

$$Y_{it} = \lambda WY_{it} + X_{it}\beta + \gamma WHDI_{it} + u_{it}, \text{ with } u_{it} = \rho Wu_{it} + e_{it} \quad (1)$$

where Y_{it} is the vector of the dependent variable ($n \times 1$), X_{it} stands for the matrix of the factor variables, while u_{it} denotes the spatial lag of the error term. As well, W represents the weights matrix, constructed as an inverse distance matrix, while e_{it} is the vector of *i.i.d.* residuals (across both members and time); i and t index the unit ($i = 1, 2, \ldots, n$) and time (which in the case of the fixed effects model is written as $t = 1, 2, \ldots, T-1$), respectively.

Furthermore, considering that the spatial lag of the motor insurance density is included in the models, the last step of the analysis consists in evaluating the types of effects that explanatory factors exhibit on the motor insurance market. Accordingly, both direct, indirect and the total effects are computed and evaluated. More specifically, via the direct effects, we are able to evaluate the impact of the factors within the economic environment of each spatial unit, while the indirect effects help us assess the important neighbouring effect. Also, we distinguish between the states' level of development in relation to the motor insurance density, by introducing a dummy

variable that accounts for emerging and post-communist countries, and re-run Equation (1) with random effects.

4. Results and discussion

4.1. Descriptive analysis

The first step is the visual assessment of data based on the spatial associated maps. On the one hand, the spatially smoothed rate maps for the motor insurance density and explanatory factors in 2019, displayed in Figures 1 and 2, clearly show that there are spatial processes taking place on the motor insurance market in Europe, conditioned by these variables. With regard to HDI, we can observe that higher ratios belong to more developed countries. Figure 1 points out that there are countries with a more developed market than their level of HDI, such as Luxembourg or Switzerland. Also, when moving from West to East, the intensity of the colours decreases, overall, suggesting that Eastern Europe has a less developed motor insurance market, with respect to the development level. The right side of Figure 1 shows Eastern Europe with a low level of urbanization, but a high motor insurance density with respect to it. Consequently, as expected, we can conclude that in these countries, there is room for further development in the motor insurance industry. Moreover, spatial distribution and clustering also reverse when the motor insurance market is conditioned by population density and unemployment (Figure 2). Eastern countries are positioned in the higher quartile groups, but the East-West clusterisation direction is preserved. The high differences and a clear clusterisation direction between old and new EU members, Western versus Eastern Europe are emphasised in all these figures (Figure 3 included), with significant clusterisation processes, along with contagion and diffusion that manifest on the motor insurance market, conditioned by both the main socio-economic and demographic factors. These aspects will be further addressed via more complex regression techniques. Besides, an essential aspect also highlighted by the maps is that there are countries with low ratios of motor insurance density, meaning that their national motor insurance markets are still underdeveloped relative to the advancement of their societies.

On the other hand, the conditional map emphasises that countries with both low urbanization and HDI (Figure 3c) have low levels of the motor insurance market, while countries with high values for these factors (Figure 3b) have values for the motor insurance market above the median. The Eastern part of Europe proves, once again, to be in deficit regarding the development of the motor insurance market, despite having a high urbanization degree (Figure 3d). However, the level of development for the countries in this region is below the median value. Figure 3 also points out that there is a group of countries that are highly developed, with high motor insurance densities, but which are characterised by low urbanisation (Figure 3a). Indeed, this is not unexpected, given that this cluster is composed of Austria, Ireland, or Switzerland, amongst others.

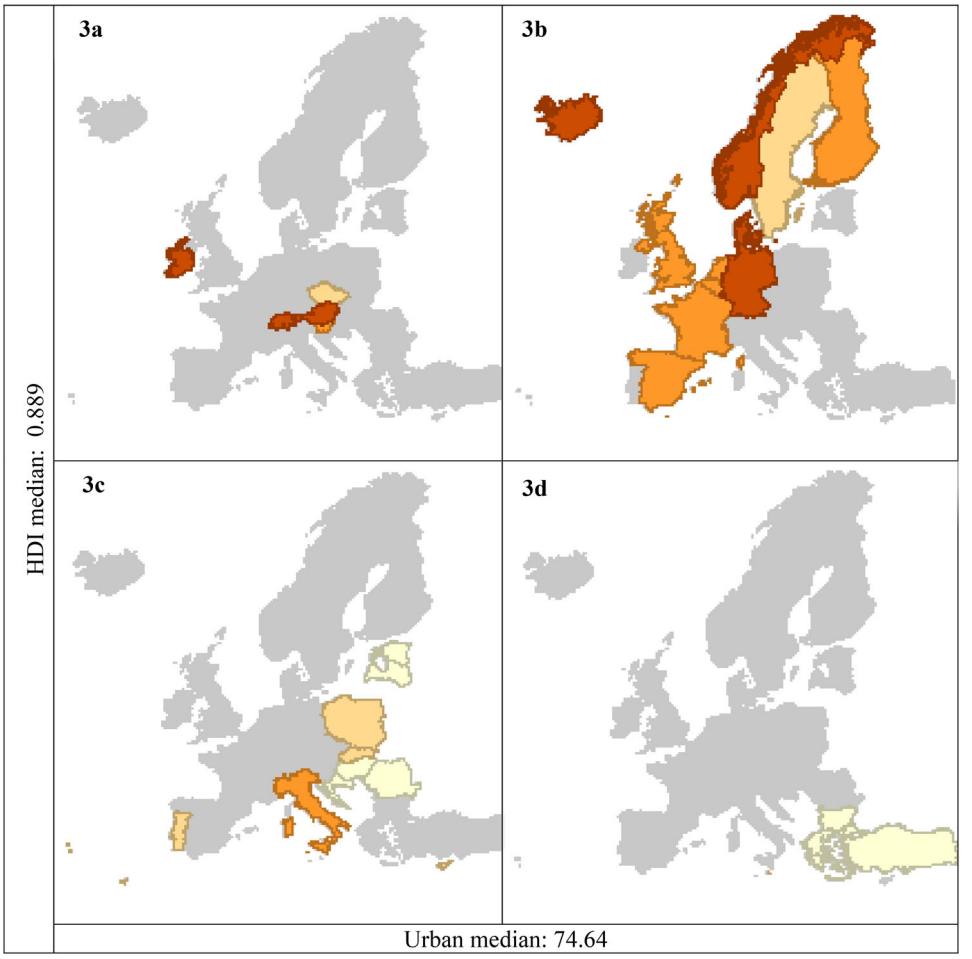

Figure 3. Motor insurance density vs. urbanization and HDI: conditional map (2019).
Source: Own computation.

4.2. Regression analysis

First, with respect to the spatial panel models expressed in Model 1 (Table 1), the findings reveal that the HDI and urbanization positively and significantly impact the development of the motor insurance market, while unemployment and population density have an opposite effect. Considering that the composite HDI captures aspects related to the standard of living, knowledge and long healthy life, its significant positive influence on the motor insurance demand shows that more educated, healthy and financially stable people are more aware of the benefits of insurance, ultimately taking advantage of them. Regarding urbanization, its positive effect on the motor insurance demand can explain the need to have additional sources of security. In this fashion, Trinh et al. (2020) note that urbanization is a good proxy for the asset value at risk, given that it is often associated with development level and economic growth. However, its effect diminishes when the control factors are introduced in the analysis. Thus, we can state that income distribution and institutional factors alter the impact

Table 1. Regression results: fixed effects models.

Dependent variable: Motor	Model 1		Model 2		Model 3	
HDI	6.609***	(1.18)	6.268***	(1.184)	6.268***	(1.184)
Urban	0.031***	(0.01)	0.018*	(0.011)	0.018*	(0.011)
Unempl	−0.017***	(0.004)	−0.02***	(0.004)	−0.02***	(0.004)
Pop_dens	−0.002***	(0.0006)	−0.001**	(0.0006)	−0.001*	(0.0007)
Cars	0.633***	(0.122)	0.563***	(0.121)	0.56***	(0.121)
Ctrl_cor			−0.056	(0.082)	−0.057	(0.082)
Gov_eff			−0.212***	(0.079)	−0.212***	(0.079)
Pol_stab			−0.132**	(0.060)	−0.132**	(0.060)
Reg_qual			0.014	(0.095)	0.014	(0.095)
Rule_law			0.395***	(0.116)	0.394***	(0.116)
Voice_acc			−0.414***	(0.135)	−0.415***	(0.135)
Gini					−0.002	(0.007)
Wmotor	0.242*	(0.125)	0.185	(0.128)	0.182	(0.129)
WHDI	−8.41***	(1.215)	−9.005***	(1.275)	−9.019***	(1.277)
Sigma_e	0.192***	(0.007)	0.186***	(0.006)	0.186***	(0.006)
Log likelihood	99.18		113.6		113.63	
Wald Chi^2 (Prob)	224.99	(0.000)	269.81	(0.000)	269.93	(0.000)
Wald test of spatial terms Chi^2 (Prob)	47.89	(0.000)	50.1	(0.000)	50.18	(0.000)

Standard error in brackets. ***, **, * denote statistical significance at 1%, 5% and 10%, respectively.
Source: Own computation.

of the urbanization process on the motor insurance market for our sample. Opposite, and consistent with the results of Chitiyo (2017) and Born and Bujakowski (2022), we find a negative relationship between unemployment rate and motor insurance demand. Indeed, it is well known that high levels of unemployment can have effects that inhibit economic development and population welfare. Also, the negative influence of population density on the motor insurance demand can be explained through the fact that very densely populated areas are better served by mass transportation systems. This result is in line with Sanghi (1976) who considers mass transportation a substitute for automobile transportation in highly populated areas, causing a lowering of automobile ownership and use.

Given that the HDI has three main components, for a first robustness check, we respecified Model 1 in Table 1 considering each constituent individually. Results presented in Appendix C, Table C1 show that the positive influence is preserved, but it is significant only in the case of income and education. The life expectancy component of HDI is not significantly impacting the motor insurance market, although it also has a positive coefficient. All other independent variables and model components keep both their significance, and their coefficient sign, proving the stability of the results.

Second, when institutional control factors are included in the model, two of them return coefficients that lack statistical significance, namely control of corruption and regulatory quality. Amongst the indicators that exhibit a statistically significant impact, government effectiveness, political stability and voice and accountability are inversely related to motor insurance density. In this direction, the capacity of the government to implement sound policies, the credibility of the government and its independence from political pressures are the most liable to impact the motor insurance market. Such a result can also be explained by the fact that the sample is composed of European countries, that are much more politically and institutionally stable than

many other countries of the world. The logged dependent variable may be interpreted in terms of elasticities. Thus, a negative relationship between these WGI indicators and the motor insurance density shows that countries that are more politically stable and with a higher propensity of the citizens to freely express themselves (meaning that their societies are more developed), had lower growth rates for the national motor insurance markets.

Furthermore, the motor insurance demand is positively influenced by the remaining WGI component, namely the rule of law. The positive impact of rule of law on the motor insurance demand is in line with Esho et al. (2004) who highlight the importance of the enforcement of property rights for the development of property-casualty insurance. Given that the insurance involves the legal transfer of risk, the enforceability of insurance contracts depends on the efficiency of the legal means to protect the property rights, and on the fairness of the judicial process.

Third, it is worth mentioning that the spatial effects decrease in intensity and lose their significance with the introduction of new explanatory variables in the model. As such, the spatial lag of the dependent variable (i.e. WMotor) is statistically significant and positive only in Model 1. Indeed, this result confirms the existence of contagion and diffusion processes on the motor insurance market in Europe, fulfilling our initial expectations. As previously stated, in the methodological subsection, countries in the sample either belong to the European Union or are closely related to it and, overall, being characterised by increased mobility of both people and goods. Additionally, due to EU membership, there are common general regulations that have to be implemented, which increase even more the interdependencies between countries. However, despite these common regulations, each national motor insurance market develops especially conditioned by the domestic governance process, which is why the governance factors alter the spatial interdependences at a global level for the whole sample. Important enough is also the spatial effect coming from the level of HDI, which displays a negative sign, pointing out an average polarization process – countries with high motor insurance densities are neighbouring low HDI level countries. This result can be explained by the fact that more developed European countries have higher motor insurance density (more developed markets). Consequently, their elasticities and growth rates are much smaller than those of the less developed nations, mostly Eastern European ones. The spatial lag of HDI provides information about the indirect effect this variable has on the motor insurance market. In this fashion, it is worth noting that the spatial lag of the dependent variable changes the impact of HDI from positive to negative when assessing the mean values of the neighbours. Indeed, this change of sign is quite plausible due to the multidirectionality characterising spatial data. Likewise, the significance of the impact suggests that there is a significant spillover effect, conditioned by the level of human development. When the types of effects are evaluated, results show that the statistically significant variables in all specifications are mostly directly impacting the dependent one: in each country, the specific level of a regressor affects its own development of the motor insurance market.

Finally, to assess the heterogeneity of our baseline findings we introduce a dummy variable which helps us examine if the group of emerging and former communist

Table 2. Regression results with dummy emerging: random effects models.

Dependent variable: Motor	Model 1		Model 2		Model 3	
HDI	5.407***	(0.706)	4.345***	(0.758)	4.348***	(0.769)
Urban	0.007	(0.007)	0.002	(0.007)	0.002	(0.007)
Unempl	−0.019***	(0.004)	−0.02***	(0.004)	−0.02***	(0.004)
Pop_dens	−0.0004	(0.0003)	−0.0003	(0.0004)	−0.0003	(0.0004)
Ctrl_cor			0.011	(0.084)	0.011	(0.084)
Gov_eff			−0.168**	(0.082)	−0.168**	(0.083)
Pol_stab			−0.1	(0.063)	−0.1	(0.063)
Reg_qual			0.038	(0.094)	0.038	(0.094)
Rule_law			0.395***	(0.109)	0.395***	(0.11)
Voice_acc			−0.489***	(0.133)	−0.488***	(0.133)
Gini					0.0001	(0.007)
Emerging	−0.660***	(0.184)	−0.854***	(0.251)	−0.853***	(0.251)
Constant	0.412	(0.602)	2.327***	(0.834)	2.32**	(0.914)
Wmotor	0.371***	(0.107)	0.362***	(0.108)	0.362***	(0.109)
WHDI	−2.128***	(0.716)	−2.361***	(0.750)	−2.362***	(0.753)
Sigma_u	0.445	(0.066)	0.552	(0.093)	0.552	(0.094)
Sigma_e	0.218	(0.007)	0.210	(0.007)	0.209	(0.007)
Log likelihood	−16.6		−3.6		−3.58	
Wald Chi^2 (Prob)	207.9	(0.000)	226.17	(0.000)	226.14	(0.000)
Wald test of spatial terms Chi^2 (Prob)	12.03	(0.002)	11.72	(0.003)	11.6	(0.003)

Standard error in brackets. ***, **, * denote statistical significance at 1%, 5% and 10%, respectively.
Source: Own computation.

countries potentially bias the full sample findings. Results reveal no influence of urbanization, population density and political stability on motor insurance demand. This finding can be explained by the fact that people in denser urban areas use car less and prefer public transportation, compared to people in less dense suburban or rural areas – Melia et al. (2018). Moreover, higher population densities associated with less driving (Naess, 2012) are features of developed economies. However, in emerging economies where the population densities are lower, they do not significantly impact the travel behaviour. For the other variables considered, the impact remains the same as for the whole sample. Additionally, regardless of the specifications of Equation (1), which follows the same pattern as in Table 1, the coefficient of the dummy variable is always highly significant and negative (see Table 2). This confirms, yet again, the evidence depicted by the map analysis, indicating that the emerging countries have a less developed motor insurance market compared to the developed ones. Another important result is that when controlling for the development status given by the dummy variables, spatial effects become highly significant and with the same signs as in Table 1, both for the spatial lag of the dependent (WMotor) and for HDI (WHDI).

5. Conclusions

Considering the heterogeneous development of motor insurance across European countries and the importance of this line of business within the non-life insurance sector, this paper aims to study the impact of HDI, urbanization, unemployment, population density and size of the car fleet on motor insurance demand for a rich sample of 31 countries over the period 2004–2019. We examined the key determinants based on the previous works on the non-life sector, given that the motor sector

covering both compulsory and voluntary insurances, accounts for almost two thirds of the non-life sector in former communist Europe.

Our article fills a gap in the empirical literature of the field, by using spatial panel data econometrics for analysing the main determinants of the European motor insurance demand and emphasising spatial effects on this specific market. In this fashion, we take into consideration the important diffusion effects, which may interfere and alter the findings, by employing appropriate modern techniques. On the one hand, the descriptive map analysis emphasises that, at European level, there are countries with low motor density ratios in relation to the considered factors, meaning that their national domestic markets are still underdeveloped with respect to the societies' potential. On the other hand, estimations show that HDI, urbanization and the national size of the car fleet exert a positive impact on the development of the motor insurance demand in Europe, while unemployment has a negative influence. These results show that improved levels of standard of living and educational attainment will increase the motor insurance consumption, while the job loss will reduce the associated demand. However, population density does not seem to favour the consumption of such products, given that it exhibits a negative impact on the motor insurance market. Overall, these findings are sensitive to the emerging and former communist countries group, but robust to the introduction of a wide range of institutional factors and income inequality. Moreover, we find that significant clusterisation processes, along with contagion and diffusion ones, manifest on the motor insurance market, conditioned by the level of HDI, probability of loss (assess primarily through urbanisation degree, but also population density), unemployment, and quality of institutions when the sample members are the emerging and former communist countries.

Our findings may offer some useful recommendations for European and national regulators who aim to sustain the development of the motor insurance market. As the motor line of business represents a particular driver of developments in the non-life segment in developing countries, the status of this sector, which mitigates the financial consequences of motor accidents, becomes even more important for these countries. According to our model, the key factors for the motor insurance demand are the levels of standard of living and educational attainment, along with urbanization, national car fleet, unemployment and population density, indicating an effective mechanism for the policymakers to enable the development of the market. Besides, our results highlight the importance of a supportive legal framework and free access to information relative to insurance sector development. Still, the process is a long one, since some of the motor insurance determinants can be enhanced by policymakers only over longer periods of time, such as increasing the standard of living and access to education, and/or reducing unemployment and income inequality. Considering the importance of purchasing car insurance and the need of protection against risk of its citizens, governments could also integrate our results through the various financial and political levers available. As future research ambitions, subject to data availability, we may analyse the influence of the Covid-19 pandemic, which emerged in 2020 and onward, on the development of the motor insurance market in Europe.

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Disclosure statement

No potential competing interest was reported by the authors.

Notes

1. Also, with respect to drivers of motor insurance consumption, the vast majority of studies focus on country-level (Dragos & Dragos, 2017).
2. Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Iceland, Italy, Latvia, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden, Spain, Switzerland, Turkey and UK.
3. Hausman test statistic equals 26.11, having the associated probability 0.000.

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Appendix A

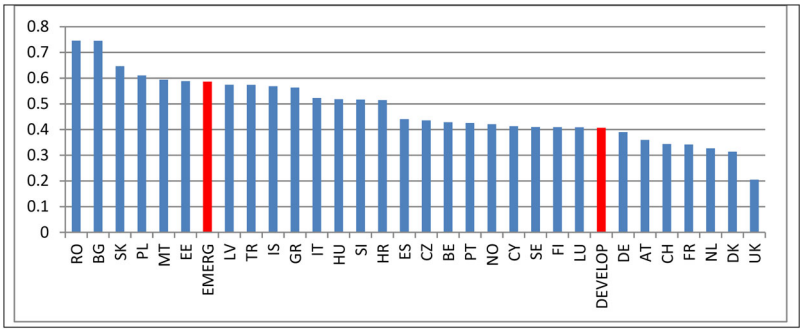

Figure A1. The proportion of motor insurance in non-life insurance in European countries (in terms of gross written premiums) (2019). *Notes*. Besides the countries from the sample, the graph also displays the average proportion of motor insurance within non-life insurance for all countries (ALL) and for emerging and former communist countries. *Source*: Insurance Europe (2021).

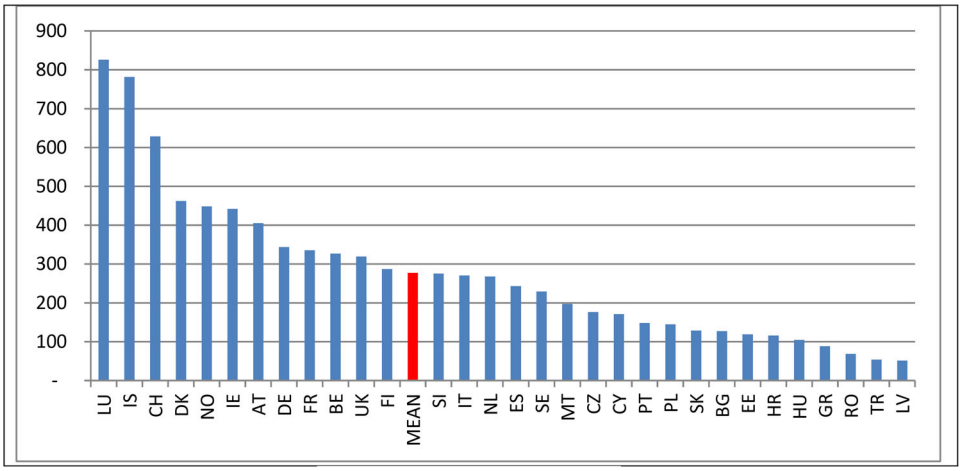

Figure A2. Insurance premiums/capita for motor insurance in Europe in Euros (2019). *Source:* Insurance Europe (2021).

Appendix B

Table B1. Variables' definition and source.

Variables	Description	Data source
Dependent variable		
Motor	Motor insurance density: total premium per capita	Insurance Europe (https://www.insuranceeurope.eu/statistics)
Explanatory factors		
Urban	Urbanization rate: Percent urban population. The data are collected and smoothed by United Nations Population Division	Global Economy (https://www.theglobaleconomy.com/download-data.php)
HDI	The HDI measures three basic dimensions: long and healthy life, knowledge, and standard of living. Four indicators are used to calculate the index: life expectancy at birth, mean years of schooling, expected years of schooling, and gross national income per capita. A higher HDI means a more developed country	
Unempl	Unemployment rate: the share of the labour force that is without work but available for and seeking employment	
Pop_dens	Population density: midyear population (counting all residents) divided by land area in square kilometers	
Cars	Number of cars per 1000 inhabitants	Eurostat https://ec.europa.eu/eurostat/data/database
Income	Gross Domestic Product per capita	World Bank
Lifeexp	Life Expectancy Index, computed as (LE-20)/(85-20), where LE – Life Expectancy at Birth	https://data.worldbank.org
Education	Education Index – computed as (MYSI + EYSI)/ 2, where MYSI – Mean Years of Schooling Index * EYSI – Expected Years of Schooling Index**	*Barro, R. J., & Lee, J. W. (2010). A new data set of educational attainment in the world, 1950–2010. NBER Working Paper No. 15902. **Unesco Institute for Statistics (2010).
Control variables		
Ctrl_corr	Control of corruption: perception of the extent to which public power is exercised for private gain: from −2.5 (weak) to 2.5 (strong) control of corruption	Worldwide Governance Indicators (https://info.worldbank.org/governance/wgi)
Gov_eff	Government effectiveness: perception of the quality of public and civil services, and the degree of its independence from political pressures, the quality and the credibility of policy implementation: from −2.5 (weak) to 2.5 (strong) governance performance	
Pol_stab	Political stability and absence of violence/terrorism measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism: from −2.5 (weak) to 2.5 (strong) political stability	
Reg_qual	Regulatory quality measures the ability of the government to formulate and implement sound policies and regulations that promote private sector development: from −2.5 (weak) to 2.5 (strong) regulatory quality	
Rule_law	Rule of law measures the agents' degree of confidence in the rules of society, the quality of	

(*continued*)

Table B1. Continued.

Variables	Description	Data source
	contract enforcement, property rights, the police, and the courts: from −2.5 (weak) to 2.5 (strong) law conformation	
Voice_acc	Voice and accountability measure the freedom of expression, freedom of association, and a free media: from −2.5 (weak) to 2.5 (strong) participation in government selection	
Gini	Gini index measures the extent to which the distribution of income deviates from a perfectly equal distribution	World Bank (https://data.worldbank.org/indicator)
Emerging	Dummy variable taking the value 1 for emerging and former communist countries, and 0 for developed countries in the sample	Emerging and former communist countries: Bulgaria, Czech Republic, Estonia, Greece, Croatia, Hungary, Latvia, Poland, Romania, Slovenia, Slovakia and Turkey

Source: Own computation.

Table B2. Descriptive statistics.

Variable	Mean	Std. dev.	Min	Max
Motor	5.193	0.846	1.82	6.717
HDI	0.870	0.049	0.685	0.954
Urban	73.67	12.52	51.31	98.04
Unempl	8.165	4.25	2.01	27.47
Pop_dens	167.65	239.88	3	1575
Ctrl_cor	1.109	0.827	−0.33	2.47
Gov_eff	1.173	0.622	−0.36	2.35
Pol_stab	0.732	0.535	−2.01	1.64
Reg_qaul	1.203	0.462	−0.01	2.05
Rule_law	1.17	0.652	−0.32	2.13
Voice_acc	1.116	0.436	−0.85	1.8
Gini	31.338	4.027	20.9	42.9

Source: Own computation.

Appendix C

Table C1. Regression results – HDI replaced by its components.

Dependent variable: Motor	Model C1		Model C2		Model C3	
Income	0.698***	(1.103)				
Education			2.54***	(0.601)		
Lifeexp					2.368	(1.443)
Urban	0.037***	(0.009)	0.034***	(0.010)	0.043***	(0.010)
Unempl	−0.01**	(0.004)	−0.021***	(0.004)	−0.020***	(0.004)
Pop_dens	−0.002***	(0.0007)	−0.002**	(0.0007)	−0.001**	(0.0007)
Cars	0.520***	(0.103)	0.791***	(0.114)	0.9***	(0.120)
Wmotor	0.160	(0.123)	0.159	(0.129)	0.144	(0.128)
Wcomponent	−0.677***	(0.138)	−4.147***	(0.732)	−5.944***	(1.409)
Sigma_e	0.193***	(0.007)	0.196***	(0.007)	0.198***	(0.007)
Log likelihood	96.98		92.14		86.95	
Wald Chi^2 (Prob)	217.74	(0.000)	203.38	(0.000)	188.23	(0.000)
Wald test of spatial terms Chi^2 (Prob)	24.88	(0.000)	32.07	(0.000)	18.04	(0.000)

Standard error in brackets. ***, **, * denote statistical significance at 1%, 5% and 10%, respectively.
Source: Own computation.