A Dynamic Econometric Study of Suicides in Turkey

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Abstract

This study is the first attempt to empirically examine the determinants of suicides in the case of Turkey using the time-series data for the period 1974-2007. This research proposes that the suicides in Turkey are related to some economic and social factors and they exhibit a dynamic relationship amongst them. Auto-Regressive Distributed Lag (ARDL) approach to cointegration testing procedure is employed to obtain the short-run and long-run elasticities of suicides with respect to per capita real income, divorce rates, urbanization and liquidation. The empirical results reveal that the urbanization has the highest impact on suicides, which is followed by per capita real income and liquidation. The results also provide some important policy recommendations to reduce suicides.

Keywords: Suicide; cointegration; time-series; Turkey.
JEL classifications: C22; I12

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1. Introduction

Taking someone's own life in many different ways (intentionally) and for many different reasons is called suicide and this type of behavior has attracted the attention of both policy makers and academics alike and has given rise to a number of governmental resolutions and academic papers. Until the late 20th century this subject was mostly studied by sociologists and psychologists. Economists stayed away from topics related to suicide despite its clear economic implications, see for a few exceptions Quinney (1965), Hamermesh and Soss (1974), Platt (1984), Stack (1989), Ruhm (2000), and Suzuki (2008).

Suicide is the 13th leading cause of death worldwide and even higher among young people as presented in WHO (2002). Internationally, suicide rates range between less than 10 and 25 per 100,000 people, see Kaplan and Sadock (1993) as cited in Yaniv (2001).

Due to lack of complete data on causes of suicides and success rates (deaths/suicide attempts) we are not able to provide similar statistics for Turkey. However, according to statistics reported by the Turkish Statistical Institute (TSI), between 1974 and 2006, on average more than 1,500 people in Turkey (approximately 1% of the total number of deaths) deliberately kill themselves each year. Even though this number is only a small fraction of the total number of deaths in Turkey, starting from 1974 it has grown by more than 350% whereas the population has increased by only 79%. It is also possible that these numbers are even higher in reality than reported, because many suicide deaths are incorrectly listed as accidents or homicides.[1] Looking at the raw data one may argue the importance of suicides in Turkey. At first this may seem as a valid argument compared to other industrialized economies' suicide rates. However, Turkey's economy is rapidly growing and given previous findings on the relationship between suicide rates and urbanization or suicide rates and income levels, it is only a matter of time before we face much greater suicide rates.

A small body of literature analyzing suicides from economic theory has been growing since the pioneering study of Hamermesh and Soss (1974). They propose that the decision of suicide is an individual decision-making process which will also be influenced by some economic factors, such as long-run economic growths and cyclical fluctuations in income and in unemployment. Hamermesh and Soss (1974) acknowledge most of the empirical and theoretical work done by sociologists in suicides. However, they argue that several aspects of the suicide problem may be rationalized by an economic theory. It is crystal clear that some suicidal behavior may not be related to any economic factor at all.

This paper aims at extending the existing literature by offering a dynamic econometric model of suicides. The proposed dynamic model, Auto-Regressive Distributed Lag (ARDL) has not been employed in the previous empirical studies of suicide. As far as this paper is concerned, there exists no other study which directly deals with the empirical measurement of suicides in Turkey from economic points of view.

[1] Douglas (1967) presents a detailed discussion of this problem.

The remainder of this paper is formed as follows: the next section highlights the literature on suicide, particularly with respect to economic theory. The third section introduces the study's model and methodology. The fourth section discusses the empirical results and the last section presents the conclusions.

2. Literature Review

As mentioned in the previous section, Hamermesh and Soss (1974), were among the first authors who developed an economic theory of suicide on the basis of the argument that much of the variation in aggregate suicide rates is due to economic decision making and, therefore, that such a variation can be explained by using hypotheses derived from economic theory using different economic methods. For instance, Yang and Lester (1996) showed that different economic models, such as cost-benefit analysis[2], demand and supply model, labor force participation analogy, signalling game theory, and investment under uncertainity, can be applied to suicidal behavior. As Suzuki (2008) presented, generally there has been microeconomic and macroeconomic approaches to the study of suicide. In theoretical literature, suicidal behavior is formalized within a framework of standard microeconomic models, for instance, see Huang (1997). Researchers have also investigated empirically the relationships between suicide and some possible explanatory variables: Hamermesh and Soss (1974), Neumayer (2003), Viren (1999), Barstad (2008), and Suzuki (2008) have used income variable; Viren (1999), Platt (1984), Yang and Lester (1992), Gerdtham and Johannesson (2003), and Ruhm (2000) have employed unemployment variable, Quinney (1965) and Rodriguez (2005) have utilised urbanisation variable; Rodriguez (2005), Neumayer (2003), Rossow (1993), Stack, (1989), Lester and Yang (1998), and Yamamura (2008) have considered divorce rates. Our aim in this section is not to provide a comprehensive review of the literature on suicide; instead just to review selected works that shed light on the link between suicidal behavior and some economic indicators, namely unemployment, bankrupcies, urbanization, and divorce rates. In the following paragraphs, the literature review on this matter will mostly be on these explanatory variables.

i) *Suicide versus Income*

Hamermesh and Soss (1974) were among the first to explain this decision- making process using the tools of economics. Although there are several reasons that force an individual to end his life, Hamermesh and Soss (1974) suggested a link between income and suicide. According to their results, suicide rates tend to go lower among higher-income groups. Neumayer (2003) discusses that in higher-income societies, the success rate of attempted suicides is relatively lower because they tend to have better quality of emergency medical services. These results were later supported by Viren (1999)[3]. However, for high-income countries, Viren (1999) claims that this relationship can be positive instead. In a more recent paper, Barstad (2008) using

[2] See Yang (1987).

[3] But he also points out that these results were largely affected by the very high suicide rates in the former Soviet Republics.

Norway as a case showed increases in suicide rates in rich countries.[4] From a different perspective Suzuki (2008) tried to explain this relationship using income uncertainty. Suzuki (2008) estimations suggest that people are more likely to commit suicide as income uncertainty increases.

ii) *Suicide versus Bankruptcy or Unemployment*

Viren (1999) claims that a decrease in bankruptcies tends to lower suicide frequency. Similarly, Platt (1984) showed that suicide and unemployment were associated in both individual and aggregate studies and in both cross-sectional and longitudinal research designs. Later, Yang and Lester (1992 and 1994) studied the USA data from 1940 to 1984 and 1957 to 1986 respectively, and found that the suicide rate is positively associated with the unemployment rate. Gerdtham and Johannesson (2003), Yang and Lester (1995), and Ruhm (2000) are among the other authors who reported a strong correlation between suicide and unemployment.

Neumayer (2004) looks at gender and age-specific suicide mortality rates for Germany over the period 1980-2000 in order to estimate the impact of unemployment suicide rates. The findings suggest that the effect of unemployment on the rate of total suicide is at its highest among the youngest and oldest. In the age group 45-65 the effect of unemployment on total suicide rate is found to be the weakest.

iii) *Suicide versus Urbanization*

Even though, sociologists have been examining urbanism as a contributing factor to suicide rates Cavan (1928), Bankston *et al.* (1983), and Linden and Breed (1976) for a long time in our review of the literature we have not came across many economists specifically studying the effects of urbanization on suicide rates. Those who studied it have found suicide directly related with urbanization and industrial development as in the case of Quinney (1965) and Rodriguez (2005). Granades (2008) is one of the many authors who studied the effects of macroeconomic fluctuations on mortality in Japan. In the study of study Grandes (2008) mortality rates in industrial countries tend to rise in economic expansions and fall in economic recessions. While most major causes of death rates have been found to be procyclical, suicides have been found to be generally countercyclical, increasing in recessions. This result is attributable to the unemployment rate, which was also found to be positively related to suicides, especially males.

iv) *Suicide versus Divorces*

A number of empirical works have suggested that divorce is positively associated with suicide see for example Rodriguez (2005)[5] and Neumayer (2003). For instance, Stack (1989)**,** Rossow (1993)**,** and Lester and Yang (1998) have used a time-series methodology, in relation to integration variables and point to the divorce rate as a factor behind increasing suicide rates. The divorce rate is also included as a factor in many, aggregate level, longitudinal studies. For instance, in a sample of 23 nations

[4] Maybe a quotation from Durkheim (1897/2002) p. 214 is in place: "remarkable immunity of poor countries" since "poverty protects against suicide because it is a restraint in itself". This idea has been later debated by modern sociologists Barnes (1983), and Stack (1980).

[5] Divorce rate is only found to be related to male suicide rates.

during 1950-1985, a significant negative effect of marriages was reported for men in six nations, for women in three as discussed in Lester and Yang (1998).

Yamamura (2008) argues that males are twice as likely to commit suicide as females in case of a divorce due to compensation costs. Yamamura (2008) claims that the likelihood that husbands become the payer of compensation is about 8 times that of wives and that this tendency becomes more distinct as the amount of compensation increases. This brings a new perspective to the claimed relationship between divorce rates and suicides. It occurs; divorce is not only a sociological factor that directly increases the likelihood of males committing suicide but also a factor that imposes a compensation cost mostly on men, thus indirectly increasing the likelihood of committing suicide.

v) *Suicide versus Other factors*

Other than those we have already discussed above, there are other factors believed to effect suicide rates, such as: the size of the family, religion, ethnicity, failure in education, medical problems, fertility, alcoholism, etc. According to Neumayer (2003) lower average household size signals a greater potential for feelings of loneliness and lack of integration and should be positively associated with suicide. Neumayer (2003) also found marriage and fertility rates negatively associated with suicide rates and Rodriguez (2005) found fertility rates negatively related to suicide rates for both males and females.

Modern research has found evidence that heavy consumption of alcohol is strongly related to higher suicide rate. Neumayer (2003) and Rodriguez (2005) emphasize that heavy alcohol consumption causes lack of integration and also increases the probability of committing violent acts (such as committing suicide) in the state of acute intoxication .

3. Model and econometric methodology

3. 1 Model

Following the empirical literature on suicide, we form the long-run relationship between suicide, income, divorce, urbanization and liquidation in linear logarithmic form as follows:

$$s_t = a_0 + a_1 y_t + a_2 d_t + a_3 u_t + a_4 b_t + \varepsilon_t \qquad (1)$$

where s_t is total number of suicides, y_t is per capita real income, d_t is divorce rate, u_t is urbanization rate, b_t is number of liquidated companies, and ε_t is the regression error term . The lower case letters in equation (1) demonstrate that all variables are in their natural logarithms. It is assumed that a decrease in income should increase the suicide numbers due to economic hardships, see Quinney (1965). Marriages are regarded as a social pillar in society and they provide solidarity and psychological comfort for the individuals whereas divorces might lead individuals to isolation and psychological break downs. Hence, one expects a positive correlation between divorce rates and suicides. Migration to cities is regarded as a cause for individuals to commit suicide since people may find it difficult to adopt economic, cultural and

social aspects of urban life in comparison to the rural environment. Therefore, an increase in urbanization may lead to a rise in suicides, as put forward by Quinney (1965). Finally, economic hardships and crises are thought to influence individuals adversely to such an extent that some individuals consider the option of suicide as a last resort.[6] Consequently, the likelihood of suicide may increase as the number of firms going into liquidation rise. The expected signs for the parameters in equation (1) are as follow: $a_1 < 0, a_2 > 0, a_3 > 0, a_4 > 0.$

3.2 Cointegration methodology

A recent cointegration approach, known as autoregressive-distributed lag (ARDL) of Pesaran *et al.* (2001) has become popular amongst researchers. Pesaran *et al*. (2001)'*s* cointegration approach, also known as bounds testing, has certain econometric advantages in comparison to other single cointegration procedures. They are as follows: i) endogeneity problems and inability to test hypotheses on the estimated coefficients in the long-run associated with the Engle-Granger method are avoided; ii) the long-run and short-run parameters of the model in question are estimated simultaneously; iii) the ARDL approach to testing for the existence of a long-run relationship between the variables in levels is applicable irrespective of whether the underlying regressors are purely *I*(0), purely *I*(1), or fractionally integrated; iv) the small sample properties of the bounds testing approach are far superior to that of multivariate cointegration, as argued in Narayan (2005).
An ARDL representation of equation (1) is formulated as follows:

$$\Delta s_t = b_0 + \sum_{i=1}^{m} b_{1i}\Delta s_{t-i} + \sum_{i=0}^{m} b_{2i}\Delta y_{t-i} + \sum_{i=0}^{m} b_{3i}\Delta d_{t-i} + \sum_{i=0}^{m} b_4\Delta u_{t-i} + \sum_{i=0}^{m} b_5 b_t + b_6 s_{t-1} + b_7 y_{t-1} + b_8 d_{t-1} + b_9 u_{t-1} + b_{10} b_{t-1} + v_t \quad (2)$$

Given that Pesaran *et al.* (2001) cointegration approach is a relatively recent development in the econometric time-series literature, a brief outline of this procedure is presented as follows. The bounds testing procedure is based on the Fisher (F) or Wald-statistics and is the first stage of the ARDL cointegration method. Accordingly, a joint significance test that implies no cointegration hypothesis, ($H_0: b_6 = b_7 = b_8 = b_9 = b_{10} = 0$), against the alternative hypothesis, ($H_1: b_6 \neq b_7 \neq b_8 \neq b_9 \neq b_{10} \neq 0$) should be performed for equation (2). The F-test used for this procedure has a non-standard distribution. Thus, Pesaran *et al.* (2001) compute two sets of critical values for a given significance level with and without a time trend. One set assumes that all variables are *I*(0) and the other set assumes they are all *I*(1). If the computed F-statistic exceeds the upper critical bounds value, then the H_0 is rejected. If the F-statistic falls into the bounds then the test becomes inconclusive. Lastly, if the F-statistic is below the lower critical bounds value, it implies no cointegration. This is a pre-testing stage in the ARDL cointegration approach.
Once a long-run relationship has been established, equation (2) is estimated using an appropriate lag selection criterion such as Akaike Information Criterion (AIC) or Schwarz Bayesian criterion (SBC). At the second stage of the ARDL cointegration

[6] However, there are cases where suicide and income is found to be positively related, see Viren (1999).

procedure, it is also possible to perform a parameter stability test for the selected ARDL representation of the error correction term (ECM).

A general error correction model of equation (2) is formulated as follows:

$$\Delta s_t = c_0 + \sum_{i=1}^{m} c_{1i}\Delta s_{t-i} + \sum_{i=0}^{m} c_{2i}\Delta y_{t-i} + \sum_{i=0}^{m} c_{3i}\Delta d_{t-i} + \sum_{i=0}^{m} c_{4i}\Delta u_{t-i} + \sum_{i=0}^{m} c_{5i}\Delta b_{t-i} + \lambda EC_{t-1} + \mu_t \quad (3)$$

where λ is the speed of adjustment parameter and EC_{t-1} is the residuals that are obtained from the estimated cointegration model of equation (1).
Kremers *et al.* (1992) and Benarjee *et al.* (1998) prove that it is possible to establish a cointegrating relationship amongst the variables on the basis of the results obtained from the ECM if the F-test results from the first stage of the ARDL cointegration method appear to be inconclusive. In this case, the statistical significance of the lagged error correction term in equation (3) may be used to establish a long-run relationship.

4. **Empirical results**

Annual data over the period 1974-2007 were used to estimate equation (2) by the ARDL cointegration procedure of Pesaran *et al.* (2001). Data definition and sources of data are cited in the Appendix.
The time series properties of the variables in equation (1) are checked through Augmented Dickey-Fuller (ADF) of Dickey and Fuller (1981). The results are displayed in Table 1. The variables of income and divorce rates appear to be stationary in their levels whereas other variables contain a unit root in their levels. Therefore, it is appropriate to use the Pesaran *et al*. (2001) procedure. The visual inspection of the variables in logarithm does not indicate structural breaks in time series.

Table 1. Tests for integration

ADF test statistic				
Variable	Levels	*k* lag	1st Differences	*k* lag
s_t	-2.75	3	-4.15*	3
y_t	-5.11*	3	-4.29*	1
d_t	-4.90*	1	-7.26*	3
u_t	-1.60	4	-5.25*	4
b_t	-1.68	1	-4.56*	1

Sample levels 1980-2007 and differences 1981-2007. Rejection of unit root hypothesis, according to McKinnon's (1991) critical value at 5 % is indicated with an asterisk. ADF tests include an intercept and a 1 to 5 lagged difference variable and *k* stands for the lag level that maximizes the AIC (Akaike Information Criteria).

4.1 Test for cointegration

Equation (2) was estimated in two stages. In the first stage of the ARDL procedure, the long-run relationship of equation (1) was established in two steps. Firstly, the order of lags on the first-differenced variables for equation (2) was obtained from unrestricted VAR by means of Akaike Information Criterion and Schwarz Bayesian Criterion. The results of this stage are not displayed here to conserve space. Secondly, a bounds F-test was applied to equation (2) in order to establish a long-run relationship between the variables. In order to avoid a possible lag selection problem at this stage, one may follow the procedure of Bahmani-Oskooee and Goswami (2003), which sequentially test the long-run cointegration relationship in equation (2) to test the sensitivity of F-tests to the lag length. This study adopts the second approach which implicitly assumes that equation (2) is free from a trend due to the differenced variables. The results of the bounds F testing are displayed in Table 2. The results demonstrate an inconclusive region at 10 percent level of significance.

Table 2. The results of F-test for cointegration

	Calculated F-test statistics for different lag lengths		
	k=1	k=2	k=3
$F_C(s \mid y,d,u,b)$	0.73	1.04	3.35

k stands for the selected lag length in the unrestricted VAR model. The critical value ranges of F-statistics with four explanatory variables are 4.61– 5.78, 3.53 – 4.66 and 3.06 – 4.08 at 1%, 5% and 10% level of significances, respectively. See Pesaran *et al.* (2001), pp.300-301, Case III.

4.2 ARDL model selection

The ARDL cointegration procedure was implemented to estimate the parameters of equation (2) with maximum order of lag set to 2 which is selected on the basis of AIC. This stage involves estimating the long-run and short-run coefficients of equations (1) and (2). In search of finding the optimal length of the level variables of the short-run coefficients, AIC and SBC selection criteria were utilized at this stage. The results of equation (2) based on AIC and SBC criteria are reported in Panel A of Table 3 along with their appropriate ARDL models. The long-run elasticities of equation (3) is displayed in Panel B of Table 3. The long-run model of SBC has all the expected signs for the parameters. Panel C of Table 3 is allocated for the summary results of equation (3). The error correction term has expected sign and significant in both models of AIC and SBC indicating that there exist a long run relationship amongst the variables in equation (1). Finally, Panel D of Table 3 demonstrates the short-run diagnostic test results of equation (2). According to the revealed results, all short-run models pass a series of standard diagnostic tests such as serial correlation, functional form, normality, and heteroscedasticity.

In regards to short-run diagnostic tests and the ECM summary results, the SBC model performs slightly better than the AIC model but it has two variables with wrong sign expectations. Therefore, the AIC model will be used in analyzing the impacts of explanatory variables on suicides.

The long-run elasticity of suicide, with respect to income, is - 0.41 suggesting that for each 1% increase in per capita real income will decrease the total suicide numbers by 0.41%. The long-run elasticity of suicide, with respect to divorce, is just 0.01, which is rather minimal. This minimal impact of divorce on suicide is attributed to the fact

that Turkish society regards highly the concept of marriage due to religious, cultural and sociological factors. Consequently, the divorce rate in Turkey is rather low in comparison to developed countries. The elasticity of suicide with respect to urbanization in the long-run is 2.20, indicating that the contribution of urbanization to suicides is rather substantial during the estimation period. In other words, a 1% rise in urbanization will cause 2.20% increase in suicides. Turkey has been experiencing a rapid internal unmanaged migration since the 1970s. The cities have been surrounded by large slums and shanty towns. The distorted urbanization may also lead to tensions and pressures amongst the different social categories of the society. The divisions between the low income and the high income households become more apparent in cities. The pressure of economic fluctuations, environmental issues, congestion, and poor housing facilities would be felt more harshly in cities than in rural areas. As a result, it would be plausible to envisage that the tendency to commit suicide will rise whilst the urbanization ratio increases.

The long-run elasticity of suicide with respect to the number of liquidation is 0.08, pointing out that for each 1% rise in liquidation, the total suicides will go up by 0.08%. The error-correction term is – 0.45, suggesting that when the suicide model equation is above or below its equilibrium level, it adjusts by 45% within the first year. The full convergence to its equilibrium level takes a little over two years.

The econometric results from this research confirm the propositions of Hamermesh and Soss (1974) that economic factors such as income and business cycles are related to suicides. Therefore, the policies designed to cope with the suicides should incorporate the economis factors in addition to socilogocial and psycholgical causes.

Table 3. ARDL cointegration results

Panel A: the short-run results

Dependent variable s_t

	Model Selection Criterion			
Regressors	AIC ARDL (1,0,0,0,1)		SBC ARDL (1,0,0,0,0)	
s_{t-1}	0.62	(3.38)*	0.54	(2.96)*
y_t	0.09	(0.24)	-0.19	(0.52)
d_t	-0.008	(0.33)	0.006	(0.25)
u_t	0.68	(1.50)	1.01	(2.40)*
b_t	0.11	(2.41)*	0.08	(1.88)**
b_{t-1}	-0.07	(1.60)		
Constant	0.08	(0.02)	-2.06	(0.75)
Panel B[a]: the long-run computed elasticities				
y_t	0.25		-0.41	
d_t	-0.02		0.01	
u_t	1.84		2.20	
b_t	0.08		0.18	
Panel C: the ECM summary results				
EC_{t-1}	- 0.37	(2.01)*	- 0.45	(2.51)*
$\overline{R}^2$	0.42		0.39	
F-statistic	12.08*		11.48*	
DW-statistic	2.06		1.81	
RSS	0.34		0.37	
Panel D: the short-run diagnostic test statistics				
$\chi^2_{SC}(1)=0.17$			$\chi^2_{SC}(1)=0.88$	
$\chi^2_{FC}(1)=3.19$			$\chi^2_{FC}(1)=3.03$	
$\chi^2_{N}(2)=1.42$			$\chi^2_{N}(2)=0.26$	
$\chi^2_{H}(1)=0.28$			$\chi^2_{H}(1)=1.41$	

* and ** indicate 5 % and 10 % significance levels, respectively

[a] Own calculations from above models. RSS stands for residual sum of squares. The absolute value of t-ratios is in parentheses. χ^2_{SC}, χ^2_{FC}, χ^2_{N}, and χ^2_{H} are Lagrange multiplier statistics for tests of residual correlation, functional form mis-specification, non-normal errors and heteroskedasticity, respectively. These statistics are distributed as chi-squared variates with degrees of freedom in parentheses.

5. Conclusions

This study has attempted to identify the causes of suicides in Turkey mainly from socio-economic points of view. The suicides are considered to be related to real per capita income, divorce rates, urbanization, and liquidation. A relatively recent econometric procedure, the ARDL approach to cointegration, has been utilized to obtain the short-run and long-run elasticities of the suicides with respect to the explanatory variables under different selection criterion. On the basis of SBC model selection criterion, the sign expectations for the explanatory variables are fully fulfilled. Of these explanatory variables, the urbanization factor seems to be more dominant than other factors in explaining the suicides. The second major determinant in explaining suicides is income level. The adverse impact of urbanization on suicides is clearly emphasized in the literature. To this end, one may argue that the unplanned urbanization in the major cities of Turkey, such as Istanbul, Ankara, Izmir, Bursa, Adana and Diyarbakir, may have significant impact on suicides. The distorted urbanization is in the form of shanty districts and towns which have been built illegally by the villagers emigrating from their own lands to big cities in search of better employment prospects, education, and health and safety concerns. However, the quality of life and the job prospects in these cities are far less than expectations. The policies aiming at improving the existing infrastructures in the slums and shanty towns along with a substantial level investment in curbing unemployment problems will bring down the level of suicides considerably. This study also points out the importance of income levels in reducing suicides. Like the previous cause, this situation requires a long-term economic policy which particularly focuses on decreasing poverty at every social category of society with a view to curb down suicides. Even though the liquidation of firms has an adverse impact on the suicides, it is rather difficult to overcome cause since it is strongly related to the economic fluctuations in the economy. Finally, reducing the negative impact of divorce on suicides requires essentially the promotion of family values. These social policies should provide special financial provisions for married couples. However, it is crystal clear that the results from this study should be treated with some caution due to data limitations and the variables being employed.

Appendix

Data definition and sources

All data are collected from International Financial Statistics of the International Monetary Fund (IMF), World Development Indicators of World Bank (WB), and Annual Statistics of Turkish Statistical Institute (TSI).

s is total number of suicides, in logarithm. Source: TSI.
y is per capita real income, in logarithm. It is deflated by consumer price index. Sources: TSI and IMF.
d is crude divorce rate, in logarithm. Source: TSI.
u is urbanization rate in percentage, in logarithm. Source: WB.
b is total number of liquidated companies, in logarithm. Source: TSI.

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