Risk of abrupt changes in the property rights protection

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Abstract. The numerous researches identify the level of property rights protection as a key determinant of economic performance. My previous research has also shown that the presence of abrupt changes in development of property rights protection also matters. This paper aims to explain probability of occurrence of these abrupt changes by properties of political systems.

Presence of abrupt changes is evaluated using techniques of measuring predictability of institutional environment based on modelling evolution of institutions as ARI(p,d) processes. The alternative way relying on detection of outliers in time-series of growth rates is also presented. The estimated probability of occurrence of abrupt changes is then explained by quality and stability of political systems.

Keywords: institutions, predictability, ARI process, abrupt changes, property rights

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1 Introduction

There is a broad consensus in recent literature on importance of institutional environment for economy and its performance. Empirical research has shown that the protection of property rights is the most important part of the general bundle of institutional environment [1]. These researches are mostly focused on the state of property rights protection. However as it could be seen in the figure 1a the average level of property rights protection can be almost identical (Cameroon: $\bar{x} = 4.76$; Burkina Faso: $\bar{x} = 4.83$) but the way of development in time may differ significantly.

My previously presented results [6] indicate, that the way of development matters with respect to economic performance as well as the level of protection. The way of development was investigated using preliminary version of techniques of evaluation of institutional environment predictability (more advanced version is described in section 3.1). The greatest importance with respect to performance was found in the case of negative abrupt (i.e. unexpected) changes. Here follows the natural question: What determines whether the abrupt changes occurs?

This paper deals with this question. This paper assumes that the main determinant of occurrence of abrupt changes should be in politics. It is a logical consequence of the fact that property rights setting is clearly issue of politics. If the government is able to set certain level of property rights protection then is also able to change it abruptly. Therefore this paper investigates whether political system matters with respect to occurrence of abrupt changes.

2 Data

As I have already mentioned the property rights protection is one of the most important parts of broader set of institutions or institutional environment. Institutions do not favour empirical research because they are directly unmeasurable. Therefore it is necessary to rely on proxies which are often based on expert evaluation. The level of property rights protection is commonly approximated by index originating from

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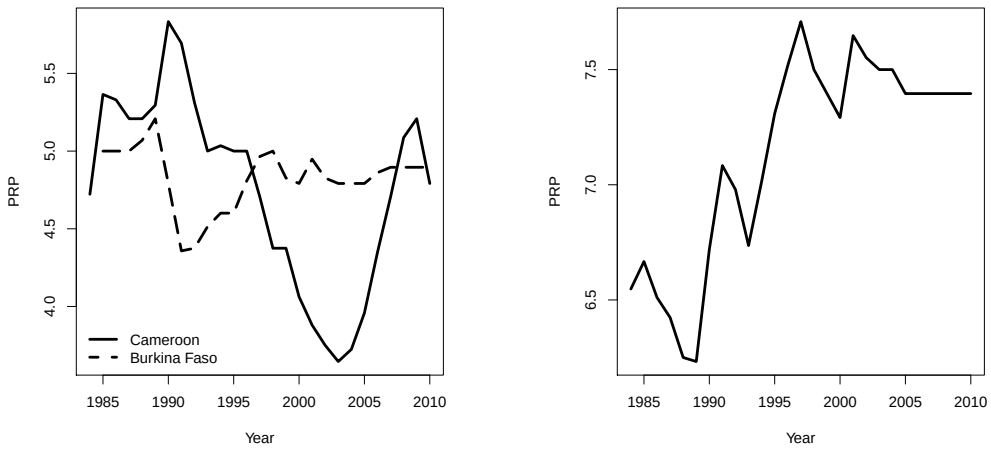

(a) PRP in Cameroon and Burkina Faso (b) PRP in Czech Republic

Figure 1: Development of PRP in selected countries during 1984–2010

Knack & Keefer [3] which is based on expert evaluations from International Country Risk Guide (ICRG). Its value is obtained as follows:

$$PRP = \frac{10}{16}BQ + \frac{10}{24}Cor + \frac{10}{48}IP + \frac{10}{24}LaO \tag{1}$$

Where BQ is Bureaucracy Quality, Cor Corruption, IP Investment Profile and LaO Law and Order (for further definition see [7]). Used weights equalize weights set in ICRG and scale resulting index on the continuous scale from 0 to 10 where higher value of PRP means better level of property rights protection. PRP index is available on yearly basis for 140 countries since 1984. This limits analysed period to 1984–2010.

Data for transitional economies of former eastern block are shortened to period 1994–2010 because it is reasonable to expect structural changes in the beginning of nineties.

3 Detection of abrupt changes

At first it is necessary to analyse time-series of PRP index to determine whether abrupt changes are present. This paper uses two approaches to this task. The first one tries to evaluate overall predictability of development of time-series which is naturally decreased by presence of abrupt changes. The second approach is focused on searching for specific observations which can be classified as abrupt changes in property rights protection. Both approaches are described in detail in the following sections.

3.1 Predictability

Concept of measuring predictability of institutional environment is based on the theory of path-dependent way of evolution of institutions. This widely accepted theory assumes that current state of institutions is not random but it depends on its past states. This assumption allows to describe development of institutional environment as ARI(p,d) process. It means that it is also reasonable to presume that agents makes their expectations on the basis of past states. Predictions which come from estimated ARI(p,d) process therefore describes expectations of agents. Basically this approach works with agents with adaptive learning.

There are almost certainly more predictors of development of property rights which agents take into account (e.g. risk of conflicts, revolutions, coup d'états, state bankruptcy etc.), but these predictors may significantly differ around the world. Moreover these additional predictors probably differ for various aspects of institutional environment. On the other hand it is necessary to keep in mind that method based solely on ARI(p,d) processes almost certainly undervalue the real predictability of institutional environment.

Evaluation of predictability is carried out in the following steps:

1. Time-series of PRP index is tested for stationarity by Augmented Dickey-Fuller test ($\alpha = 10\,\%$). If the time-series is not stationary (time-series usually contains stochastic trend – see figure 1b) then the time-series is differentiated till it is stationary. Basically in this step the parameter d of an ARI(p,d) process is found.

2. Parameters of ARI(p,d) process are estimated for $p \in [0, 10]$ using maximum-likelihood estimator and one-step ahead in-sample predictions are made using Kalman filter.

   This step needs further explanation. Agents certainly take into account more future values than only one. However results that come from one-step ahead predictions and n-steps predictions where $n \in [2, 5]$ are well correlated.[1] Using in-sample predictions is also questionable, because it basically assumes that agents know their own future – which is of course a little unrealistic. On the other hand using in-sample predictions allows evaluation of time-series without their serious shortening, which is necessary if recursive techniques are used. Moreover results that comes from in-sample and out-of-sample predictions are again well correlated.

3. Goodness-of-fit is evaluated for every p using standard defined RMSE statistics:

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n}(y_t - \hat{y}_t)^2}{n}} \tag{2}$$

4. Model which minimize RMSE is chosen.

5. On the basis of chosen model are calculated statistics RRMSE and RRMSNE defined by equations (3), (4) and (5). These statistics are then used as measures of predictability. Note that smaller values of RRMSE and RRMSNE means better predictability.

$$RRMSE = \sqrt{\frac{\sum_{t=1}^{n}\left(\frac{y_t - \hat{y}_t}{y_t}\right)^2}{n}} \tag{3}$$

$$RRMSNE = \sqrt{\frac{\sum_{t=1}^{n} e_t^2}{n}} \tag{4}$$

$$e_t = \begin{cases} \frac{y_t - \hat{y}_t}{y_t} & \text{if } (y_t - \hat{y}_t) < 0 \\ 0 & \text{if } (y_t - \hat{y}_t) \geq 0 \end{cases} \tag{5}$$

   These statistics originates from common RMSE. However they alter RMSE to reflect some specific aspects. RRMSE assigns different weights to the same absolute difference between fitted and observed variable which occurs under different state of PRP. If the level of property rights protection is low then the same absolute difference has bigger importance than if it would be high and vice versa. It makes sense – the same absolute difference may result in total expropriation under weak property rights protection and in just a little hiccup when PRP is high.

   RRMSNE takes into account only these observation where fitted value is bigger than observed value – i.e. situations when agents have expected better protection than has in fact occurred. It is possible to understand RRMSNE as a measure of unpleasant surprises. RRMSNE is important because of previously mentioned results that emphasize importance of unexpected negative changes in PRP.

   It is reasonable to expect that there should be close relationship between RRMSE and RRMSNE. This is indeed true – as it could be seen in the figure 2. However the closer look on their dependence reveals that for higher values of both statistics (i.e. worse predictability) their relation become significantly weaker. This is caused by presence of countries which experienced huge negative abrupt changes in the level of the property rights protection.

3.2 Growth rates

The second approach to detection of abrupt changes is much more simple. It focuses on identification of abrupt negative changes in time-series of PRP and therefore is closer to RRMSNE than to RRMSE. This

[1] Predictions for $n > 5$ were not tested, however there is no reason to expect any change.

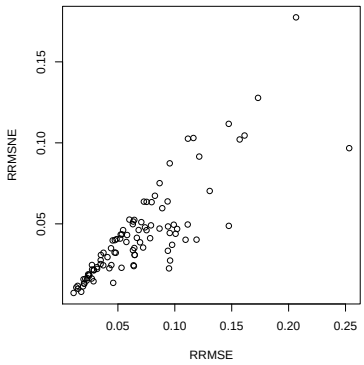

Figure 2: Correlation of RRMSE and RRMSNE with removed outliers

approach is also more oriented to concrete events compared to statistics of predictability which evaluates overall predictability of whole time-series.

As unexpected is considered such change which is bigger then usual. Evaluation is performed for each time-series. At first the annual growth rates are calculated and then the possible outliers are found. Observation y_t which meets condition (7) is considered to be an outlier. The number of identified outliers GRO can be taken as approximation of probability of abrupt negative change occurrence.

$$GRO = \sum_{t=1}^{n} x_t \tag{6}$$

$$x_t = \begin{cases} 1 & \text{if } y_t < \bar{y} - 2\sqrt{\frac{(y_t-\bar{y})^2}{n-1}} \\ 0 & \text{if } y_t \geq \bar{y} - 2\sqrt{\frac{(y_t-\bar{y})^2}{n-1}} \end{cases} \tag{7}$$

Results of analysis are depicted in thematic map in figure 3a. These results also reveal drawbacks of this approach. According this evaluation some countries (e.g. USA, Germany or Canada) experienced non-zero number of negative abrupt changes – even though their biggest negative growth rates are small in comparison to another more volatile countries.

This drawback can be partially corrected by using standard deviation obtained from all growth rates of all countries. This modification is used for calculation of GRO_w. Distribution of GRO_w is depicted in the figure 3b.

(a) GRO (b) GRO_w

Figure 3: Distribution of GRO and GRO_w around the world.

4 Explanation of abrupt changes

4.1 Explanatory variables

This paper seeks explanation of occurrence of abrupt changes in features of political system. It focuses on two characteristics: quality and stability. Quality of political system is described using following variables:

polity2 is variable from dataset Polity IV [4] which evaluate nature of regime on the discrete scale from -10 to 10, where -10 is extreme value for autocracy and 10 extreme for democracy. Values are available on yearly basis. I used average values for whole period which can be treated as continuous in value.

left originates from dataset DPI2010 [2] (variable *execrlc*) and reflects the probability that a left-wing party is in power. Variable $left$ is computed as follows:

$$left = \frac{1}{n}\sum_{t=1}^{n} x_t \tag{8}$$

$$x_t = \begin{cases} 1 & \text{if left-wing party is in power} \\ 0 & \text{if left-wing party is not in power} \end{cases} \tag{9}$$

Variable $left$ is included because of assumed tendency of left-wing parties to restrict private property.

allhouse also comes from DPI2010 and indicates whether the party in power controls all relevant houses. Value of *allhouse* is computed analogously to the $left$.

maj is last used variable from DPI2010 and reflects average fraction of seats held by the government. This variable, as well as *allhouse*, reflects ability of government to carry out the policy that it choose to implement.

Additional variable describes stability of political system:

durable is average number of years between change of *polity2* of at least 3 points. Variable *durable* comes from Polity IV.

4.2 Model

Design of the model has to deal with collinearity of variables which describe quality of political systems. This issue is solved by principal component analysis (PCA) performed on scaled matrix of these variables. First two extracted orthogonal components are used as explanatory variables. These two components account for 76.6 % of observed variability. Correlation of used components and original variables is depicted in table 1.

	polity2	*left*	*allhouse*	*maj*
Q_{pc1}	-0.85	0.15	0.69	0.88
Q_{pc2}	0.32	0.93	0.31	-0.10

Table 1: Correlation (Pearson's ρ) between PCA scores and variables describing quality of political system

The econometric model for explaining RRMSE and RRMSNE has therefore following form:

$$\log(RRMSE) \text{ or } \log(RRMSNE) = \beta_0 + \beta_1 Q_{pc1} + \beta_2 Q_{pc2} + \beta_3 \log(durable) \tag{10}$$

This model is estimated on cross-sectional data ($n = 125$) using OLS and the results are presented in table 2.

The model for explaining GRO and GRO_w has altered structure. There is an additional variable which describes stability of political system – *coup*. This variable [5] is the number of successful and attempted coups d'état during examined period 1984–2010. Number of coups is added because of event-oriented nature of GRO. Altered model has the following structure:

$$GRO \text{ or } GRO_w = \beta_0 + \beta_1 Q_{pc1} + \beta_2 Q_{pc2} + \beta_3 \log(durable) + \beta_4 coups \tag{11}$$

Equation (11) was estimated on the same data and by the same estimator as (10). Results are also presented in table 2. The model for GRO was quite unsurprisingly found insignificant and therefore is not included in the table.

Explained var.	*const.*	Q_{pc1}	Q_{pc2}	$\log(durable)$	*coups*	$\bar{R}^2$
$\log(RRMSE)$	-1.400^{***} (0.189)	0.112^{***} (0.043)	-0.116^{*} (0.060)	-0.422^{***} (0.064)		0.34
$\log(RRMSNE)$	-2.237^{***} (0.178)	0.114^{***} (0.040)	-0.119^{**} (0.056)	-0.324^{***} (0.059)		0.30
GRO_w	1.034^{***} (0.230)	0.007 (0.050)	-0.139^{**} (0.068)	-0.243^{***} (0.074)	0.1312^{***} (0.044)	0.22

Table 2: Results of OLS regression

4.3 Results

Estimated results shows that there is indeed relationship between occurrence of abrupt changes and political system. This relationship is clear especially for variables which reflects stability of political system. They are in all cases significant with expected values. Better stability (higher *durable* and lower *coup*) decrease probability of occurrence of abrupt changes – i.e. decrease of all dependent variables.

Relationship between quality and dependent variables seems to be much more complicated. The first component Q_{pc1} meets the expectations. However it is significant just in the case of RRMSE/RRMSNE. The value of estimated parameters for the second one which is closely correlated to the $left$ is inverse to expectations. It might be caused by suboptimal selection of variables or by actual insignificance of the $left$. This issue however requires further research.

5 Conclusion

This paper has investigated whether features of political systems determines probability of occurrence of abrupt changes in property rights protection level. Using cross-sectional data the significant dependence was found on the stability and quality of political systems. These preliminary results seems to promising for next research which should be focused on two areas: a) improvement in methodology of measuring of predictability (including analysis of wider set of indicators) and b) augmentation of models (10) and (11) with broader set of control variables.

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References

[1] Acemoglu, D., and Johnson, S.: Unbundling Institutions. *Journal of Political Economy* **113** (2005), 949–995.

[2] Keefer, P.: *Database of Political Institutions DPI2010,* on-line database, World Bank, 2010.

[3] Knack, S., and Keefer, P.: Institutions and Economic Performance: Cross-Country Test Using Alternative Institutional Measures. *Economics and Politics* **7** (1995).

[4] Marshall, M. G., Jaggers, K., and Gurr, T. R.: *Polity IV Project: Political Regime Characteristics and Transitions, 1800–2010* (2011), on-line database.

[5] Marshall, M. G., Marshall, D., R.: *Coup d'État Events, 1946–2010* (2010), on-line database.

[6] Mikula, Š.: On the Predictability of Institutional Environment. In: *Mathematical Methods in Economics 2011* (M. Dlouhý and V. Skočdopolová, eds.), University of Economics, Prague, 2011.

[7] PRS Group: *International Country Risk Guide (ICRG)* (2012), on-line available at: `https://www.prsgroup.com/ICRG.aspx`.