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Property Rights: Factors Contributing to the Generation of Income from Ownership of Property

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Abstract. This research investigates the determinants of property rights in the EU 28 countries for the period 2000 -2014. We study whether two groups of factors - demographic and economic- can contribute to the ability of people to enforce property rights. Using a panel fixed time effects model we prove that birth and death rates, infants mortality rate, urbanization, the unemployment rate and the military expenses explain property rights significantly. A key finding is that increasing the unemployment rate by 1% will lead to 0.02% decrease in property rights. We also investigate the influence of shadow economy, gender and income inequality on property rights. A surprising finding is that increasing the rate of shadow economy by 1% may lead to an increase in property rights by about 0.08%. This result suggests that shadow economy's importance for economic policy is broader and more complicated than previously thought. Defining property rights as the ability to generate income from ownership of properties, we indirectly examine the economic influence of law to conclude that the determinants of property rights dependent upon regulations can create incentives for people to look for underground ways to improve their property income. We identify the most common way as shadow economy.

Key Words: property rights, determinants, shadow economy, inequality, statistical modelling.

Subject Classification Codes: P48, O17, C52, C23

1 Introduction

Property rights have been a central topic in law and economics literature as they are the foundation of the market economy. Their positive influence on economic growth, distribution of resources and wealth has been broadly investigated by academics. However, what contributes to income generation from them has been left unexplored. The aim of this research is to outline the determinants of property rights by employing methodology previously not applied to property rights. Such an investigation is important as it may allow for controlling indirectly the economic effects on property rights. The importance of property rights for the economy can be summarized by the articles of Bentley [2], Ronald Coase [11], Leblang [24] and Chu [10].

Bentley [2] has investigated the relationship between the protection of the property rights and the structure of the economy. His results suggest that indigenous cultures which

have better protected property rights are more likely to establish market economy rather than planned economy. The reason is that property rights protection creates incentives for people to establish control over their income, so the distribution of resources is based on the market forces, not on government decisions. The extent to which property rights are protected can predict what system for distribution of resources in the economy will be set. He also concludes that property rights can trigger technical progress. His research [2] is based on observations on indigenous African tribes which have developed a system for protection of their rights over the land. As they have huge spots of land to utilize, they are forced to invest part of their property income into farm equipment so that they might not only generate more crop but also more income for a shorter period of time. As a result, both protection of property rights and improvement of farm equipment have occurred.

Property rights play a key role in the allocation of resources in the economic system. According to Ronald Coase [11] deciding how resources should be allocated may not always depend on economic reasons but law. For instance, economists would decide how resources in case of externalities are to be divided between two parties in order to maximize the value of production. In other words, economists look for Pareto efficient outcome (definition in [22]). From the point of view of law, paying for externalities depends on the person who has legal right to do so. As a result, allocation of resources may not be driven by the most efficient outcome but by property rights [11]. Property rights drive the law system and the way institutions work. The right to control and generate income from ownership is institutionalized by laws. Law penalizes trespassing on the control or income from property ownership. Thus, institutions work towards protecting ownership of property, which has changed the structure of the judicial system.

Property rights can also stimulate economic growth. Property rights consist of not only rights over physical ownership of goods but also intellectual goods like patents and software. Chu [10] showed that strong patent protection leads to faster technical progress that reduces the volatility of economic growth. Countries that have well protected property rights tend to grow faster than countries that do not. Property rights matter for the optimal use of resources (capital, raw materials, human capital) and play a key role in the growth rates between countries [24].

As a conclusion, establishing property rights decreases transaction costs for transferring ownership to third parties. In this way, trade can be more easily conducted. Capital can be moved easily when the business should be transferred to another city or country. At the same time, capital can be established at different places to minimize production and transportation costs. Thus, property rights provide foundation for lower transaction costs for entrepreneurs. By influencing economic growth and the allocation of resources, property rights are a factor for economic development and a driver of the market economy. Thus, knowing what factors contribute to them is a key to protecting and generating more income from them. Controlling for their determinants can indirectly help improve economic development. However, what factors drive property rights have not received much attention in the economic literature.

One of the aims of this research is to outline the demographic and economic factors that contribute to income generation from property rights. The demographic factors we investigate are birth, death and infants mortality rates, life expectancy, CO2 emissions and the percentage of people using the Internet. According to the World Bank, all these indi-

cators measure the demographic and geographical differences that contribute to economic development. We consider the unemployment rate, urbanisation, military expenses as % of GDP, the inflation rate and health expenditure as % of GDP economic factors which affect economic growth and development.

The second aim of our research is to investigate whether income and gender inequality as well as shadow economy can contribute to the income generation from property rights. We consider income inequality as an independent variable as it can affect wealth distribution. For instance, Rubin et al [29] show that current GDP per capita growth increases income inequality by increasing the income share of the top richest 1% population in the world and by decreasing the share of the poorest. The authors also discovered that the wealth income is more sensitive to GDP growth compared to the labour income. If property rights affect wealth distribution and income inequality affects wealth distribution, is it possible that income inequality affects property rights, thus indirectly changing the distribution of resources?

Gender inequality is another variable, which affects wealth distribution. Gender inequality changes wealth distribution indirectly through affecting income inequality. Chantreuil [8] gives an example. According to his results, women in France tend to have lower wages because employers tend to be biased towards them. Despite gender inequality in payment, economic growth was rapid due to the inclusion of women in the economy. Industralization made gender inequality a cause for economic growth. But whether gender inequality can be a cause for redistribution of property rights, thus for reallocation of resources, is a topic that has not been investigated.

Goel [17] examines how the increase in shadow economy leads to breach of intellectual property rights. He reports that the higher the levels of shadow economy in a country, the higher the levels of software piracy. His finding is important as it confirms the negative effects of shadow economy on the distribution of resources. What factors contribute to shadow economy is a key to distributing resources more evenly. As shadow economy and property rights are important for resource allocation, a question about the contribution of shadow economy to property rights emerges.

We contribute to the research of property rights by providing answers to the abovementioned questions about what economic and demographic factors drive property rights, thus income generation from them. We combine variable selection methods used in data mining with panel fixed time effects models to achieve our aims. Although our methodology is not novel, we believe it proposes a consistent approach to modelling the determinants of property rights as such a methodology has not been yet developed.

We survey related literature in Section 2. Section 3 presents the dataset and the variables we use. Sections 4 and 5 comment on the methodology and results. Section 6 concludes.

We use distinct notation for three groups of models in section 3 and 5: variable selection methods as models 1.1, 1.2, 1.3 and 1.4; ols panel models as 2.1,2.2,2.3 and 2.4; GMM panel models as 3.1, 3.2, 3.3 and 3.4.

2 Literature

Academic literature has broadly examined the influence of property rights on income inequality. [1] Adams studies how globalization contributes to income inequality. His key finding is that globalization can promote more evenly distribution of income in developing countries, which have strong government institutions that promote quality education and technical progress. Globalization, on the other hand, comes at a price. Strengthening intellectual property rights, as his results suggest, is positively correlated with income inequality. The better protected the property rights in a developing country, the higher the income inequality. Some authors predict the cycle of income inequality. According to Roogour [28], in the recent decades there has been a decreasing trend of income inequality. Measured by the Gini coefficient the lowest level of income inequality will be observed about 2027 and after that it will start increasing. As gender inequality contributes to income inequality [8], implications about the indirect contribution of property rights to gender inequality can be made through income inequality.

Economic literature defines property rights as the right to earn money from the good. Property income is, by definition, received by virtue of owning property. Rent is received from the ownership of land or natural resources; interest is received by virtue of owning financial assets; and profit is received from the ownership of production capital. Property income is not received in return for any productive activity performed by its recipients. [26]. The Heritage Foundation together with the Wall Street Journal proposes another definition of property rights: property rights are the extent to which a countrys legal framework allows individuals to freely accumulate private property. In this paper, we will adhere to Leblangs [24] definition of property rights that contain the rights to exploit, control and generate income from ownership of goods and property.

Property rights are closely related with economic development. They are also related with shadow economy. Economic theory has provided different definitions and names for shadow economy as well as various approaches to measure it. In this paper, we stick to the definition of Schneider [32]. We define shadow economy as all legal but unregistered economic activity from which people generate income.

Understanding the causes of shadow economy is the way to handle it in order to enhance economic development. For instance, one of the reasons for the existence of shadow economy in Europe is the shadow labour market that resulted from high unemployment rates, increased burden of taxation and social security [31]. As shadow economy allows people to redistribute higher amount of their incomes for themselves, it may encourage people to generate and keep higher proportion of their income from property rights for themselves. Thus, the way shadow economy affects property rights may have important implications for the distribution of resources.

Although economic research has focused on examining property rights as independent variable, Leblang [24] tried to identify the institutional determinants of property rights. He built an endogenous growth model in order to examine how different factors contribute to the differences in growth rates among countries. One of the factors he examined is property rights. He used two proxy variables to model property rights. These are exchange controls and how much funds as % of the GDP are distributed to nongovernment companies. He considered these two variables appropriate for proxy variables as they are correlated with

the property rights index provided by the Freedom House that he used as a benchmark. Although he indirectly examined the institutional factors behind property rights, his model cannot provide sound conclusions about what drives property rights.

Moreover, the economic literature has not established a consistent approach to examining property rights. We propose nonnegative garrote for variable selection combined with panel time fixed effects models to outline the demographic and economic determinants of property rights. We apply panel control variable models to check whether income and gender inequality and shadow economy contribute to property rights. Finally, we confirm our results by robustness checks.

3 Methodology and Models

Our methodology consists of several steps:

- As the dataset consists of panel observations we have transformed the variables in order to have stationary variables.
- We have applied variable selection methods like Ridge, Lasso regression, adaptive Lasso and nonnegative garrote to our data set in order to select the variables for econometric models. We have identified the nonnegative garrote as the most appropriate one given the small size of the sample (420 observations). We have put all variables from nonnegative garrote whose coefficients are different from zero into panel models. All included variables can be divided into two groups - demographic factors (birth, death and infants mortality rates) and economic factors (unemployment, urbanisation, military expenses).
- As the panel data set contains time series and cross sectional observations, we have performed statistical tests (Hausman test, Pesarans test for cross-sectional dependency) to identify the type of effects in the panel (fixed vs random).
- After the tests suggested the presence of fixed effects we further investigated the type of fixed effects - either period or individual fixed effects. In this way, we have built a model (Model 2.1) exploring the statistical relationship between the selected by the nonnegative garrote model variables and property rights. We have used model 2.1 as a baseline model.
- We have upgraded the baseline model (Model 2.1) using control variables to test the statistical significance of income and gender inequality and shadow economy for property rights. We have developed three control variable models using the baseline model each tracking the relationship between gender inequality and property rights (Model 2.2), income inequality and property rights (Model 2.3) and shadow economy and property rights (Model 2.4), respectively.
- As a final step, we have applied panel GMM models with period fixed effects (Models 3.1, 3.2, 3.3 and 3.4) along with other statistical tests to perform robustness checks.

We base our models on data about property rights contained in economic freedom indices. Both the Heritage Foundation and the Fraser Institute propose an economic freedom index which contains property rights index. The differences and similarities between the two indices are described in [13] .

Many research papers outlining the role of economic freedom for economic development and growth have been made [3] , [23] , [14] , [4]. However, implications about the effects of property rights on economic development as well as the determinants of property rights cannot be made from economic freedom indices. That is why, the property rights index should be examined separately from economic freedom index.

As a measure of property rights in this study we will use the property rights index that is a component of the economic freedom index, proposed by the Heritage Foundation and the Wall Street Journal and used in the research papers of Zhu [39] and Kandogan [23].

Although there are particular methods to estimate regional inequality as proposed by Litchfield [25] , we will use the proportion of urban population as a proxy variable to regional inequality.

3.1 Variable Selection Methods

So that we might determine which variables to include in panel models, we apply variable selection methods like the regressions of Ridge, lasso and adaptive lasso. A detailed description of the advantages and disadvantages of the ridge and lasso regression is made by Tibshirani [35]. The Lasso regression helps identify the variables whose coefficients are different from zero by shrinkage. Unlike ridge regression that performs only shrinkage, Lasso performs both shrinkage and variables selection [35]. The adaptive lasso [6]. As well as the ridge and lasso regression contain penalized term which shrinks the some or all coefficients estimates to zero. For comparisons, the three regressions are shown.

Lasso regression:

$$\arg\min \ \ ||y - \sum_{j=1}^{p} x_j \beta_j||^2 + \lambda \sum_{j=1}^{p} |\beta_j|; \tag{1}$$

Adaptive Lasso regression:

$$\arg\min \ \ ||y - \sum_{j=1}^{p} x_j \beta_j||^2 + \lambda \sum_{j=1}^{p} w_j|\beta_j|; \tag{2}$$

Ridge regression:

$$\arg\min \ \ ||y - \sum_{j=1}^{p} x_j \beta_j||^2 + \lambda \sum_{j=1}^{p} \beta_j^2 \, . \tag{3}$$

Ridge and Lasso, however, suffer from some limitations. As Breiman [6] shows, they fail to capture the significant variables when applied to datasets which are not large enough, for example, less than thousands of observations. Instead, Zou [40] proposes the adaptive lasso as a consistent variable selection method in smaller datasets, which contain hundreds of observations. The adaptive lasso attributes weights to each variable based on its statistical significance. All insignificant variables are shrunk to zero at the end of the procedure.

Table 1: Variable selection methods results

Variables	Lasso	Ridge	Adaptive Lasso	NNG	Panel models significance
dbirth	-0.05	-0.05	0.	0.	**/*
drate	-0.11	-0.13	-0.03	-0.05	**
mortality	-0.04	-0.04	-0.04	-0.48	***
unempl	-0.02	-0.02	-0.02	-0.22	**
dshadow	0.04	0.04	0.01	0.01	***
dgender	0	0.01	0	0.	
infl	0	0	0	0.	
loginternet	-0.02	-0.01	0	0.	
dexpect	-0.05	-0.07	0	0.	
emissions	0.01	0.01	0.01	0.	
dhealth	0	0	0	0.	
urban	0.01	0.01	0.01	0.33	***
lgini	-0.07	-0.11	0	0.	
dmilitary	0.2	0	0.13	0.08	*

Table 1 makes comparison between the three methods. The adaptive lasso has confirmed the results from the panel models. Most of the identified nonzero variables by the adaptive lasso have proven to be statistically significant in the panel models.

Despite the relatively accurate results from the adaptive lasso, the emissions from CO2 seem to be significant according to the shrinkage regression and insignificant in the panel models. A question whether a more suitable method for variable selection in small datasets exists has been raised.

Breiman [6] proposed a new method for consistent variable selection in smaller datasets called nonnegative garrote. Nonnegative garrote is scale invariant method, which performs shrinkage similar to lasso and adaptive lasso. Shrinkage, though, is performed under the assumption that all parameters β are positive. Nonnegative garrote gives solution to eq. (4):

$$\min_{c_k} \sum_k (y_n - \sum_k c_k \hat{\beta}_k x_{kn})^2 , \tag{4}$$

under the constraints that $c_k \geq 0, c_k \leq s$, where s is the shrinkage parameter. The nonnegative garrote eliminates some variables and shrinks others. The nn garrote outperforms variable selection methods 1-3 as table 1 shows. The main advantage of the method [6] compared to methods 1.1-1.3 is that it performs reliable variable selection not only in large datasets but also in datasets with n ¡ 1000 observations. Although the results from the nng procedure are comparable to the results from adaptive lasso (table 1), the nng procedure returns results that are confirmed by panel models explained in section 3.2. Unlike nng, the results from the adaptive lasso deviate from the results of the panel models.

As robustness checks have been performed for the panel models in section 3.2, we aim to identify which variable selection method will return comparable results to those from

the panel models given two limitations of our dataset. The first is the small number of n (only 420 observations) given methods like lasso and ridge perform reliable shrinkage in large datasets. The second is the type of data. As panel data are analyzed, we raised the question whether we can identify appropriate variable selection method for panel data which provides similar results to econometric panel models. As panel models require identifying the types of effects in the panel fixed or random, a procedure for shrinkage that accounts for the types of panel effects is required.

As Table 1 shows, lasso and ridge fail to capture what variables in the panels are significant. Adaptive Lasso is better than Lasso and Ridge but it does not capture the fixed effects present in the panel so there are some differences between the significant variables in adaptive lasso and panel models. Unlike adaptive lasso, the nonnegative garrote outlines significant variables, which correspond to those identified by the panel models. As we have identified the presence of fixed effects in the panel models in 3.2 that is all regressors are assumed to be fixed, we have used nn garrote procedure, which accounts for fixed regressors. As Breiman [6] proposes two versions of nn garrote with fixed and random regressors, we have applied the little bootstrap procedure proposed by Breiman [5] for choice of the shrinkage parameter s as X variables are assumed to be fixed.

A key finding in our research is that the nn garrote can not only perform variable selection in relatively small datasets but it also provides reliable results compared to panel models with fixed effects. The nonnegative garrote procedure has proved to be the most appropriate variable selection method for our dataset. Its main advantage for our dataset stems from the possibility to recognize the significant variables in the panel without going through the extensive and time consuming procedure of identifying the appropriate panel model.

The results from the nonnegative garrote show that the determinants of the property rights index are the differenced death rate, the infants mortality rate, the unemployment rate, the percentage of urban population and the differenced military expenses. We then have built panel fixed effects models described in 3.2 and performed robustness checks in 5.3.

3.2 Panel models

Model 2.1: Panel fixed time effects model to outline the determinants of property rights

In order to confirm the results from the nonnegative garrote procedure and for the purpose for our further research, we have built a panel model with period fixed effects using the variables in equation (5). The equation of model (5) is as follows:

$$lproperty_t = \beta\, f(dbirth_t, drate_t, morality_t, unempl_t, urban_t, dmilitary_t) + c_{it} + \varepsilon_{it}\,, \quad (5)$$

where c_{it} is the time fixed effects for each of the 28 EU countries, $i = 1 : 28$ EU countries, $t = 2000 : 2014$ and ε_{it} is the random term for the panel data.

Models 2.2 - 2.4 examine the influence of gender and income inequality as well as shadow economy on property rights by adding a control variable to the initial panel model with time fixed effects. In this way, it is possible to estimate the separate influence of shadow economy and inequality on property rights.

Model 2.2 Control variable - gender inequality

Table 2: Transformation of variables

Variables	Transformation	Definition	Source
dbirth	first difference	Crude birth rate per 1000 people	[37]
drate	first difference	death rate per 1000 people	[37]
mortality	-	Infants mortality rate	[37]
unempl	-	Unemployment rate	[37]
urban	-	percentage of urban population	[37]
dmilitary	first difference	military expenses as % of GDP	[37]
dshadow	first difference	shadow economy as % of GDP	[30, 33]
dgender	first difference	female to male labour force participation rate	[37]
lgini	ln	Gini coefficient	[37, 38]
lproperty	ln	Property rights index	[34]
logecfr	ln	Economic freedom index	[34]

The equation is as follows:

$$\begin{aligned} lproperty_t = \quad & \beta\, f(dbirth_t, drate_t, morality_t, unempl_t, urban_t, \\ & dmilitary_t + dgender_t) + c_{it} + \varepsilon_{it}\,, \end{aligned} \tag{6}$$

where c_{it} is the time fixed effects for each of the 28 EU countries, $i = 1 : 28$ EU countries, $t = 2000 : 2014$ and ε_{it} is the random term for the panel data.

Model 2.3 Control variable - income inequality

Equation (7) describes the model:

$$\begin{aligned} lproperty_t = \quad & \beta\, f(dbirth_t, drate_t, morality_t, unempl_t, urban_t, dmilitary_t + lgini_t) \\ & + c_{it} + \varepsilon_{it}\,, \end{aligned} \tag{7}$$

where c_{it} is the time fixed effects for each of the 28 EU countries, $i = 1 : 28$ EU countries, $t = 2000 : 2014$ and ε_{it} is the random term for the panel data.

Model 2.4 Control variable - shadow economy

$$\begin{aligned} lproperty_t = \quad & \beta\, f(dbirth_t, drate_t, morality_t, unempl_t, urban_t, \\ & dmilitary_t + dshadow_t) + c_{it} + \varepsilon_{it}\,, \end{aligned} \tag{8}$$

where c_{it} is the time fixed effects for each of the 28 EU countries, $i = 1 : 28$ EU countries, $t = 2000 : 2014$ and ε_{it} is the random term for the panel data.

By applying these models we can make conclusions about what allows people to generate income from property rights and examine particular factors of interest that play the role of control variables.

4 Data

In this section we will provide description of the data set as well as detailed explanation of the property right index we use in the paper. Data set consists of variables for the EU28

Table 3: Descriptive statistics. Observations are 419.

	Mean	Std. Dev.	Skewness	Kurtosis	JB Prob
dbirth	-0.03	0.34	-0.23	3.6	0.01
drate	-0.03	0.26	-0.19	4.41	0
dexpect	0.27	0.29	0.96	6.47	0
dgender	0.45	0.99	0.41	6.05	0
dhealth	0.1	0.39	0.92	6.19	0
dmilitary	-0.03	0.14	-3.22	29.36	0
dshadow	-0.32	0.43	0.35	3.89	0
carbon	8.18	3.58	2.02	9.09	0
infl	3.04	4.04	4.89	41.44	0
lgini	3.38	0.13	0.08	1.97	0
lproperty	4.21	0.33	-1.05	3.26	0
unempl	8.91	4.39	1.38	5.23	0
urban	71.93	12.05	0.2	2.34	0.01
loginternet	3.85	0.62	-1.48	5.08	0
mortality	5.4	3.34	2.46	10.26	0

in the period 2000 - 2014. As not all variables in the dataset are stationary, Table 2 shows the necessary transformations to stationarity. Table 3 summarizes the descriptive statistics of the dataset.

The Heritage Foundation provides a detailed description of the property rights index that we use can. Score of 100 denotes efficient court system with no corruption or risk of expropriation, which punishes unlawful confiscation of property rights. Score of 0 denotes very high levels of corruption with no lawful opportunities to protect property rights. The average score of the EU28 countries for the period 2000 -2014 is 70 which shows that property rights are relatively well protected in the EU despite some levels of corruption.

5 Results

5.1 Main determinants of property rights

This section presents the results obtained from the models. The nonnegative garrote as well as the panel model 2.1 with fixed time effects suggest that property rights depend on the rate of birth and death, the infants mortality rate, the unemployment rate, the rate of military expenses as percentage of the GDP and the percentage people living in cities. The results are presented in table 4 (baseline models). Balanced panels are used in the models with exception of Model 2.4 where one observation was missing.

The results suggest that one unit rate of growth of birth would trigger 0.06 % decline in property rights. A 1-unit increase of the death rate leads to 0.10% decrease in property rights as well. On the one hand, increased birth rate means increased population among which income from properties should be distributed. Resources must be allocated in a

different manner, which poses the problem of efficient vs lawful allocation of resources. Assuming the quantity of property remains the same, it should be distributed among bigger amount of people. On the other hand, when the death rate starts to increase, population declines. Allocation of resources should change. With slower birth and growth rates, the enforcement of property rights will not decrease. In economies where the growth rates of birth and death are not too divergent from each other, property rights index should be higher than in countries with highly divergent from each other birth and death growth rates.

High death rates combined with underpopulated regions like villages can lead to the disappearance of villages and the enforcement of property rights can decrease. As our results suggest, the percentage urban population is statistically significant. However, its influence on property rights is so small that it can be neglected. In the previous sections we have stated that urban population is a proxy variable for regional inequality. In other words, regional inequality measured by the extent of urbanization has a negligible effect on property rights. As urbanization is connected with people looking for an improved lifestyle, the concentration of big amount of population forces them to protect their property rights and gives them the opportunity to generate more income. Thus, the positive effect of urbanization on property rights is not surprising.

Negative relationship is present between the infants mortality rate and the property rights. As infants mortality rate increases, the number of future population decreases implying a decreased number of people to enforce property rights. On the other hand, decreased infants mortality rate does not account for higher birth rate or slower death rate. It is an interesting topic of research to be found optimal birth and death rate that can lead to Pareto efficient distribution of property rights given infants mortality rate increases.

Another result shows that one percent increase in unemployment will lead to almost 0.02% decrease in property rights. On the one hand, unemployment is connected with the qualities and willingness of people to work. In the case of low-skilled workers, job opportunities decrease along with their income. Their opportunities to protect, therefore, generate income from property rights decrease. On the other hand, unemployment is an economic factor. Long periods of unemployment may be connected with recession, increased poverty and loss of living standards. In times of economic slowdown, less money is available for income collection from property. Due to the inability of unemployed people to maintain a stable source of income, they can lose their properties. Thus, they can lose the ability to make money from their properties. A recent example of the case is the 2008 financial crisis. Moreover, even if the unemployed person is able to maintain their property for a while, the lack of labour income sufficiently decreases the ability of the person to maintain their properties and generate income from them. Therefore, the results are not surprising.

Another curious determinant of property rights are the military expenses. Our finding suggests that one percent increase in the military expenses growth rate will trigger 0.26% increase in property rights. Although military expenses may be connected with war and logically should decrease property rights, for the EU countries military expenses increase property rights. As the period is 2000 -2014, the increase for military expenses in the EU in the last few years is for protecting boarders. Migrant crisis and political instability have led to more money spent on protecting citizens that is protecting property rights from invaders. In fact, military expenses will increase in the next few years proportionally to the internal

Table 4: Property rights determinants (Models 2.1 - 2.4). Author's calculations

	Model 2.1	Model 2.2	Model 2.3	Model 2.4
dbirth	-0.06**	-0.06**	-0.06**	-0.05*
	(-28.66)	(-28.67)	(-27.47)	(-25.22)
drate	-0.10**	-0.10**	-0.10**	-0.11**
	(-26.17)	(-26.16)	(-25.81)	(-27.16)
mortality	-0.05***	-0.05***	-0.05***	-0.05***
	(-70.89)	(-72.08)	(-72.58)	(-70.78)
unempl	-0.02**	-0.02**	-0.02**	-0.02**
	(-27.96)	(-27.96)	(-25.91)	(-28.54)
urban	0.01***	0.01***	0.01***	0.01***
	(35.26)	(34.75)	(32.54)	(35.84)
dmilitary	0.26*	0.27*	0.27*	0.26*
	(24.76)	(24.78)	(25.06)	(24.08)
dgender		-0.00		
		(-0.05)		
lgini			-0.09	
			(-0.51)	
dshadow				0.07***
				(40.37)
R2	0.67	0.67	0.67	0.68
F-stat	135.59***	115.93***	116.55***	118.45***
Data set	2000 -2014	2000 -2014	2000 -2014	2000 -2014
	Annual	Annual	Annual	Annual
N	420	420	420	419

and external threats to the stability of the EU countries.

5.2 Additional determinants of property rights: Control Variables models

Model 2.2 suggests that gender inequality expressed by the female to male labour force participation rate does not affect property rights. Although there is a discrepancy between payment for men and women, both genders have equal opportunity to participate in the economic life and generate property income. Therefore, they have equal opportunity to exercise their property rights. The resulting allocation of resources, however, is not necessarily fair for both genders.

Model 2.3 shows that increasing income inequality does not affect property rights. Laws enforce property rights. However, laws cannot cancel income inequality; it relies on individuals abilities to make decisions about how to use their resources. Therefore, income inequality does not determine property rights, but property rights can affect income inequality due to distributional changes of income due to constantly changing regulations.

As for shadow economy, it has a positive statistically significant relationship with prop-

Table 5: Instrumental Variables. Author's calculations. R designates regressands that participate in the respective model. IV corresponds to the instrumental variables used in each model

	Model 3.1	Model 3.2	Model 3.3	Model 3.4
dbirth	R, IV	R, IV	R, IV	R, IV
drate	R, IV	R, IV	R, IV	R, IV
mortality	R, IV	R, IV	R, IV	R, IV
unempl	R, IV	R, IV	R, IV	R, IV
urban	R, IV	R, IV	R, IV	R, IV
dmilitary	R, IV	R, IV	R, IV	R, IV
dgender		R, IV		
lgini			R, IV	
dshadow				R, IV
logecfr	IV	IV	IV	IV

erty rights (model 2.4). Our findings suggests that if the growth rate of shadow economy increases, property rights increase. Although Goel [17] shows that greater shadow economy is consistent with higher levels of software piracy (a dimension of property rights), our results suggest that the rate of growth can affect positively property rights. As taxation increases, incentives for people to participate in shadow activities increases as transaction costs decrease. If shadow economy increases faster, people hide from authorities more money for a shorter period, including income from property rights.

Although with higher taxes paid, less money can be devoted to protecting property rights, income from properties may be unchanged due to lawful regulations. Thus, shadow economy may not affect the amount of income people gain. What shadow economy changes is the amount people hide from the state. The faster they do that, the less likely it is to be discovered. From economic perspective, shadow economy improves the ability of people to retain bigger part of their properties income for themselves and not share it with the state. Following the definition for property rights in section 1, the greater the ability of people to generate income from their properties, the bigger property rights index. That is why, shadow economy through its rate creates underground channels for redistribution of property rights. What the effects of this type of redistribution are is not the subject of our paper.

5.3 Robustness Checks

In order to show that the fixed time effect model produces robust results, a Breusch Pagan [7] test for time and individual effects was performed. The period effects models proved the most appropriate one. We also run a Hausman test [21] to find out whether models with random effects perform better than fixed effects models. A Pesarans test [27] for cross sectional dependency shows lack of cross sectional dependency among the EU 28 countries.

In addition, the results about the baseline models presented in Table 6 are based on the robust covariance matrix (the sandwich estimator) which allows for heteroscedasticity but no serial correlation. The robust covariance matrix has shown that the statistically significant variables are the same as those the nn garrote has selected.

In order to confirm the estimates we also run a panel GMM with fixed period effects models. Table 5 also shows what variables are included in the GMM panel fixed time effects models. We estimate models 3.1, 3.2, 3.3 and 3.4 that contain the same variables as in models 2.1, 2.2, 2.3 and 2.4 but the underlying method is the generalized method of moments (GMM) which is described in details in [20].

The results (Table 6 models 3.1 - 3.4) show that the variables from the GMM estimation keep their statistical significance as in the panel period fixed effects models. The coefficients estimates remain unchanged in comparison with our baseline models. As the instrumental variables account for heteroscedasticity and the results of the GMM and baseline models remain unchanged, we conclude that our baseline models are homoscedastic. Based on the aforementioned tests, our models are robust.

Table 6: Robustness checks: Panel GMM with fixed time effects. Author's calculations

	Model 3.1	Model 3.2	Model 3.3	Model 3.4
dbirth	-0.06**	-0.08***	-0.06**	-0.05*
	(-1.93)	(-2.57)	(-1.92)	(-1.60)
drate	-0.11***	-0.10***	-0.10***	-0.11***
	(-2.35)	(-2.53)	(-2.35)	(-2.41)
mortality	-0.05***	-0.05***	-0.05***	-0.05***
	(-15.93)	(-14.30)	(-15.33)	(-15.78)
unempl	-0.02***	-0.02***	-0.02***	-0.02***
	(-7.08)	(-7.56)	(-6.57)	(-7.07)
urban	0.01***	0.01***	0.01***	0.01***
	(10.21)	(9.95)	(10.01)	(10.32)
dmilitary	0.27***	0.26***	0.27***	0.26***
	(3.96)	(3.83)	(4.01)	(3.86)
dgender		0.01		
		(0.81)		
lgini			-0.09	
			(-1.19)	
dshadow				0.08***
				(2.39)
R2	0.67	0.63	0.67	0.68
Instrument rank	22	9	23	23
J-stat	139.34***	105.40***	149.22***	137.48***

6 Concluding Remarks

Understanding the drivers of property rights has a key role in understanding how they can be enforced more effectively. As the level of property rights is connected with economic prosperity, changing the determinants can lead to a new allocation of resources.

In order to uncover what drives property rights, suitable methodology should be developed. We show that data mining techniques combined with panel models successfully reveal key factors for income generation from property rights. Despite the small size of the sample, nonnegative garrote captures all significant variables in the data. Panel models confirm the robustness of the nonnegative garrote. A key finding, therefore, is that patterns in property rights can be examined with data mining techniques as successfully as with ordinary panel models. This finding allows a more time saving and consistent approach to analyzing factors behind property rights.

By monitoring the growth rate of birth and death, the infants mortaliy rate and unemployment rates policy makers may be able to affect resources allocation by influencing property rights. By influencing the rate of increasing military expenses and urbanization, the government may be able to increase the protection of property rights and thus, economic growth.

Surprisingly, shadow economy growth rate can have a more important role than thought in the economy. The positive effects it has on property rights may uncover new policies to achieve more efficient distribution of resources. Although sufficient evidence to explain this relationship lack, it is subject to further research to find out whether an optimal level of shadow economy exists for property rights and whether beyond it, shadow economys growth rate can increase property rights.

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