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City Growth Rates in Eastern European Transition Economies

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Abstract: *The paper investigates the dynamics of city growth rates in twelve transition economies from the former communist bloc. The study explores the validity of Gibrat`s law using a battery of parametric and nonparametric methods that are robust to cross-sectional dependence. The analysis is conducted on data for cities over 100,000 inhabitants in the period 1970-2007, as well as on detailed city data in the period 2000-2009 for three of the countries. To capture the influence of a potential break due to the fall of the communist regime, two subsamples, respectively 1970-1989 and 1990–2007, are also analyzed. Although there is mixed evidence, the findings provide support for accepting Gibrat`s law in ten of the countries, especially after the break is accounted for.*

Keywords: cities, city growth, Gibrat`s law, transition economies, post-communist economies

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1 Introduction

The demise of the socialist economic system and its subsequent restructuring has led to profound changes in the spatial patterns of urban economies in cities of the Central and Eastern European (CEE) and Commonwealth of Independent States (CIS) countries. The most important and visible trend of urban development during the transition period has been the decentralization of economic activities, a process which has played a major part in the transformation of the post-socialist city. The privatization of assets and the introduction of land rent have been the main driving factors for the process of urban spatial readjustments within the reality of a new market-oriented social environment (Stanilov, 2007).

One of the most striking regularities in the location of economic activity is how much of it is concentrated in cities. Understanding urbanization and economic growth requires understanding the variety of factors that can affect the size of cities and their short-term dynamics. The existence of very large cities and the wide dispersion in city

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sizes are all particularly interesting qualitative features of urban structure worldwide. A surprising regularity, Gibrat's Law (Gibrat, 1931), states that the growth rate of an economic entity (in this case a city) is independent of its initial size.

Although in the 1990s numerous studies began to test the validity of Gibrat's law, the evidence on the fulfillment of this law in the former communist transition economies is lacking. On the other hand, the law has been tested extensively for advanced economies, with a consensus that it holds in the long term. Eaton and Eckstein (1997) concludes that considering only the 39 most populated French cities there is no correlation between city size and growth rate, accepting Gibrat's Law. This result goes against the one obtained by Guérin-Pace (1995) when considering a wide sample of cities with over 2,000 inhabitants. This is no surprising contradiction since Eeckhout (2004) demonstrates the importance of choosing sample size in the analysis of city size distribution: the arbitrary choice of a truncation point can lead to skewed results. However, Eaton and Eckstein (1997) and Davis and Weinstein (2002) accept the Gibrat's Law for Japanese cities, although they use different sample sections (40 and 303, respectively) and time horizons. Moreover, Davis and Weinstein (2002) argue that the effect of large temporary shocks (Allied bombing in the Second World War) on growth rates disappears completely in less than 20 years. Brakman et al. (2004), taking into consideration 103 German cities, concludes that bombing had a significant, but temporary impact on post-war city growth. Bosker et al. (2008) employs a sample of 62 cities in West Germany and finds evidence against Gibrat`s law for about 75% of the cities in the sample. Clark and Stabler (1991), using data panel methodology and unit root tests, accept the hypothesis of proportional urban growth for Canada. Resende (2004) accepts Gibrat`s law by applying the same methodology to 497 Brazilian cities. Ioannides and Overman (2003) accept the fulfillments of Gibrat's Law for the case of the US, taking into consideration a sample of 135 MSAs (Metropolitan Statistical Area). However, the hypothesis is rejected by Black and Henderson (2003) using a different set of MSAs. These contradictory results may also be explained by the usage of different econometric methods. While Ioannides and Overman (2003) employs nonparametric techniques, Black and Henderson (2003) focuses mainly on panel data unit root tests. Eeckhout (2004) is the first study to use all the sample of cities in US, without size restrictions. Using both parametric and nonparametric methods, Eeckhout (2004) accepts Gibrat's Law for the US. For China, Anderson and Ge (2005) obtains a mixed result with a sample of 149 large cities. Petrakos et al. (2000) and Soo (2007) reject Gibrat's Law in Greece and Malaysia, respectively. Recently, a reassessment of Gibrat's Law in the context of countries size and in the context of regions within a country has been carried out. González-Val and Sanso-Navarro (2010) finds evidence of Gibrat's Law if countries growth rates are considered. Giesen and Suedekum (2010) provides empiric evidence supporting the theory that Gibrat's law is satisfied not only at the aggregate national level, but also at the region level, showing that urban growth among large cities is scale independent basically "everywhere" in space in Western Germany.

The present paper extends the existing literature in several directions. First, it fills a gap in the literature by providing a comprehensive analysis of the Gibrat`s law for the Eastern European transition economies. Second, it explores the impact of the breakdown of the communist regime on the dynamics of city growth rates in these countries. Finally, the methodology consists in a battery of parametric methods that are robust to the presence of cross-sectional dependence. More specifically, growth regressions with Driscoll and Kraay (1998) cross-sectional dependence robust standard errors and Pesaran (2007) panel unit root test that account for the presence of cross-sectional dependence are employed**.** Another methodological novelty consists in the usage of non-parametric techniques capable of dealing with a mix of continuous and discrete data (Hayfield and Racine, 2008; Li and Racine, 2003). This is convenient because it allows identifying, using non-parametric methods, the influence of discrete variables accounting for possible structural breaks.

2 Data

The analysis of this paper in based on a unified and comprehensive database for the CEE and CIS countries city size data (Necula et al., 2010). Obviously, when studying the dynamics of the city distribution, employing a large sample of cities, towns and villages increases the accuracy of the results. However, there is a trade-off between the size and the frequency of the available data sample. To account for this trade-off, the analysis in this paper is conducted on two datasets.

The first dataset consists in detailed city size data from Poland, Belarus and Latvia for the period 2000-2009. More specifically, in the case of Poland the largest 200 cities are considered, in Belarus the largest 50 cities, and in Latvia the largest 30 cities. The main source of the detailed data is the national official statistical information services of the respective countries.

The second one is focused on data on cities over 100,000 inhabitants in Eastern European countries for the period 1970 – 2007. The main source of the data is the annual United Nations Demographic Yearbooks (UNDY). The main difficulty consisted in reconstructing the data backwards, before 1989, on cities in the CIS countries since they are reported under USSR. The situation is similar for some of the CEE countries, such as the countries in the Former Yugoslavia, or in the Czech Republic and Slovak Republic. To ensure that the database has a reduced number of missing observations, the data were collected irrespective of the methodology employed in the UNDY in different years (i.e. CDJC - census de jure, complete tabulation; ESDF - estimates, de facto; ESDJ - estimates, de jure). Because data on cities over 100,000 inhabitants in Albania, Moldova, and countries from the Former Yugoslavia is too sparse to be of any use, these countries are excluded from the analysis. The number of cities over 100,000 inhabitants in the countries from our sample is reported in Table 1.

[INSERT Table 1]

As one can easily observe from Table 1 in some countries the sample size for cities over 100,000 inhabitants is insufficient for robust results. Therefore, five of the countries are pooled into two groups, since there is a relatively low cross-section dimension when analyzed separately. The first group consists of the Baltic States (Estonia, Latvia, Lithuania), the second one of the countries from the Former Czechoslovakia (Czech Republic, Slovak Republic). The average number of cities over 100,000 inhabitants for the remaining units is as follows: Russian Federation 152, Ukraine 45, Poland 37, Romania 21, Belarus 12, Bulgaria 8, Hungary 8, Former Czechoslovakia 8, and Baltic States 8.

Table A.1 in the Appendix describes the dataset, presenting the number of observations, the time and cross-section dimensions of the panel, the average, standard deviation, minimum and maximum city size.

3 Methodology

The Gibrat`s law hypothesis is tested by employing both parametric and nonparametric methods. The simplest parametric test consists in estimating the following growth equation:

$$\ln S_{it} - \ln S_{it-1} = \alpha + \beta \ln S_{it-1} + \varepsilon_{it} \qquad (1)$$

where S_{it} denotes the size of city i at the time t. Gibrat`s law holds if $\beta = 0$ (i.e. growth is independent of the initial size). To ensure validity of the statistical results one must adjust the standard errors of the coefficient estimates for possible dependence in the residuals. The results of these regressions are usually heteroskedastic (Gonzalez-Val et al., 2008), so it is suggested in the literature to compute the standard errors using White Heteroskedasticity-Consistent Covariance Matrix Estimator (White, 1980). However, another question to be tackled is the presence of cross-sectional dependence in panel data on city sizes. The cross-sectional dependence is tested using the Pesaran (2004) test, which does not depend on any particular spatial weight matrix when the cross-sectional dimension is large. In this paper, to account for the effect of potential cross-correlated residuals, Driscoll and Kraay (1998) standard errors are employed. Driscoll and Kraay (1998) modifies the standard Newey and West (1987) covariance matrix estimator such that it is robust to very general forms of cross-sectional as well as temporal dependences. Moreover, it is suitable for use with both, balanced and unbalanced panels (Hoechle, 2007).

Clark and Stabler (1991) pointed out that testing for Gibrat’s Law is equivalent to testing for the presence of a unit root. This idea has also been emphasized by Gabaix and Ioannides (2004). If the null hypothesis that the city population time series has a unit root is rejected, the null hypothesis that its size evolves according to Gibrat’s Law is also rejected. Panel data unit root tests have been proposed as alternative, more powerful tests than those based on individual time series unit roots tests. The panel unit root approach to investigate the validity of Gibrat`s Law has been pioneered by Clark and Stabler (1991) and has already been applied by Davis and Weinstein (2002), Resende (2004), Henderson and Wang (2007), Soo (2007) and Bosker et al. (2008).

Also, when exploring the existence of unit roots in panel data, it is important to take into account the presence of cross-sectional dependence. Most of these studies employed conventional (*i.e.* first generation) unit root tests that assume cross-sectional independence. The first generation test proposed by Levin, Lin and Chu (2002) is applicable for homogeneous panels where the coefficients for unit roots are assumed to be the same across cross-sections. Im, Pesaran and Shin (2003) allows for heterogeneous panels and proposes panel unit root tests which are based on the average of the individual ADF unit root tests computed from each time series. The null hypothesis is that each individual time series contains a unit root, while the alternative allows for some but not all of the individual series to have unit roots. However, the correct application of these techniques depends crucially on the assumption that individual time series are cross-sectional independent. This might be a restrictive assumption when using city size panel data. Conventional panel unit root tests, such as Levin, Lin and Chu (2002) and Im, Pesaran and Shin (2003), could lead to significant size distortions in the presence of neglected cross-section dependence and, generally, to over-rejection of the null hypothesis.

Much of the recent research on non-stationary panel data has focused on the problem of cross-sectional dependence. Second generation panel unit root tests that take into account the potential cross-section dependence in the data have been developed; see the recent survey by Breitung and Pesaran (2008). A number of panel unit root tests that allow for cross section dependence have been proposed in the literature that use orthogonalization type procedures to asymptotically eliminate the cross dependence of the series before standard panel unit root tests are applied to the transformed series (Bai and Ng, 2004; Moon and Perron, 2004). On the other hand, Pesaran (2007) suggests a simple way of accounting for cross-sectional dependence. This method is based on augmenting the usual ADF regression with the lagged cross-sectional mean and its first difference to capture the cross-sectional dependence that arises through a single-factor model. The proposed test has the advantage of being simple and intuitive. It is also valid for panels where the cross-sample dimension (N) and the time dimension (T) are of the same orders of magnitudes. The Monte Carlo simulations employed by Pesaran (2007) suggests that the panel unit root tests have satisfactory size and power even for relatively small values of N and T (i.e. $10<N<200$ and $10<T<200$).

The present study makes use of a battery of first and second generation panel unit root tests. More specifically we employ the first generation Levin, Lin and Chu (2002) and Im, Pesaran and Shin (2003) tests, and the second generation Pesaran (2007) test.

In order to increase the robustness of the results, nonparametric tests are also implemented. As suggested by Ioannides and Overman (2003) and Eeckhout (2004) for the non-parametrical analysis of Gibrat's law it is better to use normalized city growth rates (*i.e.* from growth rate of city i in year t the mean is subtracted and the result divided by the standard deviation of the growth rates). The widely employed Nadaraya-Watson kernel regression technique (Nadaraya, 1964, 1965; Watson 1964; Hardle, 1992) establishes a functional form-free relationship between population growth and country size for the entire distribution. It consists of taking the following specification:

$$g_i = m(s_i) + \varepsilon_i \qquad (2)$$

where g_i stands for the normalized growth of city i, and s_i is the logarithm of its size. Therefore, instead of assuming a linear relationship between these two variables, as in equation (1), $m(\cdot)$ is estimated as a local average, using a kernel function $K(\cdot)$:

$$m_{NW}(s) = \frac{\frac{1}{n}\sum_{i=1}^{n} K\left(\frac{s-s_i}{h}\right) g_i}{\frac{1}{n}\sum_{i=1}^{n} K\left(\frac{s-s_i}{h}\right)} \qquad (3)$$

where n is the sample size, and h the kernel bandwidth.

Starting from the estimated mean, $m_{NW}(\cdot)$, the variance of the growth rate can also be computed using the corresponding Nadaraya-Watson estimator:

$$\sigma_{NW}^{2}(s)=\frac{\frac{1}{n}\sum_{i=1}^{n}K\left(\frac{s-s_i}{h}\right)\left(g_i-m_{NW}(s)\right)^2}{\frac{1}{n}\sum_{i=1}^{n}K\left(\frac{s-s_i}{h}\right)} \tag{4}$$

Under the null of urban growth independent of initial size one would expect that all cities, regardless of their size, have mean normalized growth rate equal to zero and variance equal to one. These hypotheses are tested by constructing bootstrapped 95-percent confidence bands, calculated from 500 random samples with replacement, as suggested by González-Val and Sanso-Navarro (2010).

The nonparametric techniques employed in this paper allows computing a variety of nonparametric and semi-parametric kernel-based estimators appropriate for a mix of continuous, discrete, and categorical data (Hayfield and Racine, 2008). This kind of non-parametric technique is convenient because it allows identifying the influence of discrete variables accounting for possible structural breaks. The basic idea underlying the treatment of kernel methods in the presence of a mix of categorical and continuous data lies in the use of generalized product kernels. Li and Racine (2003) proposed the use of these generalized product kernels for unconditional density estimation and developed the underlying theory for a data-driven method of bandwidth selection for this class of estimators. The use of such kernels offers a seamless framework for kernel methods with mixed data. Further details on a range of kernel methods that employ this approach can be found in Li and Racine (2007). When all the variables are continuous, these methods collapse to the familiar Nadaraya-Watson nonparametric regression estimators.

The default Gaussian kernel is employed since the specific form of the local averaging function does not have a major impact on the results. On the other hand, bandwidth selection is a key aspect of sound nonparametric kernel regression estimators. The basic approach in the related urban literature (Eckhout, 2004) is to compute the bandwidth according to the "rule of thumb" proposed by Silverman (1986) based on inter-quartile range. In the present study, the bandwidth is selected using a data-driven method, more specifically, the Kullback - Leibler cross-validated bandwidth selection, using the method of Hurvich et al. (1998).

4 Results

4.1 Gibrat`s law for detailed city data

In this subsection the analysis is conducted on the dataset containing detailed city size data in Poland, Belarus and Latvia for the period 2000 – 2009. Pooling observations and using panel data methods is a necessary strategy to increase the reliability of the estimates when the observed period is relatively short (Banerjee, 1999). First, the growth equation (1) was estimated using both pooled data and a fixed effects panel model. The results of these estimations are presented in the first two lines of Table 2.

[INSERT Table 2]

In the urban literature, to test the significance of the parameters, White (1982) standard errors are generally employed since they are robust to heteroskedastic innovations. However, in this case, the estimated regression residuals of the fixed effects model are cross-sectionally dependent, as is clearly noticeable in the third line from Table 2. The pair-wise cross-section correlations coefficients of the residuals are not zero, since the average absolute correlation between the residuals of two cities is 0.318 in Poland, 0.39 in Belarus, and 0.341 in Latvia. Also, Pesaran (2004) cross-sectional dependence test rejects the null hypothesis of spatial independence on any standard level of significance. Therefore, this finding indicates that it is advisable to test for significance using Driscoll and Kraay (1998) standard errors, since they are robust to very general forms of cross sectional and temporal dependence.

The estimates of the pooled model provide strong evidence for the rejection of Gibrat`s law in Poland and Belarus. The evidence in the case of Latvia is less clear since the null hypothesis that the parameter connecting the growth rate and the size of a city is zero can be rejected at a level of significance of 5%, but not at a level of significance of 1%. These findings are consistent with the results of the non-parametric estimations, presented in Figure A.1 in the Appendix. This is no coincidence, since the non-parametric technique is an alternative estimation method of the pooled model.

However, one has to be careful when pooling the data since this can invalidate the analysis. For example, if the true model is fixed effects, the pooled OLS yields biased and inconsistent estimates of the regression parameters (Baltagi, 2005). In order to test for the presence of cross-section specific fixed effects, it is common to perform a Hausman (1978) test. In this paper, the null hypothesis of no fixed effects is tested using a version of the Hausman (1978) test proposed by Wooldridge (2001) and Hoechle (2007). Since this version of the test is robust to very general forms of spatial and temporal dependence it should be suitable for the case of city size panel data. The results of the tests are presented in the fourth line of Table 2. They provide strong evidence in the favor of the fixed effects model because the null of no fixed effects is rejected at any usual level of significance. The estimates from the fixed effects model provide contrary evidence to that indicated by the pooled data model. As it turns out, when accounting for city specific effects, the null hypothesis of cities growing independent of their size can not be rejected at the level of 5% for any of the three countries.

Next, the panel structure of the city population data is further exploited in order to test for a unit root. Although only 10 observations over time are available, the use of a panel unit root test with a relatively large cross-section dimension is likely to alleviate the small-sample bias of a usual ADF unit root test. Black and Henderson (2003) also employs 10 time observation (decade by decade) in their study on urban evolution in the USA. Following Clark and Stabler (1991) only a constant has been included as the deterministic term. The results for the first generation Levin, Lin and Chu (2002) and Im, Pesaran and Shin (2003) tests, and the second generation Pesaran (2007) test are reported in the last three lines of Table 2. Although, the first generation tests are used for completeness, more weight is given to the test of Pesaran (2007) since it allows investigating the presence of a unit root taking into account cross-sectional dependence, which is the case of the analyzed sample. Moreover, the test is robust to size distortions caused by the potential presence of serially correlated errors. As one can easily notice, the test can not reject the null of a unit root at any usual level of significance, therefore, providing support for the acceptance of Gibrat`s law in all the three countries.

However, it has to be stressed that, since specific city effects are taken into account, the deterministic component (the expected growth rate) is different across cities. Therefore, although the coefficient that quantifies the influence of the size on growth is zero, a consistent difference in the expected growth rate between “small” cities and “large” cities might indicate that Gibrat`s law does not hold. This could be the case of Belarus, because the non-parametric analysis indicates that there are differences between the behavior of small cities, medium cities and large cities.

To investigate further, the cities in Belarus are grouped in three categories, respectively the “large” cities group consisting of the largest 8 cities, the “medium” group comprising the next largest 27 cities, and the “small” group with the last 15 cities. The grouping was done such that the modified Hausman (1978) test indicates that for each of the group a pooled model is adequate. There is a significant difference between the average growth rates of the cities in these groups, with an average annual growth of 0.49% for the first group, -0.15% for the second group, and -0.46% for the small cities group. Therefore, a growth regression was estimated for each of the group, and another one for the entire sample but controlling for group specific characteristics. The results are reported in Table A.2 in the Appendix. It seems that for the large cities group there is a significant dependence of growth on size. Moreover, after the dummy variables controlling for different groups are accounted for, the coefficient quantifying the dependence of the size of the city on its growth rate is statistically significant at 5%. This finding proves the validity of intuitive doubts as to proportionality of growth in Belarus where the intentionally designed redistribution measures are evident.

Overall, in the period 2000-2009 there is very strong evidence that Gibrat`s law holds for Latvia and strong evidence that in is valid in Poland. However, it seems that, at least in the short run, there is a divergence pattern in the case of Belarus. A longer time span is necessity for a deeper investigation of the long run dynamics of city growth.

4.2 Gibrat`s law for cities over 100,000 inhabitants in the period 1970 - 2007

In this subsection the analysis turns to cities over 100,000 inhabitants in the period 1970 – 2007. There are twelve countries in the sample, but, after pooling some of them as described above in the data section, nine units remain, respectively Russia, Ukraine, Poland, Romania, Belarus, Bulgaria, Hungary, Former Czechoslovakia, and Baltic States.

A major problem with this dataset is the existence of missing observations. Although, data were collected irrespective of the methodology employed in the UNDY in different years, Hungary is the only country in the sample that has all the 38 observations over time. In the Baltic States there are 32 time observations, in Bulgaria 28, in Belarus and Poland 27, in Romania 26, in Former Czechoslovakia 25, in Russia 24, and in Ukraine only 17. Moreover, since growth rates are needed in our analysis, the problem of missing data is further amplified since the growth rate can not be computed if consecutive year data is not available. When estimating the growth regression using pooled data or the fixed effects model, an assumption had to be made in order to alleviate this problem of missing growth rates. More specifically, if city sizes data is missing in year t, but not in year t-1, the growth rate of a city for the period t/t-1 is, however, computed by assuming to be equal to the annual average growth rate between year t and the year with the next available city sizes data. This is a reasonable assumption since it does not lead to the introduction of new city data by interpolation. It uses only the original city size data, but it computes the growth rates with different formulas depending on the situation. First, the growth equation (1) was estimated using both pooled data and a fixed effects panel model. To capture the influence of the breakdown of the communist regime the sample is also divided in two subsamples, respectively 1970-1989 and 1990-2007. The results are reported in Table 3. The null of no fixed effects can not be rejected at the level of significance of 1% for any of the countries. Although, the results of the fixed effects model are reported for completeness, more weight should be, therefore, given to the pooled model in this case.

[INSERT Table 3]

To ensure that the panels are balanced some of the cities with sparse observations were drooped. Therefore, the number of analyzed cities is 108 for Russia, 31 for Ukraine, 23 for Poland, 13 for Romania, 9 for Belarus, and 6 for Bulgaria, Hungary, Former Czechoslovakia and the Baltic States. The average absolute value of the off-diagonal elements of the correlation matrix of the regression residuals varies from 31.7% for Poland to 72.6% for Romania. Also, the null hypothesis of cross-sectional independence is rejected for all the countries, implying the necessity of using Driscoll and Kraay (1998) standard errors to correct for cross sectional dependence. The results of the pooled regression indicates that, in the post-communist period, Gibrat`s law is valid in all of the countries, with some doubts in the case of Hungary. When all the sample is considered the evidence for accepting Gibrat`s law is less clear in Russia, Ukraine, Poland, and Romania. These findings are largely confirmed by the results of the non-parametrical regressions that are provided in Figure A2 in the Appendix. However, these results indicate that there is strong support for the law of proportional effect in the case of Russia and Ukraine, when the entire sample is considered.

Next, the analysis turns to investigating the presence of a unit root taking into consideration the panel structure of the data. When using classical panel data techniques, the growth rates and the city sizes can be looked at as two different inputs and the procedure for filling some of the missing growth rates described above is employed. However, an even major problem arises when the unit root tests are considered. In this case, the input consists only in the city size data. Testing for a unit root in a time series with missing observations has received little attention in the econometric literature. Shin and Sarkar (1996) tested for a unit root in a AR(1) time-series using irregularly observed data and obtain the limiting distributions associated with the case where the gaps are ignored (i.e. the series are closed), and with the case where the gaps are replaced with the last available observation. They show that replacing the gaps with the last observation, or simply ignoring the gaps, does not alter the usual asymptotic results associated with DF statistics. Shin and Sarkar (1996) also investigated the finite sample properties of the two alternatives of dealing with missing observations in the case of an "A-B sampling scheme", where A is the number of available observations and B is the number of missing observations. Their simulation results show that the unit root test performs relatively well in small samples. Shin and Sarkar (1994) investigated a unit root test for an ARIMA(0,1,q) model with irregularly observed sample and prove to have the same asymptotic distribution as the DF statistics for the complete data situation. Some simulation results for the ARIMA(0,1,1) model show that the sizes of the tests for A-B = 6-1, 5-2 and 4-3 were similar to those for the case where there are no missing observations (i.e. A-B=7-0).

When dealing with time series data with missing observations, the other most common technique besides ignoring the gaps, and replacing the gaps with the last available observation, consists in filling the gaps with a linear interpolation method. It could be argued that instead of using the last available observation to fill these gaps, a linear interpolation between the known observations could provide a “smoother” alternative of dealing with gaps. However, the distributional implications of such a procedure require careful consideration, even in large samples. Giles (1999) extended the results of Shin and Sarkar (1996) and investigated the behavior of unit root tests when a linear interpolation method for dealing with the gaps in the data is employed. They prove that the limiting distribution includes an adjustment factor which results in critical values that are less negative than for the usual DF statistic. Giles (1999) also investigated the finite sample properties of the three alternatives for dealing with missing data. The findings obtained by Giles (1999) within a simulation experiment framework indicate that the unit root tests are more powerful when gaps are ignored, as compared with the other two alternatives of filling missing data. Following Giles (1999), when testing for a unit root in the case of cities over 100,000 inhabitants, the gaps are ignored. The results are reported in Table 4.

[INSERT Table 4]

Again, in order to ensure a balanced panel, the analysis focuses on 108 cities in Russia, 31 in Ukraine, 23 in Poland, 13 in Romania, 9 in Belarus, and 6 for Bulgaria, Hungary, Former Czechoslovakia and the Baltic States. The unit root tests are not conducted unless at least 10 time observations are available, which is the case of Ukraine when the sample is split in the two sub-periods. When the tests indicate contradictory results, the priority is given to Pesaran (2007) test since it is robust to cross-sectional dependence. The results confirm, in general, the findings of the growth regressions. More specifically, the unit root tests indicate that, after 1989, the Gibrat`s law is valid in all the countries except Russia and Ukraine. If the entire sample is considered, there is less evidence in the case of Poland and Hungary.

There is one major caveat of the regressions and of the unit root tests analyzed so far. That is the existence, after 1989, of a potential change in the deterministic component of the growth rates of the cities in the former communist bloc, at which the analysis is focused on in the next subsection.

4.3 Accounting for a potential structural break in 1989

In most transition countries the economic and political reforms have been accompanied, at least in the first years after the fall of communism, by a rapid impoverishment of large sections of society and increasing uncertainty about the future. According to UNICEF (1994), between 1989 and 1994, marriage rates in transition countries fell by between one-quarter and one-half, birth rates shrank by up to 40 percent and death rates among male adults due to cardiovascular and violent causes often more than doubled. By 1994 the natural increase of the population had become negative in

Bulgaria, the Czech Republic, Hungary, Romania, the three Baltic States, Russia, Ukraine and Belarus. Demographic changes started in the mid 1980s or even 1970s in the case of Hungary. It should be noted that, in spite of a similar pattern of life births decline in the first decade after 1989 for the countries in the sample (excluding non-European CIS countries), only Poland demonstrates positive rate of natural population increase (excluding changes due to migration) and negative net external migration at the same time. This may indicate that as opposed to other countries, Polish formal and informal institutions were able to soften economic and social difficulties not restricting out-migration to more prosperous countries. One of the evidences of a specific institutional influence in Poland can be a negative dynamics of abortion percentage (abortion as percentage of pregnancies excluding fetal deaths/miscarriages). While in the examined transition countries abortion percentage grew after 1989, in Poland, where this indicator was lowest in the region, a tendency was opposite.

Surprisingly, deep econometric studies of population crisis conditioning factors in transition economies are not numerous. From these factors a fertility decline is investigated more often (see a survey provided by UNECE, 2000). A notable exception is Cornia and Paniccià (1998) who challenge the viewpoint that attributes the population crisis in transition economies to factors broadly unrelated to the economic and social difficulties experienced during the transition. The authors conclude that, although important demographic changes occurred in the 1970s and 80s, in three-quarters of the cases examined the after 1989 shifts in nuptiality, fertility and mortality show large, growing and statistically significant variations from past trends. Authors find little or no evidence that these drastic variations are the result of shifts toward Western models of marriage or reproductive behavior. They instead explain these variations by negative shifts in the economic circumstances of the marriageable population and of the families already formed, and in particular by the fall in real wages and rising cost of housing and other goods needed to establish and maintain a family. They are also due to the deterioration in and the modest impact of family policies on reproductive behavior. In contrast, expectations about the economic outcomes of the current crisis appear to exert a sizeable influence on the decision to marry and, particularly, to have a child. UNECE (2000) results provide ample support for the hypothesis that the declines in household incomes have put downward pressure on fertility.

Looking for the explanation of cities population decline in the beginning of transition it is useful to bear in mind the urban sociologists' view that in the course of their evolution cities exploit not only a local site but a nodal geographical situation and develop as long as the networks they control are expanding (Pumain, 2010). Political and economic transition leads to multiple breaks in social and economic relationships. It is not unexpected then that even with large population increases in some cities due to nearby conflicts, the average metropolitan city in the former Soviet Union lost population between 1989 and 1997. For example, Moscow declined by 350,000 and St. Petersburg by more than 200,000 (Rowland, 1998). At the same time over the period from the last Soviet census in January 1989 to the beginning of 1997, the net immigration to Russia offset the negative natural increase so that Russia's population increased over the period from 147,022 ths to 148,029 ths.

The explanation, at least partial, of this inverse population dynamics in the whole countries and theirs big cities could be behind the failure of industrialization policy. In contrast to non-socialist economies, where urbanization is driven largely by market forces, socialist planners accelerated the process by moving people to cities more rapidly so that forced industrialization could generate faster economic development. Chenery and Syrquin (1986) study affords to estimate that, for a given level of per capita income, the share of the population in cities in the transition region was, on average, of the order of 12 percentage points higher than it was in comparator countries. Buckley and Mini (2000) stress that per capita income in 1990 was at least 40 percent lower than in countries that urbanized more spontaneously largely because the industrialization strategy failed. After command system collapse, people and firms start to take private decisions in an atmosphere of spatial competition. Unbalanced and undiversified industrial structure of socialist cities required deep structural changes and inter-industry reallocation of resources. Significant territorial adaptation and relocation of production factors among cities become a pressing task. With more freedom, workers in over-industrialized cities can, in the words of Buckley and Mini (2000), "vote with their feet" and move away from cities.

First, the effect of a potential break on the previous results on the unit roots tests is investigated. Regarding unit root tests, Perron (1989) pointed out that failure to account for an existing break leads to a bias resulting in an under-rejection of the unit root null hypothesis. To overcome this problem, Perron (1989) proposed allowing for an exogenous structural break in the standard ADF tests. Following this breakthrough, several authors including, Zivot and Andrews (1992) and Perron (1997) proposed determining the break point endogenously from the data. To account for a possible break in the series, a Zivot and Andrews (1992) unit root test was conducted. For each country, the largest city and a hypothetical city with the size equal to the average city size in the respective country were investigated. The last column in Table 4 reports the results. Zivot and Andrews (1992) structural break test is a sequential test which employs the full sample and a different dummy variable for each possible break date. The break date is selected at the time where the t-statistic of the ADF test is at a minimum, therefore, where the evidence is least favorable for the unit root hypothesis. Even accounting for a potential break, the hypothesis of a unit root, in the case of the "average" city, could not be rejected for any of the countries, except Belarus. This finding provides strong evidence in favor of accepting Gibrat`s law in all the countries in the sample except Belarus.

When estimating the growth regressions in the previous subsection, the sample was split in two sub-periods to account for a possible change in the fulfillment of Gibrat`s law. However, it could be argued that splitting the data into subsets may lead to a loss in efficiency due to the reduction in the sample size. Therefore, another alternative to control for a potential change in the deterministic component of the growth rates of the cities is also employed. More specifically, a dummy variable, taking the value zero before 1989 and the value one afterwards, is introduced in the growth regressions. The results are reported in Table 5.

[INSERT Table 5]

The estimates of the pooled data model, which, as argued in the previous subsection, is given priority over the fixed effects model, indicate that the coefficients of the variable accounting for a change in the deterministic component are significantly different from zero in all the countries, except Belarus. As already mentioned, the non-parametric techniques employed in this paper (Li and Racine 2003; Hayfield and Racine, 2008) are appropriate for a mix of continuous and discrete data. This is convenient because it allows investigating, by means of non-parametric regression, whether the influence of discrete variables accounting for potential structural breaks is significant.

[INSERT Figure 1]

The graphs in Figure 1 depict the impact on city growth rates of the dummy variable accounting for a structural break in 1989. As it is standard in non-parametric analysis, to capture the sole influence of one variable (in this case the dummy), the other variable (in this case the relative city size) is held at the median value. The 95% distribution free (bootstrapped) error bounds, computed using 500 random samples with replacement, are also depicted. The results confirm the findings of the parametric analysis with a shift in the deterministic component detected in all the countries except Belarus.

After the influence of the change in the deterministic component is accounted for, the null hypothesis of the validity of Gibrat`s law can not be rejected at any standard level of significance for six of the analyzed countries or groups of countries, respectively Poland, Romania, Belarus, Bulgaria, Former Czechoslovakia, and the Baltic States. For Hungary the null can not be rejected at 5%, and for Russia and Ukraine it cannot be rejected at 1%.

4.4 Gibrat`s law using five years averages

Another caveat of the analysis using yearly data on cities over 100,000 inhabitants is given by the existence of missing data in some of the years in the time span. As argued in the previous subsections, the treatment of missing data in this study is reasonable and the consistency of econometric methods assured. However, in order to check the robustness of the results, in this subsection the analysis is also conducted using five years averages. For the last period, 2005-2007, only three years are available and, therefore, three years averages are employed.

To ensure that the panels are balanced some of the cities with missing observations were drooped. Therefore, the number of analyzed cities is 130 for Russia, 37 for Ukraine, 25 for Poland, 15 for Romania, 9 for Belarus, 7 for Bulgaria, Hungary and the Baltic States, and 6 for Former Czechoslovakia. Because the time dimension is too low (8 periods) to use panel unit root tests, only growth regression are estimated using pooled data. The results quantifying the influence of the five year average size on the annualized growth rate are reported in Table 6.

[INSERT Table 6]

The results of the pooled regression indicates that, in the post-communist period, Gibrat`s law is valid in all of the countries, with less evidence in the case of Ukraine and Hungary. When all the sample is considered Gibrat`s law is rejected in Russia and Ukraine. However, this is contrary to the findings of the non-parametrical regressions, reported in Figure A3 in the Appendix, that indicate the acceptance of the proportional effect law in Russia and Ukraine in all of the three subsamples.

Also in the case of using five years averages, the estimates from the parametric method, as well as the results of the non-parametric method (Figure A4 in the Appendix), indicate that the dummy variable accounting for a change in the deterministic component has a significant influence in all the countries. After accounting for the shift in the deterministic component, the null hypothesis of the validity of Gibrat`s law can not be rejected at any standard level of significance for seven of the analyzed countries or groups of countries, respectively Poland, Romania, Belarus, Hungary, Bulgaria, Former Czechoslovakia, and the Baltic States. On the other hand, there is strong evidence against Gibrat`s law in the case of Russia and Ukraine.

5 Concluding Remarks

Most of the empirical literature investigating the dependence of growth rates of cities on their size focused mainly on advanced economies. This paper has explored the dynamics of city growth rates in twelve transition economies from the former communist bloc, namely Russia, Ukraine, Poland, Romania, Belarus, Bulgaria, Hungary, Czech Republic, Slovak Republic, Estonia, Latvia and Lithuania.

Using both detailed city data in the period 2000-2009 for Poland, Belarus and Latvia, as well as data on cities over 100,000 inhabitants in the period 1970-2007 for all the twelve countries, the study has employed a battery of parametric and non-parametric methods to give a thorough investigation of the validity of Gibrat`s law in transition economies. The methodological novelties of the paper are twofold. First, the analysis is based on parametric methods that are robust to cross-sectional dependence in the residuals. Second, the non-parametric techniques used are capable of dealing with a mix of continuous and discrete data.

The first finding concerns detailed city data in the period 2000-2009 for Poland, Belarus and Latvia. The estimates of the pooled model, using both parametric and non-parametric methods, provide evidence for the rejection of Gibrat`s law in the three countries. On the other hand, when accounting for city specific effects, there is support for the acceptance of the law of proportional effect, with cities seemingly growing independent of their size. The latter evidence is also confirmed by the panel unit root tests. However, in the case of Belarus, as indicated by the non-parametric methods and confirmed by a deeper parametric analysis, there is a significant difference between the behavior of small and large cities, with the growth of large ones having a significant dependence on size. Overall, in the period 2000-2009 there is strong evidence that Gibrat`s law holds for Latvia and Poland. However, at least in the short run, a divergence pattern was detected in the case of Belarus.

The other major contribution resides in the analysis conducted for cities over 100,000 inhabitants using yearly data for the period 1970-2007. Two main problems had to be addressed, respectively the existence of a potential break in the deterministic component of the growth rates of the cities in the former communist bloc, and missing observations given limited availability of data. After the influence of the change in the deterministic component is accounted for, there is strong support for the validity of Gibrat`s law in Poland, Romania, Belarus, Bulgaria, Former Czechoslovakia (Czech Republic, Slovak Republic), and the Baltic States (Estonia, Latvia and Lithuania), with weaker evidence for Hungary, Russia and Ukraine. In order to ensure robustness, the analysis has also been conducted using five years averages, with the results largely confirming the findings using yearly data. In the case of Russia and Ukraine, the parametric methods detected a convergence pattern. However, this is not confirmed by the non-parametric analysis. Overall, the findings indicate that, in the long run, there is strong support for accepting Gibrat`s law in Poland, Romania, Bulgaria, Former Czechoslovakia (Czech Republic, Slovak Republic), and the Baltic States (Estonia, Latvia and Lithuania), less strong support in the case of Belarus and Hungary, and weak support or even contrary evidence in the case of Russia and Ukraine.

Therefore, it can be affirmed that Gibrat`s law holds for a significant part of examined transition countries indicating that the population mobility of post-communist cities is similar to previously studied developed countries. However, we can not be totally sure that the driving forces behind this proportionate growth process are the same for developed and transition countries and even that the nature of urban systems dynamics of the latter group of countries is identical. Our results show that it is a reasonable strategy to use a battery of models and tests which allowed us to prove the validity of our intuitive doubts as to proportionality of growth in relation to several countries, especially to Belarus where the intentionally designed redistribution measures are evident.

We can only agree with Eeckhout (2004) that further analysis of the data should be done, particularly of the entire size distributions over time. Thus it would be interesting for future work to examine the distribution of city sizes in transition economies, to investigate the factors that drive the variation of the distribution parameters over time, to examine for possible non-Pareto behavior using detailed city data, and to explore the "within distribution" dynamics of specific classes of cities.

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Appendix

[INSERT Table A.1]

[INSERT Table A.2]

[INSERT Figure A.1]

[INSERT Figure A.2]

[INSERT Figure A.3]

[INSERT Figure A.4]

Table 1. Number of cities over 100,000 inhabitants in the period 1970 – 2007 in the Eastern European countries in the sample

		average	min	max
1	Belarus	12	9	15
2	Bulgaria	8	4	10
3	Czech Republic	6	4	8
4	Estonia	2	1	2
5	Hungary	8	6	9
6	Latvia	2	2	3
7	Lithuania	4	3	5
8	Poland	37	23	43
9	Romania	21	13	26
10	Russian Federation	152	127	163
11	Slovak Republic	2	2	2
12	Ukraine	45	39	51

Table 2. *Results for detailed city data in Poland, Belarus and Latvia*

	Poland	Belarus	Latvia
ln(Size)	-0.0011	0.0029	0.0006
pooled	[0.0001]	[0.0004]	[0.0003]
	(0.0000)	(0.0000)	(0.0550)
ln(Size)	-0.0063	-0.0827	-0.1423
fixed effects	[0.0076]	[0.0475]	[0.0770]
	(0.4030)	(0.0880)	(0.0750)
ACSC	0.3180	0.3900	0.3410
PCS	34.6650	24.2510	7.6140
	(0.0000)	(0.0000)	(0.0000)
HWH	25.0400	27.7400	9.1400
	(0.0000)	(0.0000)	(0.0053)
URLLC	-0.0026	-0.6400	-3.2343
	(0.4989)	(0.2610)	(0.0006)
URIPS	10.8370	4.5420	1.4160
	(1.0000)	(1.0000)	(0.9220)
URPCS	-0.0060	-0.6400	-0.3220
	(0.4980)	(0.2610)	(0.3740)

Driscoll - Kraay robust standard errors are reported in squared parentheses; p-values are reported in round parentheses; ACSC is the average absolute value of the off-diagonal elements of the correlation matrix of the regression residuals; PCS is the Pesaran (2004) cross-section independence test; HWH is the modified Hausman (1978) test; URLLC, URIPS, URPCS are Levin et al (2002), Im et al (2003) and Pesaran (2007) panel unit root tests; the transformed t statistics are reported for the unit root tests

Table 3. *Growth regressions results for cities over 100,000 inhabitants for the period 1970-2007*

		Pooled regression			HWH	Fixed effects regression			ACSC	PCS	
		estim.	std. err.	p-value		estim.	std. err.	p-value		statistic	p-value
Russia	all sample	-0.0060	0.0027	0.0265	5.7100	-0.2052	0.0655	0.0022	0.3800	100.58	0.0000
	before 1989	-0.0036	0.0010	0.0003	(0.0186)	-0.1499	0.0633	0.0196	0.6350	135.03	0.0000
	after 1989	-0.0065	0.0044	0.1418		-0.4061	0.0591	0.0000	0.4910	38.66	0.0000
Ukraine	all sample	-0.0094	0.0039	0.0231	6.3300	-0.1645	0.0563	0.0065	0.5050	41.63	0.0000
	before 1989	-0.0046	0.0020	0.0269	(0.0175)	-0.0715	0.0080	0.0000	0.3680	9.91	0.0000
	after 1989	-0.0114	0.0078	0.1560		-0.3873	0.0524	0.0000	0.6920	41.56	0.0000
Poland	all sample	-0.0031	0.0015	0.0443	4.4200	-0.0859	0.0239	0.0016	0.3170	23.14	0.0000
	before 1989	-0.0042	0.0014	0.0085	(0.0472)	-0.0676	0.0288	0.0282	0.2620	11.35	0.0000
	after 1989	0.0008	0.0019	0.6617		-0.1881	0.1236	0.1423	0.5280	15.65	0.0000
Romania	all sample	-0.0065	0.0023	0.0146	8.0600	-0.0741	0.0249	0.0117	0.7260	21.27	0.0000
	before 1989	-0.0048	0.0017	0.0176	(0.0149)	-0.0241	0.0234	0.3242	0.7990	26.39	0.0000
	after 1989	0.0013	0.0008	0.1614		-0.0924	0.0426	0.0510	0.7490	33.06	0.0000
Belarus	all sample	-0.0053	0.0034	0.1524	2.8500	-0.1516	0.0867	0.1186	0.5500	16.42	0.0000
	before 1989	-0.0101	0.0067	0.1695	(0.1299)	-0.2295	0.1360	0.1300	0.7660	12.84	0.0000
	after 1989	-0.0001	0.0018	0.9644		-0.4539	0.1107	0.0034	0.4370	8.55	0.0000
Bulgaria	all sample	-0.0016	0.0026	0.5666	0.6500	-0.0635	0.0174	0.0148	0.3450	5.77	0.0000
	before 1989	-0.0015	0.0032	0.6482	(0.4576)	-0.0470	0.0099	0.0051	0.3830	4.59	0.0000
	after 1989	0.0013	0.0037	0.7402		-0.2676	0.0599	0.0066	0.4050	2.04	0.0416
Hungary	all sample	-0.0046	0.0018	0.0515	5.7800	-0.1440	0.0433	0.0209	0.5300	12.10	0.0000
	before 1989	-0.0052	0.0029	0.1403	(0.0613)	-0.1994	0.0339	0.0020	0.2730	3.23	0.0012
	after 1989	-0.0040	0.0014	0.0353		-0.0859	0.0764	0.3121	0.7070	11.62	0.0000
Fr. Czechosl.	all sample	-0.0040	0.0021	0.1214	3.0200	-0.0874	0.0289	0.0293	0.6580	12.49	0.0000
	before 1989	-0.0068	0.0021	0.0234	(0.1430)	-0.0540	0.0347	0.1803	0.6430	8.63	0.0000
	after 1989	0.0010	0.0009	0.3523		-0.0909	0.0537	0.1514	0.5350	7.18	0.0000
Baltic States	all sample	-0.0030	0.0014	0.0888	5.2600	-0.0953	0.0188	0.0039	0.6240	13.46	0.0000
	before 1989	-0.0014	0.0011	0.2796	(0.0703)	-0.0508	0.0047	0.0001	0.2050	2.51	0.0122
	after 1989	-0.0021	0.0016	0.2510		-0.0359	0.0253	0.2162	0.3500	4.41	0.0000

std. err. are Driscoll - Kraay robust standard errors; ACSC is the average absolute value of the off-diagonal elements of the correlation matrix of the regression residuals of the fixed effects model; PCS is the Pesaran (2004) cross-section independence test; HWH is the modified Hausman (1978) test for the case when all the sample is considered; p-values are reported in round parentheses.

Table 4. *Unit root tests results for cities over 100,000 inhabitants for the period 1970-2007*

		URLLC		URIPS		URPCS		ZA		
		statistic	pvalue	statistic	pvalue	statistic	p-value		statistic	bkp.
Russia	all sample	-10.5586	0.0000	-6.5340	0.0000	2.3070	0.9890	Russia		
	before 1989	-27.8783	0.0000	-10.7660	0.0000	-0.9860	0.1620	average	-3.8670	1999
	after 1989	-12.1703	0.0000	-4.9730	0.0000	-6.6840	0.0000	max	-4.5920	2002
Ukraine	all sample	-2.5530	0.0053	0.9990	0.8410	1.0150	0.8450	Ukraine		
	before 1989	-	-	-	-	-	-	average	-4.1640	1993
	after 1989	-	-	-	-	-	-	max	-6.0970***	1985
Poland	all sample	-4.0467	0.0000	-1.6410	0.0500	-1.3670	0.0860	Poland		
	before 1989	-4.6524	0.0000	-0.6220	0.2670	-0.7110	0.2390	average	-4.2310	1987
	after 1989	-5.9089	0.0000	0.1470	0.5580	0.0350	0.5140	max	-3.5700	1990
Romania	all sample	-3.9243	0.0000	-2.2200	0.0130	-2.7190	0.0030	Romania		
	before 1989	-1.1504	0.1250	1.5330	0.9370	-2.0380	0.0210	average	-3.2650	1981
	after 1989	0.1505	0.5598	-0.8680	0.1930	1.3510	0.9120	max	-1.9660	1995
Belarus	all sample	-4.5845	0.0000	-3.5480	0.0000	-0.8670	0.1930	Belarus		
	before 1989	-4.0950	0.0000	-0.3580	0.3600	-2.0620	0.0200	average	-5.5840***	1989
	after 1989	-2.2261	0.0130	-0.0920	0.4630	1.0640	0.8560	max	-34.1120***	1999
Bulgaria	all sample	-0.8885	0.1871	-0.4400	0.3300	-1.0940	0.1370	Bulgaria		
	before 1989	-0.6097	0.2710	0.5820	0.7200	-1.0400	0.1490	average	-3.8340	1984
	after 1989	2.8549	0.9978	3.1260	0.9990	-0.6410	0.2610	max	-4.5170	1978
Hungary	all sample	-2.6283	0.0043	-5.2390	0.0000	-2.9440	0.0020	Hungary		
	before 1989	-6.7794	0.0000	-6.0500	0.0000	-3.5510	0.0000	average	-4.7470	1978
	after 1989	-2.2863	0.0111	-1.4060	0.0800	-0.7280	0.2330	max	-4.2150	1994
Fr. Czechosl.	all sample	-6.1552	0.0000	-4.6060	0.0000	-0.9050	0.1830	Fr. Czechosl		
	before 1989	-1.7602	0.0392	0.8580	0.8040	-0.2510	0.4010	average	-3.1240	1985
	after 1989	-2.8482	0.0022	-0.4750	0.3180	-1.0010	0.1580	max	-2.0380	1997
Baltic States	all sample	-1.2091	0.1133	1.0560	0.8540	1.1210	0.8690	Baltic States		
	before 1989	-0.4943	0.3105	0.9690	0.8340	-1.2810	0.1000	average	-4.2770	1982
	after 1989	-4.5589	0.0000	-2.0140	0.0220	0.6400	0.7390	max	-2.8640	1993

URLLC is the Levin et al (2002) panel unit root test; URIPS is the Im et al (2003) panel unit root test; URPCS is the Pesaran (2007) panel unit root test; the transformed t statistics are reported for the panel unit root tests; ZA is the Zivot and Andrews (1992) unit toot test wit structural breaks, bkp. indicates the year a breakpoint was detected ; *,** and *** denotes statistical significance at 10%, 5% and 1% level .

Table 5. *Structural breaks in the growth regressions for cities over 100,000 inhabitants for the period 1970-2007*

	Russia	Ukraine	Poland	Romania	Belarus	Bulgaria	Hungary	Fr. Czechosl.	Baltic States
Pooled regression									
ln(Size)	-0.0054	-0.0078	-0.0023	-0.0016	-0.0034	0.0002	-0.0045	-0.0031	-0.0017
	[0.0027]	[0.0038]	[0.0014]	[0.0012]	[0.0029]	[0.0023]	[0.0018]	[0.0018]	[0.0009]
	(0.0491)	(0.0473)	(0.1109)	(0.2316)	(0.2764)	(0.9261)	(0.0548)	(0.1460)	(0.1294)
postcom	-0.0156	-0.0256	-0.0156	-0.0302	-0.0167	-0.0210	-0.0218	-0.0152	-0.0269
	[0.0035]	[0.0084]	[0.0030]	[0.0078]	[0.0096]	[0.0042]	[0.0051]	[0.0037]	[0.0028]
	(0.0000)	(0.0047)	(0.0000)	(0.0022)	(0.1190)	(0.0040)	(0.0079)	(0.0096)	(0.0002)
Fixed effects regression									
	Russia	Ukraine	Poland	Romania	Belarus	Bulgaria	Hungary	Fr. Czechosl.	Baltic States
ln(Size)	-0.2144	-0.1549	-0.0683	-0.0296	-0.2122	-0.0332	-0.1378	-0.0631	-0.0424
	[0.0708]	[0.0605]	[0.0236]	[0.0206]	[0.1217]	[0.0199]	[0.0336]	[0.0276]	[0.0074]
	(0.0031)	(0.0157)	(0.0084)	(0.1760)	(0.1193)	(0.1552)	(0.0093)	(0.0707)	(0.0023)
postcom	0.0063	-0.0057	-0.0100	-0.0232	0.0347	-0.0152	-0.0206	-0.0096	-0.0234
	[0.0092]	[0.0090]	[0.0018]	[0.0072]	[0.0235]	[0.0051]	[0.0037]	[0.0024]	[0.0021]
	(0.4962)	(0.5324)	(0.0000)	(0.0073)	(0.1785)	(0.0307)	(0.0024)	(0.0097)	(0.0001)
ACSC	0.3850	0.5010	0.2230	0.7930	0.5470	0.3280	0.3590	0.6080	0.3240
PCS	102.1650	40.8250	13.1820	34.9980	15.8190	5.2890	8.1830	11.5450	6.1380
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

postcom is a dummy variable taking the value zero before 1989 and the value one aftewards; Driscoll - Kraay robust standard errors are reported in squared parentheses; p-values are reported in round parentheses; ACSC is the average absolute value of the off-diagonal elements of the correlation matrix of the regression residuals of the fixed effects model; PCS is the Pesaran (2004) cross-section independence test

Figure 1. *The non-parametrical estimates of the potential shift after 1989 in the deterministic component of growth rates*

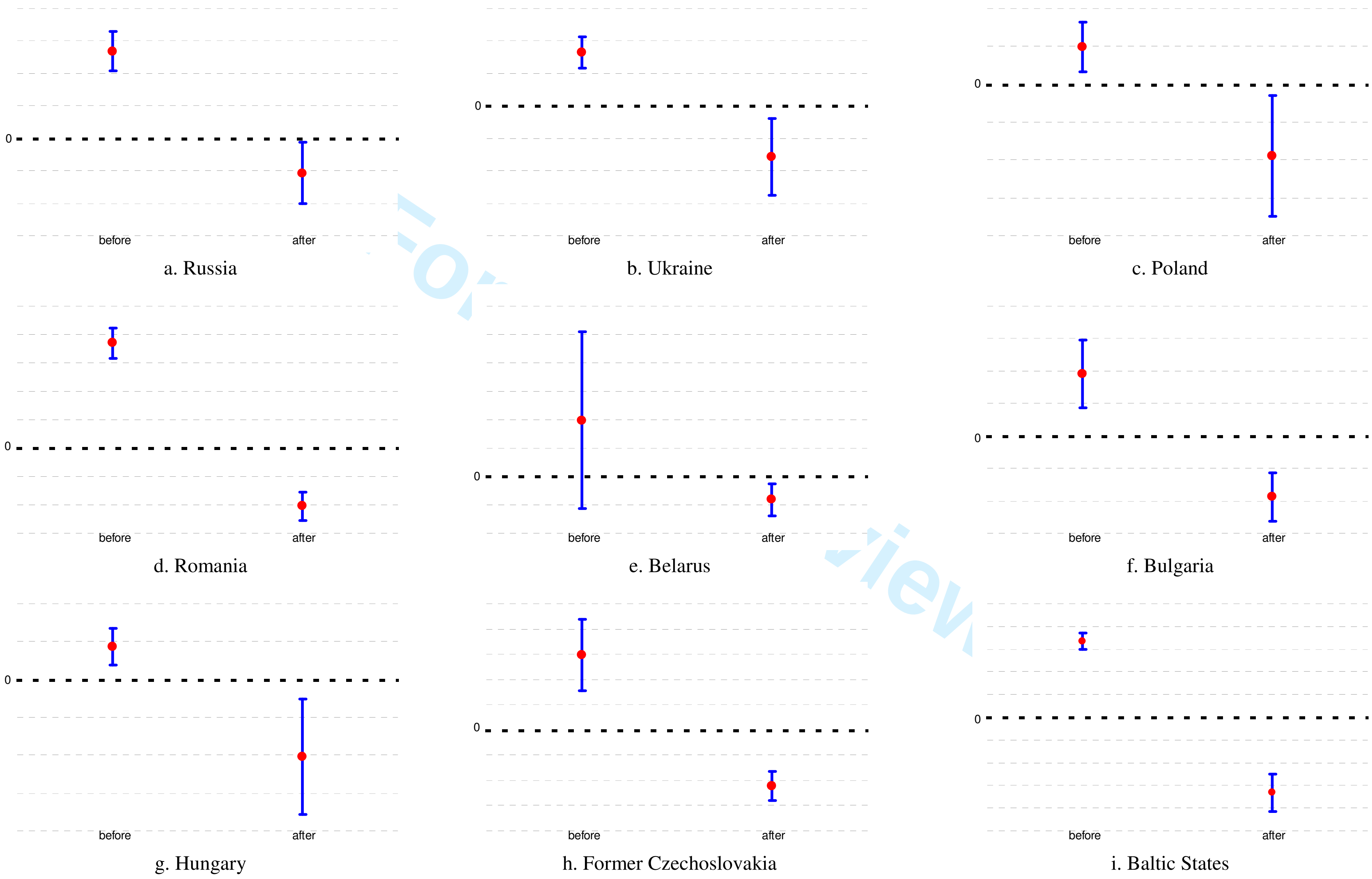


Table 6. *Growth regressions results for cities over 100,000 inhabitants using five years averages for the period 1970-2007*

		Pooled regression			Pooled regression with dummy			
		all sample	before 1989	after 1989	all sample			
Russia	ln(Size)	-0.0023	-0.0020	-0.0006	ln(Size)	-0.0012	postcom	-0.0175
		[0.0008]	[0.0003]	[0.0004]		[0.0005]		[0.0034]
		(0.0034)	(0.0000)	(0.1618)		(0.0097)		(0.0000)
Ukraine	ln(Size)	-0.0072	-0.0057	-0.0050	ln(Size)	-0.0053	postcom	-0.0212
		[0.0019]	[0.0010]	[0.0023]		[0.0013]		[0.0047]
		(0.0004)	(0.0000)	(0.0387)		(0.0002)		(0.0001)
Poland	ln(Size)	-0.0032	-0.0058	0.0013	ln(Size)	-0.0019	postcom	-0.0166
		[0.0025]	[0.0011]	[0.0013]		[0.0022]		[0.0041]
		(0.2127)	(0.0000)	(0.3107)		(0.3946)		(0.0005)
Romania	ln(Size)	-0.0087	-0.0090	0.0010	ln(Size)	-0.0036	postcom	-0.0314
		[0.0041]	[0.0008]	[0.0008]		[0.0026]		[0.0087]
		(0.0536)	(0.0000)	(0.2599)		(0.1817)		(0.0029)
Belarus	ln(Size)	-0.0032	0.0000	0.0026	ln(Size)	0.0015	postcom	-0.0287
		[0.0018]	[0.0031]	[0.0015]		[0.0010]		[0.0031]
		(0.1159)	(0.9969)	(0.1282)		(0.1467)		(0.0000)
Bulgaria	ln(Size)	-0.0001	0.0001	0.0019	ln(Size)	0.0021	postcom	-0.0159
		[0.0013]	[0.0011]	[0.0034]		[0.0018]		[0.0037]
		(0.9265)	(0.9256)	(0.5956)		(0.2939)		(0.0049)
Hungary	ln(Size)	-0.0002	-0.0035	0.0006	ln(Size)	-0.0008	postcom	-0.0133
		[0.0008]	[0.0008]	[0.0002]		[0.0010]		[0.0036]
		(0.8148)	(0.0088)	(0.0242)		(0.4320)		(0.0099)
Fr. Czechosl.	ln(Size)	-0.0039	-0.0068	0.0005	ln(Size)	-0.0028	postcom	-0.0148
		[0.0023]	[0.0011]	[0.0005]		[0.0020]		[0.0039]
		(0.1525)	(0.0017)	(0.3546)		(0.2157)		(0.0125)
Baltic States	ln(Size)	-0.0028	-0.0011	-0.0014	ln(Size)	-0.0013	postcom	-0.0218
		[0.0008]	[0.0004]	[0.0014]		[0.0008]		[0.0040]
		(0.0121)	(0.0389)	(0.3406)		(0.1426)		(0.0015)

postcom is a dummy variable taking the value zero before 1989 and the value one afterwards; Driscoll - Kraay robust standard errors are reported in squared parentheses; p-values are reported in round parentheses.

Table A.1 *Summary statistics of the data employed in testing the validity of Gibrat`s Law*

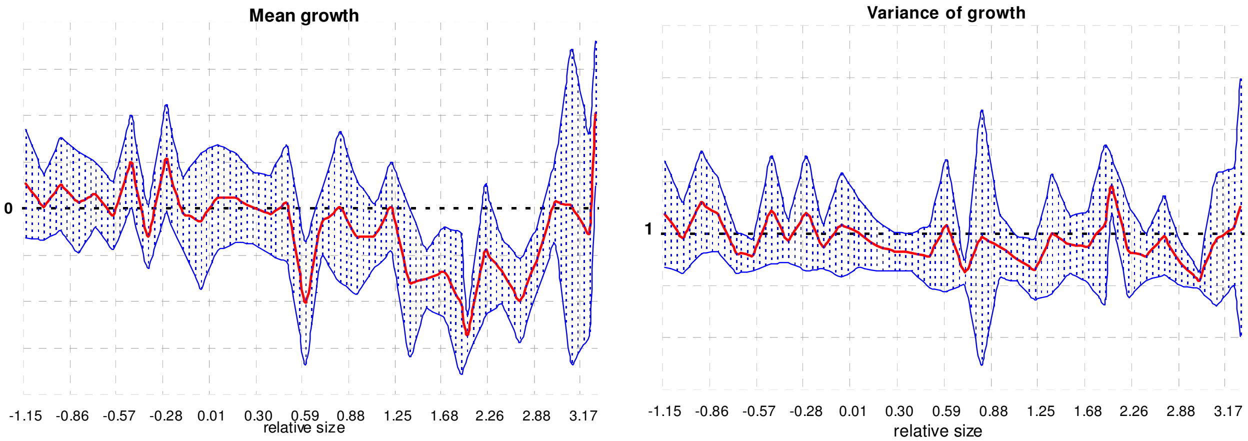
	Data on cities over 100,000 inhabitants									Detailed city data			
	Russia	Ukraine	Poland	Romania	Belarus	Bulgaria	Hungary	Fr. Czechosl.	Baltic States		Poland	Belarus	Latvia
no. obs.	3644	741	995	554	351	226	313	197	260	no. obs.	2000	500	300
period	1970 - 2007	1970 - 2007	1970 - 2007	1970 - 2007	1970 - 2007	1970 - 2007	1970 - 2007	1970 - 2007	1970 - 2007	period	2000-2009	2000-2009	2000-2009
T dim.	24	17	27	26	27	28	38	25	32	T dim.	10	10	10
CS dim.	164	51	43	26	15	11	9	10	9	CS dim.	200	50	30
Average	416,797	401,355	285,662	281,715	321,515	297,009	370,851	360,179	331,561	Average	90,701	120,767	48,314
Std. dev.	816,582	437,791	282,120	368,143	378,803	300,340	594,286	330,581	235,663	Std. dev.	159,557	255,850	130,224
Min	90,000	100,000	96,648	99,494	91,300	96,099	100,100	94,436	100,431	Min	21,710	15,100	7,943
Max	10,456,490	2,676,789	1,704,717	2,127,194	1,797,500	1,155,403	2,116,548	1,216,568	917,000	Max	1,709,781	1,829,100	766,381

Table A.2 *Growth regression results using detailed city data in Belarus for the period 2000-2009*

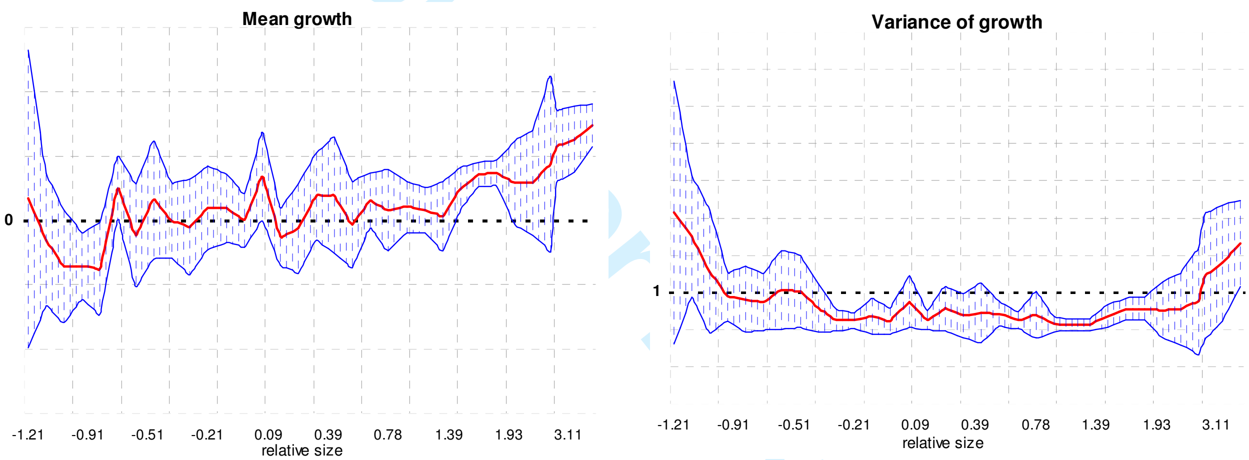
	all sample	large cities	medium cities	small cities
ln(Size)	0.0015	0.0030	0.0006	0.0085
	[0.0008]	[0.0007]	[0.0008]	[0.0064]
	(0.0461)	(0.0043)	(0.4438)	(0.2062)
d_medium	-0.0035			
	[0.0016]			
	(0.0287)			
d_small	-0.0050			
	[0.0014]			
	(0.0011)			
HWH		7.8100	0.7600	1.7900
		(0.0267)	(0.3900)	(0.2028)

d_medium is a dummy variable controlling for medium cities and d_small a dummy variable contolling for small ones; Driscoll - Kraay robust standard errors are reported in squared parentheses; p-values are reported in round parentheses; HWH is the modified Hausman (1978) test.

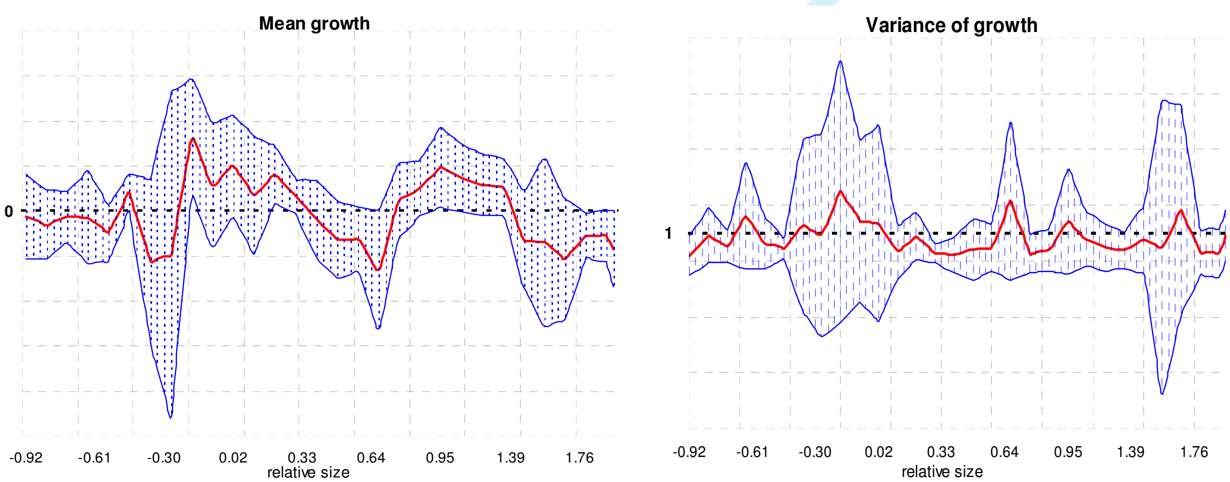
Figure A.1. *Non-parametric estimation using detailed city data in Poland, Belarus and Latvia for the period 2000-2009*



a. Poland

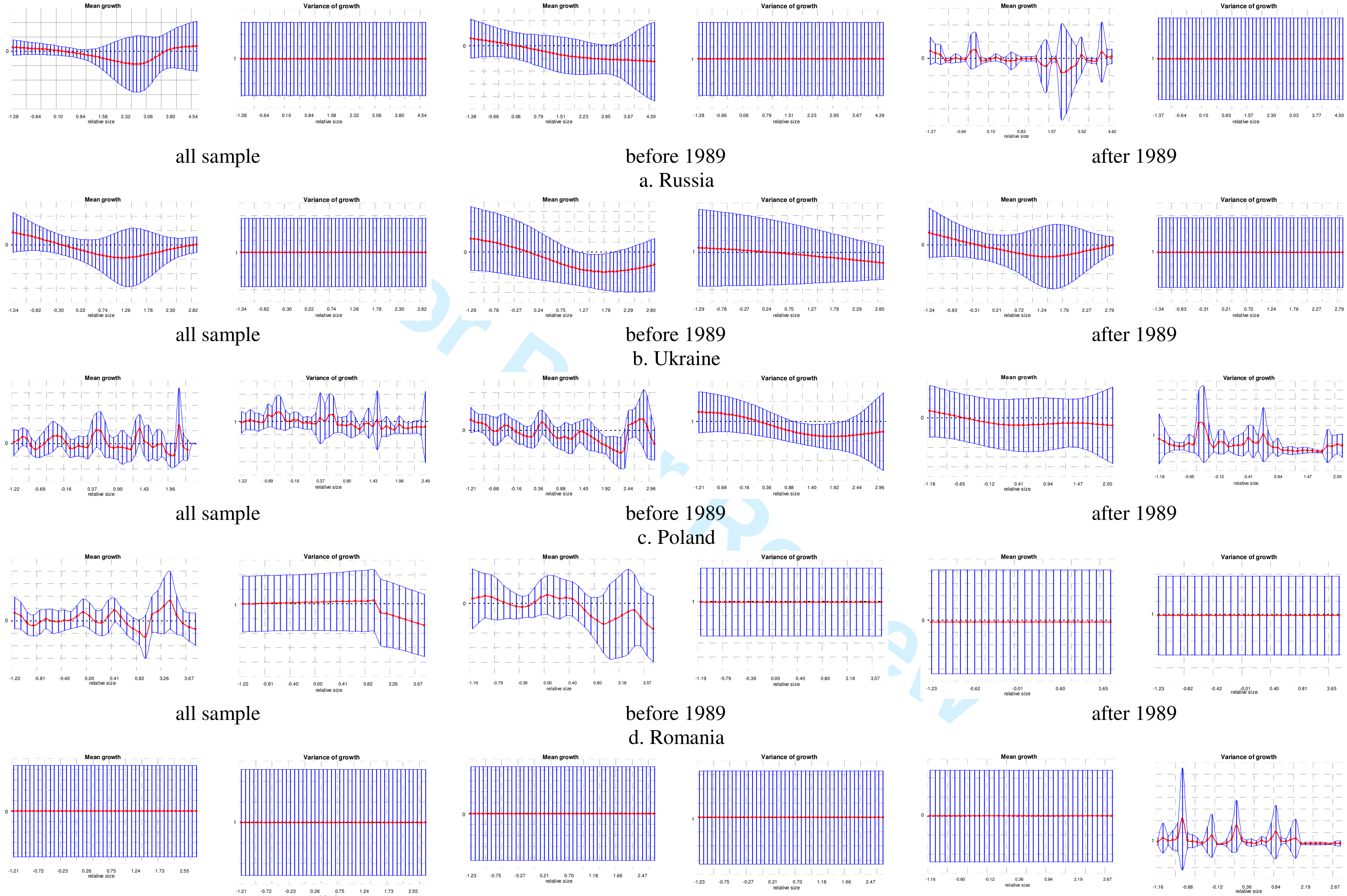


b. Belarus



c. Latvia

Figure A.2. *Non-parametric estimation for cities over 100,000 inhabitants for the period 1970-2007*



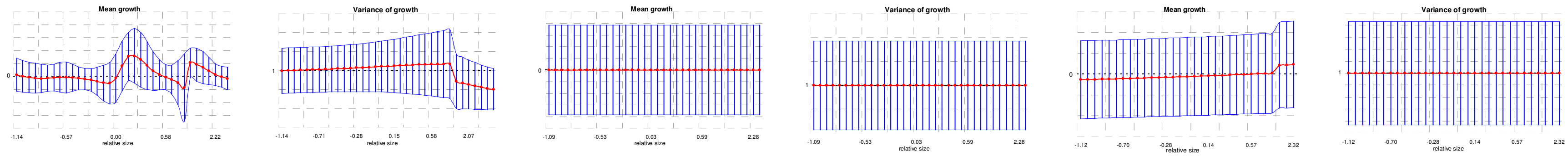
all sample before 1989 after 1989
a. Russia

all sample before 1989 after 1989
b. Ukraine

all sample before 1989 after 1989
c. Poland

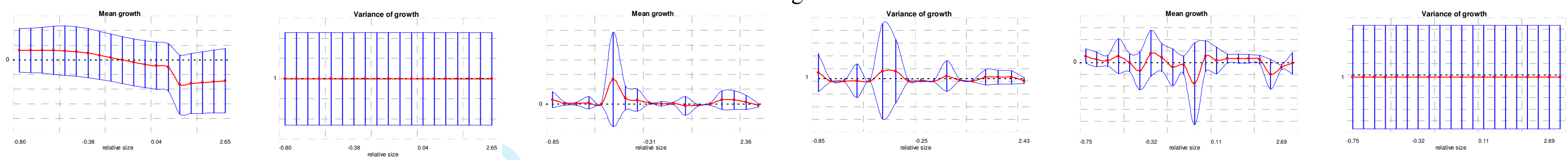
all sample before 1989 after 1989
d. Romania

all sample before 1989 after 1989
e. Belarus



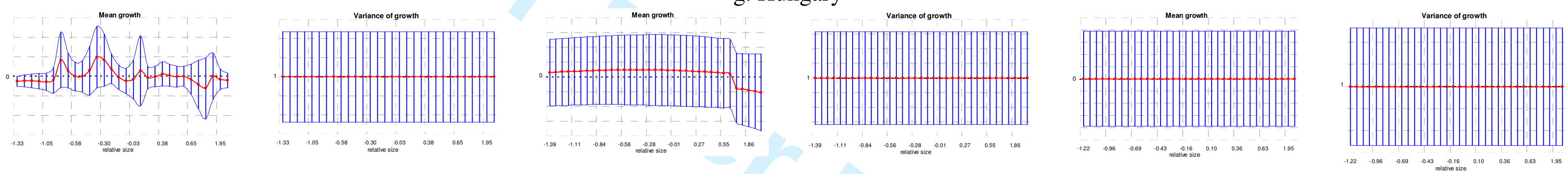
all sample before 1989 after 1989

f. Bulgaria



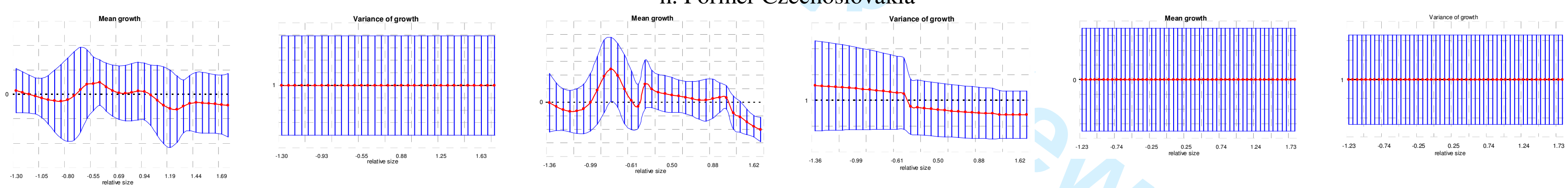
all sample before 1989 after 1989

g. Hungary



all sample before 1989 after 1989

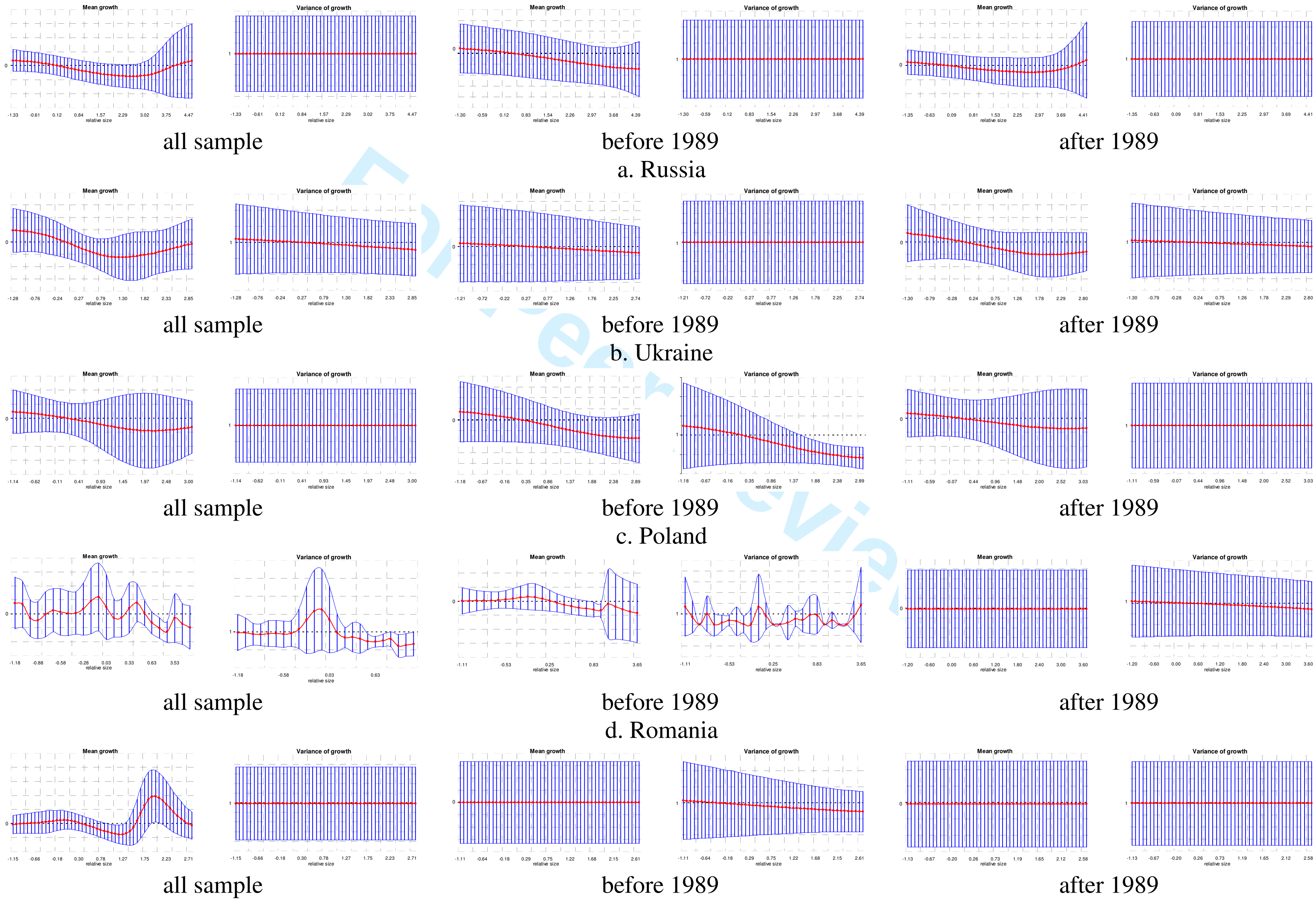
h. Former Czechoslovakia



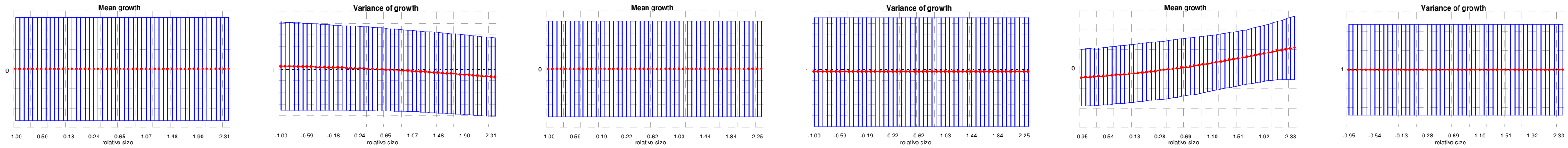
all sample before 1989 after 1989

i. Baltic States

Figure A.3. *Non-parametric estimation for cities over 100,000 inhabitants using five years averages for the period 1970-2007*

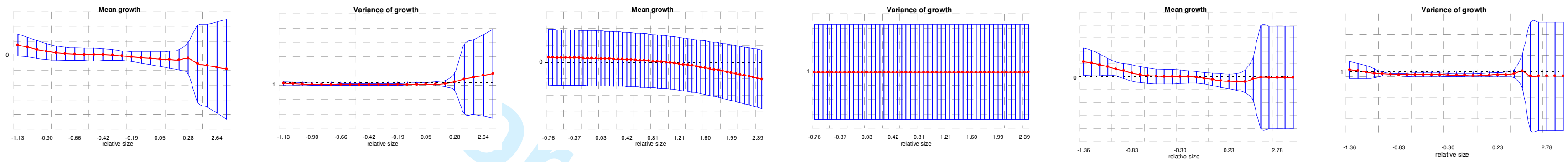


e. Belarus



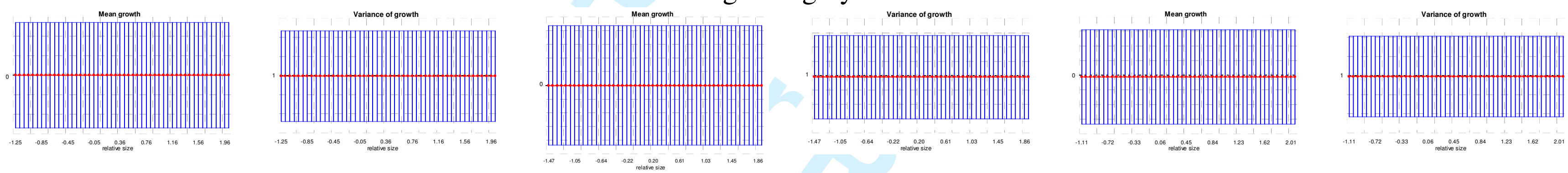
all sample before 1989 after 1989

f. Bulgaria



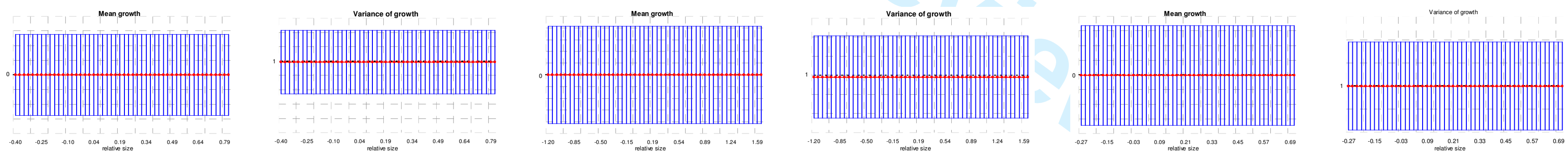
all sample before 1989 after 1989

g. Hungary



all sample before 1989 after 1989

h. Former Czechoslovakia



all sample before 1989 after 1989

i. Baltic States

Figure A.4. *The non-parametrical estimates of the potential shift after 1989 in the deterministic component of growth rates using five years averages*