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MODELLING OF HEALTH IMPACT ON INEQUALITY IN TRANSITION COUNTRIES

This paper aims to evaluate the effect of health and aspects of health on income inequality. The research is motivated by data on sharp deterioration in health, combined by significant increase in income inequality, during the early transition period in Ukraine and other CIS countries. Following mainstream literature, life expectancy is used as a proxy for health. In order to deal with reverse causality problem we employed Arellano-Bover/Blundell-Bond dynamic GMM methodology. According the estimation of the elaborated econometric model the significant impact of health on income inequality has been found in transition countries, including Ukraine.

Keywords: modeling, Gini index, inequality, health, GMM methodology, transition countries.

Introduction

Significant decrease in economic growth at the beginning of transition processes in Ukraine and other CIS countries was followed by a sharp decrease in all health aspects. Lack of public finance led to permanent underfunding of healthcare sector, growth of out-of pocket payments and decease of accessibility of medical services to the most vulnerable groups of population. This fact contributed to the growth of inequality which was observed at the beginning of transition period. Despite significant distortions in the economic development, social type of economy which dominated in Ukraine for 70 years of XXth century managed to create quite efficient system of healthcare, which in 1978 at the Alma-Ata Conference was recognized as one of the most fair and accessible. Despite this fact, for the last years of transition most achievements of Soviet healthcare system were lost. The key motivation of this research is based on the fact that health factor influence on inequality, especially in Ukraine and former USSR countries is heavily underestimated. So, the research questions that are very important to answer are the following. First, how much income inequality can be explained by inequality in health? Second, how much inequality can be explained by different aspects of health?

Literature analysis

Numerous studies have examined the relation between income and health, not many have related inequality in income to inequality of health within a given countries, particularly in Ukraine, as well as across countries. This can be partially explained by the fact that an inequality measure can be constructed only for macro-level datasets. In turn, investigations of causality from health to income are also useful for understanding if differentials in health explain differentials in income. Many papers evidence positive relation between health and income, although the question of causality leads to arguments. There are empirical papers that investigate the effect of income on health, and there are papers that investigate impact of health on income. In studies of Beck, Deaton and Grossman historical aspects of relationship between health and income is investigated [1, 5]. Beck, Becker and others in there researches paid attention to variation in mean income across different areas (countries and states) and related it to observed measures of health status [1, 2, 3, 6]. Frijters et al. related variations of inequality of income across areas to variation in the average level of health across areas [4].

There also exist some empirical literature on causality from health to income; those papers come mainly from developed countries. The researchers, usually keeping in mind the reverse causality problem, try to come up with exogenous health shocks or in other way to control for the reverse causality. Wu investigated the effect of exogenous health shocks on wealth of married couples aged between 51–61 and found strong effect [10]. Wagstaff uses changes in body mass index (weight in kilos divided by squared height in meters) as proxy for health [9]. His results, obtained using Vietnamese individual-level dataset, suggests that adverse shock to health in fact were associated with reductions in earned income. He also found that non-medical consumption of better-off households decreased more than that of worse-off households, which was because worse-off households, unlike better-off ones, relied on disserving and borrowing.

Despite a lot of researchers tried to investigate different determinants of poverty, the impact of health aspect was not much covered, especially in context of transition countries [7, 11]. Some issues of this aspect were covered by authors in one of the

GDN Working Papers with Krasnikova l. and Osinkina O [8].

The aim of this paper is to fill the gap and investigate causality from health to income inequality and from health to income in Ukraine and other transition economies with higher time horizon. For this purpose we investigate on macro-level the effect of health on measure of income inequality, Gini index, using elaborated econometrics tools.

Data analysis and construction of variables. Major sources of data for the empirical research on macro-level include "OECD Health DATA 2010", WIDER databases, World Bank WDI 2010, and TransMONEE 2010 database of UNICEF. Combined macro-level panel database for estimation of macro-model includes information across 51 European countries (including Commonwealth of Independent States, Central and Eastern Europe, as well as Western, Northern and Southern Europe), for years 1992-2010. Major variables used are presented in Table 1.

Table 1. **Summary statistics of macro-level data**

Variable	Obs	Mean	Std. dev.	Min.	Max
Gini	556	32.049	7.123	18.000	62.500
Year	816	1998.5	4.613	1991	2006
Lifexp	660	73.677	4.561	62.386	81.515
Gdp	751	$236*10^{11}$	$4.81*10^{11}$	$7.09*10^{8}$	$2.90*10^{12}$
Gdppc	541	13115	14748	155	89778
Gdp_def	739	119.1	688.5	-15.7	15442.3
Export	737	$7.97*10^{10}$	$1.47*10^{11}$	$8.15*10^{7}$	$1.31*10^{12}$
Import	737	$7.66*10^{10}$	$1.40*10^{11}$	$2.40*10^{8}$	$1.15*10^{12}$
Open	737	91.875	40.769	22.229	326.598
Reinvest	734	21.3	5.4	2.6	53.2
Cis	816	0.216	0.412	0	1
Cee	816	0.392	0.489	0	1

Gini coefficient ('gini') – represents level of inequality for a given economy in a certain year. Gini ranges from 0 (complete equality) to 100 (absolute inequality). Sample max represents Armenia in 1996, min represents Slovak Republic in 1992.

Public health ('lifexp') – is included to capture the joint effect of various aspects of health on inequality. Application of life expectancy as a appropriate proxy for public health is used in large number of researches. During further stages of our research we plan to define a number of aspects of health and analyze the effect of each of the aspects of health separately. Maximum Life expectancy in the sample refers to Switzerland in 2006, while minimum to Turkmenistan in year 2002. GDP per capita ('gdppc') – considered as an explanatory variable for Gini. Measured in current US Dollars. Minimum – Tajikistan (1996), maximum – Luxembourg (2006). Inflation ('gdp_def') – deflator of GDP, considered as an explanatory variable for inequality, as it is probably more comparable between countries, than CPI. Minimum observed value – Bosnia and Herzegovina in 1997, maximum – Georgia in 1996. Openness of the economy ('open') – calculated as the ratio of exports plus imports to GDP, multiplied by 100. Minimum – Tajikistan in 1992, maximum – Luxembourg in 2006. Dummy variables for CIS and CEE countries ('cis' and 'cee') – these dummy variables (0 and 1) were constructed so that to facilitate analysis of peculiarities for these groups of countries.

The methodology of the research and the results obtained

As for dynamic methodology, the Arellano-Bower (1995)/ Blundell-Bond (1998) linear generalized method of moments has been used, which is specially designed for data-sets with small "T" (time periods) and large "N" (number of individuals). This methodology allows to deal with autocorrelation and heteroscedasticity, as well as cushion the endogeneity (reverse-causality problem). An important advantage of dynamic set-up over cross-section one is that it is less vulnerable to the problems of unobserved heterogeneity in individuals, as it includes fixed-effects in the panel data [12].

The regression equation would include lagged dependent variable in its right-hand side, as well as full set of time dummies, besides additional lags of practically all regressors form the matrix of instruments, according to the Arellano-Bower/ Blundell-Bond methodology. The equation of relationship between income inequality and health factor, as introduced in the cross-section paragraph, under dynamic set-up is arranged as follows (variables are logged):

$$\Delta G_{i,t} = \alpha_0 + (\alpha_1 - 1)G_{i,t-1} + \alpha_2 y_{i,t} + \alpha_3 H_{i,t} + \gamma Z_{i,t} + \lambda N_{i,t} + \varepsilon,$$

or alternatively

$$G_{i,t} = \alpha_0 + \alpha_1 G_{i,t-1} + \alpha_2 y_{i,t} + \alpha_3 H_{i,t} + \gamma Z_{i,t} + \lambda N_{i,t} + \varepsilon_{it}, \quad (1)$$

where $G_{i,t}$ – Gini index is a proxy for income inequality in country i, time period t; $G_{i,t-1}$ – is prior realization of Gini index, $\alpha_1$is expected to be in range (0; 1); $y_{i,t}$ – per capita GDP in country i, time period t; $H_{i,t}$ – health factor variable in country i, time period t, calculated by principal component analysis methodology from a set of relevant health variables. The other variables include years of schooling attainment ($Z_{i,t}$) and number of other variables as in cross-section set-up – inflation, degree of international openness, etc. ($N_{i,t}$), and time-dummies.

Considering the macroeconomic panel-data analysis the following equation has been estimated:

$$G_{t,i} = \beta_0 + \alpha G_{i,t-1} + \beta_1 Lifex_{i,t} + \beta_2 gdppc_{i,t} + \beta_3 gdp\_def_{i,t} + \beta_4 open_{i,t} + \delta Year_{i,t} + \varepsilon_{i,t}, \quad (2)$$

where $G_{t,i}$ – index Gini at time t for country i; $Lifex_{t,i}$ – life expectancy (proxy for health) at time t for country i; $gdppc_{t,i}$ – GDP per capita at time t for country i; $gdp\_def_{t,i}$ – GDP deflator at time t for country i; $open_{t,i}$ – openness of the economy – (*Exports+Imports*)/*GDP* – at time t for country i; $Year_{t,i}$ – complete vector of year-dummies (except for years 1991 and 1994); $\varepsilon_{i,t}$ – error term.

According this model the different specifications has been verified and respectively, the different method of estimations have been used– ordinary OLS, fixed- and random-effects, fixed- and random-effects with autoregressive residual, system GMM Arellano-Bover /Blundell-Bond. The results of all specifications are summarized in the table 2.

As we would like to remark, the simple OLS may not be optimal with panel data. The estimates of coefficients derived from regression may suffer from omitted variable bias – which arises when there is some unknown variable or variables that cannot be controlled for that affect the dependent variable. While using specific panel-data methodology we can control for omitted variables even without observing them. Hence, fixed- and random-effects methodology would be superior to simple OLS. The decision on fixed versus random-effects estimation is usually based on Hausman test. If the null hypothesis is rejected then the fixed effects estimation should be used. For our model fixed effects were chosen based on this criterion. In case of autocorrelation problems the estimators remain unbiased and consistent despite no longer efficient (we include lag of Gini coefficient among explanatory variables). The inefficiency of estimators means that t statistics and F statistics tests cannot be trusted any more. With this in view, we applied 'xtregar' operator in Stata, which offers a within estimator for a fixed effect model and the Baltagi-Wu GLS estimator of the random effects model. Although random effects Baltagi Wu GLS model provided us with coefficients closer to expectations, based on Hausman test we were forced to pick fixed-effects model with autocorrelated residuals. We relate the 'illogical' signs in both fixed-effects models to the endogeneity problem in our model. It is important to mention that our proxy for health, *Life expectancy*, could be itself a function of inequality in current and/or previous period – inequality relates to unequal medical treatment and higher stress in the society. Endogeneity problem leads to biased estimates, and unreliable predictions. To deal with the endogeneity problem, we estimate Arellano-Bover/ Blundell-Bond linear dynamic panel-data model. Briefly, benefits of this method is that it corrects for unobserved effects by taking differences, applies instrumental variable procedure to correct for endogeneity problem.

The equation with estimated coefficients using the system GMM methodology (Arellano-Bover/ Blundell-Bond procedure)is provided (t-values in parentheses):

$$\hat{G}_{t,i} = \underset{(11.15)}{92.698} + \underset{(3.22)}{0.206}\, G_{i,t-1} - \underset{(-9.92)}{0.898}\, Lifex_{i,t} + \\ + \underset{(3.82)}{0.00007}\, gdppc_{i,t} + \underset{(3.15)}{0.0025}\, gdp\_def_{i,t} - \underset{(-7.85)}{0.0339}\, open_{i,t}.$$

The direction of coefficients obtained coincides with underlying intuition. There is certain 'path dependency' as Gini coefficient is dependent on its *lagged value*. *GDP per capita* does not have an effect on inequality, as richer countries are not usually more equal. Theoretically, inequality should not be related to the level of average per capita income, as income growth rate of the richest quintiles could outpace that of the poorest. *GDP deflator* is positive and statistically significant. The result is consistent with the mainstream economic theory, which defines a number of ways in which inflation in a given economy 'hits' the low-income part of population stronger than the high-income part of population. Coefficient of *openness of the economy* is negative and statistically significant, meaning that higher openness may lead to a decrease in income inequality. According to results of estimating parameters of this model, an increase in life expectancy by 1 year, leads to a decrease in index Gini by 0,9. In terms of average elasticity, an increase in health (life expec-

Table 2. **Macro-level estimation results of the panel data-model (2)**

	(1) Simple OLS		(2) Fixed effects		(3) Autoreg FE		(4) Arellano-Bover	
	coeff.	**p-value**	**coeff.**	**p-value**	**coeff.**	**p-value**	**coeff.**	**p-value**
$Gini_{(t-1)}$	0.704***	0.000	0.284***	0.000	-0.157***	0.002	0.206***	0.001
$Lifexp_{(t)}$	-0.375***	0.000	0.179	0.581	0.573***	0.000	-0.898***	0.000
GDP p.c.$_{(t)}$	0.000	0.162	-0.000	0.538	-0.0001	0.109	0.0001***	0.000
GDP deflator$_{(t)}$	0.003***	0.001	0.0003	0.755	0.003**	0.019	0.0025***	0.002
Openness$_{(t)}$	-0.015***	0.002	0.0004	0.977	0.0029	0.791	-0.0339***	0.000
Constant	37.876***	0.000	10.405	0.658	-5.341***	0.001	92.698***	0.000
R^2 *(adjusted)*	0.7044		0.5415		0.4096		0.5109	
No obs.	417		417		376		417	

* significant at 10 %; ** significant at 5 %; *** significant at 1 %.

tancy) by 1% leads to decrease in inequality (index Gini) by 2,1%. This is, probably, also coincides with expectations.

Conclusions. The focus of present analysis was to explore how different aspects of health affect the relation to income inequality. According to the theoretical and empirical debate, it was assumed that in the case of Ukraine and other transition countries influence on income inequality of health factors was heavily underestimated. Our research was motivated by data on sharp deterioration in health, combined by significant increase in income inequality, during the early transition period in Ukraine and other CIS countries. In order to address this research question, we implemented empirical analysis on macro levels. Specifically, according to macro-level results, a 1 % increase in life expectancy leads to a 2,1 % decrease in income inequality as measured by index Gini. These findings are consistent with previous international studies that have indicated evidence about health-income inequality causality. Our findings expand current debates about health-income inequality association by considering for different aspects of health in income equation in case of Ukraine. It is necessary that future empirical investigations should deeper consider for health-care sector, besides it should utilize subsequent rounds of ULMS in order to apply dynamic analysis. The meaning of specific health aspects that influence income inequality is important in order to get a deeper understanding of the health-income inequality relationship.

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МОДЕЛЮВАННЯ ВПЛИВУ ФАКТОРА ЗДОРОВ'Я НА НЕРІВНІСТЬ У КРАЇНАХ ІЗ ПЕРЕХІДНОЮ ЕКОНОМІКОЮ

У статті досліджено ефекти впливу факторів здоров'я на нерівність в доходах. Гіпотетичну можливість такого зв'язку підтверджено статистичними даними щодо різкого падіння індикаторів здоров'я з одночасним зростанням нерівномірності в доходах населення України та інших країн із перехідною економікою. Індикатор тривалості життя використано як замінник фактора здоров'я. Для врахування можливого прямого та зворотнього зв'язку використано процедуру Арелано–Бовера під час оцінювання розробленої економетричної моделі лонгітюдних даних методом узагальнених моментів, оцінка моделі на реальній інформації підтвердила наявність суттєвого взаємозв'язку між факторами здоров'я та нерівністю в доходах населення як України, так і країн із перехідною економікою.

Ключові слова: моделювання, індекс Джині, нерівність, здоров'я, узагальнений метод моментів, країни з перехідною економікою.

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