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Essays on Income and Consumption of the Belarusian Population

Maksim Yemelyanau

Dissertation

Prague, August 2011

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Dissertation Committee

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Abstract

This dissertation studies some particular aspects of income and consumption of the population of the Republic of Belarus, one of the least studied transition countries, using a dataset virtually unknown to the Western researchers. In the first chapter the low level of income and expenditure inequality in Belarus is explained with the use of Ukraine as a benchmark. Inequality decomposition by sources and application of DiNardo-Fortin-Lemieux counterfactual kernel densities show that the difference in inequality is explained by the income policies of the two countries. The second chapter explores the roles played by small land plots in Belarus and Ukraine. The conclusion is that less efficient social safety net in Ukraine makes the urban poor use their land plots as a subsistence mechanism, while in Belarus they use it mostly for leisure. The third chapter explores the effect of the Chernobyl nuclear disaster on schooling, labor market and health outcomes in Belarus. The findings are that younger children coming from the more contaminated regions have more job-related health issues and lower wages than those who were older at the time of the accident or who came from the less contaminated regions. The absence of an effect on education could be caused by special privileges for prospective students from the contaminated regions.

Abstrakt

Tato disertační práce využívá nově dostupný unikátní soubor údajů ke studiu některých aspektů příjmů a výdajů obyvatelstva Běloruské republiky, což je jedna z nejméně studovaných tranzitivních ekonomik. V první kapitole je vysvětlena nízká nerovnost příjmů a výdajů v Bělorusku pomocí srovnání se situací na Ukrajině. Rozklad nerovnosti podle zdrojů a využití simulovaného rozdělení metodou DiNardo-Fortin-Lemieux ukázalo, že rozdíl v nerovnosti je způsoben příjmovou politikou obou zemí. Druhá kapitola se zabývá rolí malých zemědělských pozemků a zahrad v Bělorusku a na Ukrajině při obraně před nízkými příjmy. Analýza naznačuje, že kvůli méně efektivní síti sociálního zabezpečení na Ukrajině tamní chudí městští obyvatelé používají tyto pozemky jako náhradní zdroj potravin v rámci boje s chudobou, zatímco v Bělorusku se tyto pozemky většinou používají jen v rámci volnočasových aktivit. Třetí kapitola zkoumá vliv černobylské jaderné katastrofy na vzdělávání, trh práce a zdraví v Bělorusku. Mezi hlavní zjištění patří to, že mladší děti (v době katastrofy) z více kontaminovaných regionů mají v dospelosti více pracovních zdravotních problémů a nižší mzdy, než ti, kteří byli starší v době nehody nebo kteří přišli z méně znečištěných regionů. Nulový efekt kontaminace na vzdělávání může být způsoben zvláštními privilegii pro vysokoškolské studenty z kontaminovaných oblastí.

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Introduction

The Republic of Belarus is one of the least studied transition countries. Yet because of its lack of reforms, both on the supply side of the economy and on its social support system, Belarus offers an interesting benchmark case for studying many economic questions. This dissertation consists of three essays and uses a dataset virtually unknown in the Western literature to study several uncommon aspects of income or consumption of the Belarusian population.

The first chapter, "Inequality in Belarus from 1995 to 2008" studies the inequality in Belarus since 1995. When the USSR collapsed, inequality increased in all transition economies, albeit to different levels. The existing literature suggests that countries that were slow to undertake reforms had the biggest increases in inequality. The notable exception is Belarus, one of the least reformed ex-Soviet republics, where inequality has remained low. This essay studies the evolution of inequality in Belarus, decomposing inequality by sources of income. A comparison of Belarus and Ukraine suggests that the difference in inequality is explained by the income policies of the two countries: Belarus avoided mass privatization and kept many of the "Soviet" social security features.

The second chapter, "Second agriculture in Belarus and Ukraine: subsistence or leisure?" studies the "second agriculture" in Belarus and its role. In many post-Soviet countries, more than half of all urban households use small land plots to produce significant agricultural output even though their members have paid jobs or collect state pensions. Existing studies suggest that in Russia such "second agriculture" helps smooth consumption during times of economic uncertainty. Using household budget survey data, this essay studies the role of "second agriculture" in Belarus and Ukraine, two countries that differ significantly in the coverage of their social safety nets. In both countries most urban households use their small land plots for leisure, and since the mid-1990s they tend to decrease their use. The conclusion is that the Ukrainian urban poor indeed use "second agriculture" to substitute for the lack of social transfers, while

in Belarus the poor are better covered and for them it is more of a leisure activity.

The third chapter, "Evidence from the Chernobyl accident: the effect on schooling, labor market and health outcomes in Belarus", co-written with Aliaksandr Amialchuk and Mir Ali (the University of Toledo, USA), studies the effect of the Chernobyl nuclear accident on wages and labor market attainments of the most affected part of the Belarusian population. The Chernobyl nuclear accident of 1986 had deleterious health consequences for the population of Belarus (in particular, thyroid malignancies), especially for children below 4 years of age at the time of the disaster. This essay utilizes the natural experiment generated by this accident, which produced a sizable increase in radiation levels in several regions of Belarus irrelative of any other factors. The effect of radiation on schooling, labor market and health outcomes among the cohorts and regions that varied in the amount of exposure is estimated; the findings are that younger children coming from the more contaminated regions had more job-related health issues and lower wages than those who were older at the time of the accident or who came from the less contaminated regions. While the essay does not find an effect on education, this could be caused by special privileges for prospective students from the contaminated regions.

Chapter 1

Inequality in Belarus from 1995 to 2008[1]

Abstract

Inequality increased in all transition economies, albeit to different levels. The existing literature suggests that countries that were slow to undertake reforms experienced the biggest increases in inequality. The notable exception is Belarus, one of the least reformed ex-Soviet republics, where inequality has remained low. This essay studies the evolution of inequality in Belarus between 1995 and 2008, decomposing inequality by sources of income. A comparison of Belarus and Ukraine suggests that the difference in inequality is explained by the different income policies of the two countries: Belarus avoided mass privatization and kept many of the "Soviet-era" social security features.

Keywords: Belarus, Ukraine, transition, income inequality, expenditure inequality, social security, DiNardo-Fortin-Lemieux counterfactual kernel densities

JEL classification: D31, D63, H55, O15

[1] **An earlier version of this work has been published as Yemelyanau, M. (2008). "Inequality in Belarus from 1995 to 2005". CERGE-EI WP No. 356, 55 p. I wish to thank my advisor Štěpán Jurajda for motivation, valuable comments, and helpful suggestions. I would also like to thank Alena Bičáková, Tom Coupé, Randall K. Filer, Igor Livshits, Daniel Munich, Alina Verashchagina, and Viatcheslav Vinogradov for their useful and pertinent comments. Many thanks go to Jody Ono, Robin-Eliece Mercury, and Lawrence Smith for help with editing this paper. I am also very grateful to the National Statistical Committee of the Republic of Belarus and the IPM Research Center (Minsk, Belarus) for the data they provided. The purchase of the data was funded by Charles University GAUK grant 257602 (project 60207). All errors remaining in this text are the responsibility of the author.**

1.1 Introduction

Income and consumption inequality are often associated with greater poverty and more social tensions.[2] Because of these relationships and inequality indices are clear economic indicators easily understood by the general public, inequality is of high concern among policymakers.

Since the collapse of the central planning systems in Central and Eastern Europe, inequality increased from its initial artificially low levels in all post-communist countries, albeit to varying extents. While inequality rose only moderately in most central European economies, it increased rapidly in most post-Soviet countries. The existing literature (e.g., World Bank, 2000) suggests that post-communist countries that implemented slower and less consistent pro-market reforms also saw the biggest increases in overall inequality with the notable exception of the Republic of Belarus.

Although there is much research on inequality in most transition economies, including the post-Soviet countries of Russia and Ukraine, the existing literature on inequality[3] in Belarus does not go beyond mentioning the overall inequality level in this country (e.g., Milanovic, 1998; World Bank, 2000, 2004). This essay helps to fill this gap in the literature by providing the first detailed analysis of inequality in Belarus, a country with an atypical transition path.

The lack of research on inequality in Belarus is not very surprising; Belarus remains the least known European country for Western researchers, and one of the least known countries of the former USSR.[4] Yet because of its lack of reforms, both of the supply side of the economy and of its social support system (noted, e.g., by the International Monetary Fund [IMF], 2005, 2006), Belarus offers an interesting benchmark case for

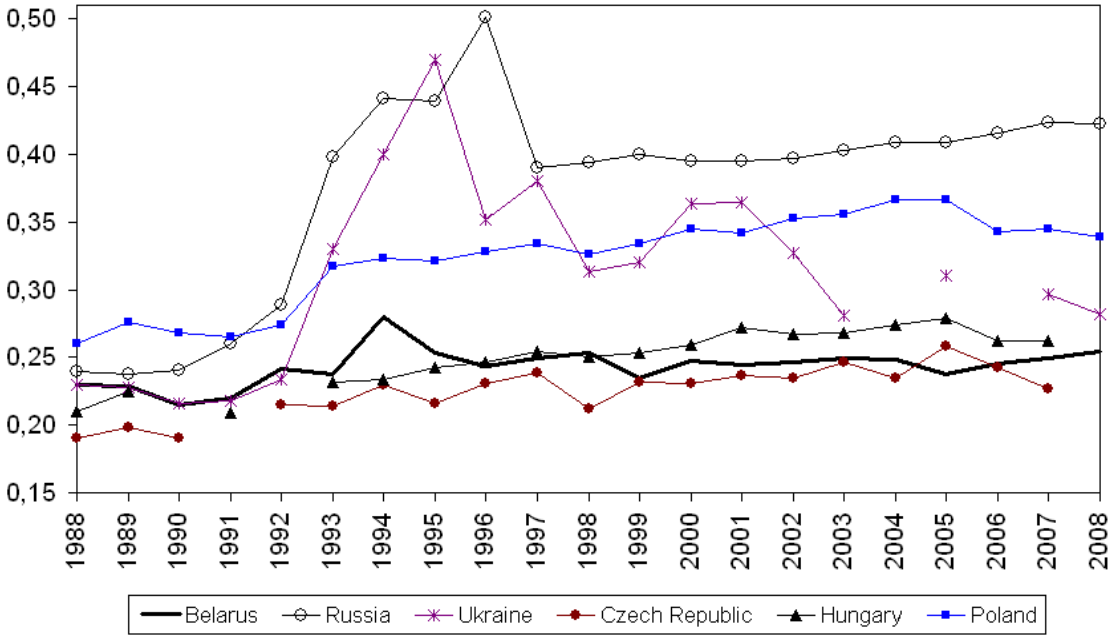
[2] It may also be associated with higher mortality, as discussed by Brainerd (1998, 2002), who finds a negative and statistically significant correlation between income inequality and the change in life expectancy in Russia.

[3] Several articles by Pastore and Verashchagina (2005, 2006a, 2006b, 2011) study a narrower subject of wages, especially their gender aspect.

[4] As of August 2011, the Scopus database lists only 97 economics, econometrics, and finance articles containing the word "Belarus" in their titles or abstracts, versus 2002 for Russia, 688 for Ukraine, 1066 for Poland, and 297 and 160 for the small countries of Lithuania and Latvia, respectively. If one takes CEE countries comparable by their population size, the numbers are 1121 for the Czech Republic and 862 for Hungary.

studying many economic questions including inequality. In many respects, Belarus can be viewed as a country that is still in the early stages of transition.

Figure 1.1. Evolution of income inequality in selected transition countries measured by the Gini Index, 1989-2008



Source: TransMONEE 2010 Database, unless noted otherwise; Milanovic (1998, Table 4.1) for Belarus, Russia, and Ukraine in 1989 and 1993; Kakwani (1995, Table 20) for Belarus, Russia, and Ukraine in 1990; Russian GKS[5] for Russia 1997-2008; the World Bank WDI[6] for Ukraine 1996-1997, 2003-2005; author's own calculations based on BHBS for Belarus 1995-2008.

Note: The pre-1995 data for Belarus, Russia, and Ukraine are not very reliable. They are taken from different sources and may not be directly comparable with both previous and subsequent periods and with other countries (due primarily to the lack of data and different methodologies used).

Within the Soviet Union, Belarus had the lowest inequality level, with a Gini coefficient of around 0.22, followed very closely by Russia and Ukraine (Dikhanov, 1996; Kakwani, 1995). Historically these three countries share tight political, cultural, and

[5]Retrieved from http://www.gks.ru/free_doc/2005/b05_13/06-01.htm, http://www.gks.ru/free_doc/2006/b06_13/06-01.htm and http://www.gks.ru/free_doc/new_site/population/urov/urov_32g.htm on April 28, 2011.

[6]Retrieved from http://go.worldbank.org/6HAYAHG8H0 on April 28, 2011.

economic links, they followed somewhat similar transition paths, at least for most of the 1990s (World Bank, 2002, Figure 2.1). In spite of these commonalities, Figure 1.1 shows that the evolution of inequality in these economies has been strikingly different. While in Russia and Ukraine inequality doubled within just the first few years after the Soviet Union's breakup, reaching levels typical of some of the most unequal (and poor) countries in the World, inequality trends in Belarus remained similar to those of the Czech Republic and Hungary—countries that had very different transition paths and implemented quick and significant pro-market reforms but also maintained income equality with generous, Western-European-style social support systems (World Bank, 2000).

There are three possible main reasons for the low inequality in Belarus. The first is that the Belarusian population has some inherent features that assure low inequality even during major social and economic changes like the transition "from plan to market" (e.g., Belarusians may have more homogeneous skills and education). The second is that the Belarusian government deliberately kept inequality low (and inflation/depreciation high) mainly by keeping many of the old Soviet social guarantees, which were almost entirely abolished in Russia and Ukraine. The third is that in Belarus the large Soviet enterprises have not been privatized, keeping many people covered by the more compressed "Soviet" wage grid.

This essay aims to explain which of these potential explanations work and which do not. Using the data from the Belarusian Household Budget Survey, it answers the following questions: (i) What is the structure of household income and expenditure inequality in Belarus? (ii) What was the influence of the 1998 Russian financial crisis[7] on the level of inequality? (iii) Do demographic and labor market characteristics explain the inequality gap between Belarus and Ukraine after 10 years of transition?

The essay is structured as follows: Section 1.2 provides a brief review of the literature on inequality in other transition countries; Section 1.3 gives some background

[7]This is the most important macroeconomic shock Belarus faced during its independence (before the ongoing world economic crisis). Otherwise, the economic situation there has been remarkably stable since the mid-1990s.

information on the transition path of the Belarusian economy; Section 1.4 describes the data used; Section 1.5 provides detailed information on the inequality in Belarus and its breakdown by sources; Section 1.6 offers a comparison of Belarus and Ukraine using the DiNardo-Fortin-Lemieux Counterfactual Kernel Densities; and Section 1.7 concludes.

1.2 Literature review

A 2005 World Bank survey of poverty and inequality in Eastern Europe and the Former Soviet Union during transition (Alam, Murthi, Yemtsov, Murrugarra, Dudwick, Hamilton, and Tiongson, 2005) recounts:

> The wage distribution was compressed under central planning because of the egalitarian ideology and the centralized wage-setting mechanism. [...] The new market economy environment has contributed to the widening of wage disparities. Although the increase in wage disparities is consistent with growing productivity differentials, market distortions have also played a role (particularly pronounced in CIS countries). The worst affected have typically been those who are the most vulnerable to shocks and least able to adjust to the new market paradigms: mostly less skilled and older workers (p.14).

Indeed, income and consumption/expenditure inequality increased[8] in all transition economies during the late 1980s and 1990s. In central European countries such as Hungary, the Czech Republic, Poland or the Baltic republics, this increase was modest.

[8] Some researchers (e.g., Garner and Terrell, 1998; Keane and Prasad, 2002) ask whether the comparison of inequality indices before and after the transition is meaningful at all. They note the distortion of pre-transition figures on income distribution and the use of surveys with differing methodologies, coverage, and objectives. According to the World Bank (2000), "pre-transition surveys were usually not designed to be representative of the entire population but rather of certain socioeconomic groups. As a result, they tended to be biased toward the average household and to exclude nonstandard [sic] households—in particular, marginal groups with a high probability of being poor. Thus, the distribution of income was usually truncated, leading to an underestimation of true income disparities" (p. 142). Henderson, McNab and Rozsas (2008) report much higher values of Gini coefficients for pre-transition countries than Milanovic (1998) and other authors, but they obtain them by assuming arbitrary values for average income values for population subgroups.

On the other hand, the rise in inequality was dramatic in the Commonwealth of Independent States (CIS). In Russia, Armenia, Moldova, Tajikistan, and Turkmenistan, the Gini coefficients for income almost doubled according to the World Bank's WDI and UNICEF's TransMONEE databases which both collect information from the national statistical offices.[9] Measured by Gini coefficients of 0.5 or more, inequality in these countries is now comparable to levels observed in some of the most unequal economies in Latin America. However, unlike in Latin America, where inequality has been high but fairly stable, the deterioration of the income distribution in the CIS has occurred within only a few years, resulting in an unprecedented magnitude and speed of inequality change.

The existing literature usually attributes this surge in inequality to three main factors: increase in wage disparities; government transfers and taxes; and rising educational premia.

Some authors (e.g., Milanovic, 1998) argue that the real increase in wage disparities was the most important factor behind the increase in income inequality in transition and not the underestimated and underreported inequality in the past. Aghion and Commander (1999) study inequality in Russia and argue that the Kuznets curve representation does not apply in this and other CIS countries, meaning that inequality is not likely to fall away from its peak (as it did in Central Europe) because it settled early at a higher persistent level due to big differences in labour income within the private sector. In the long run Aghion and Commander predict increases in both between and within group inequality, because a deterioration in the education systems will further amplify wage and earnings differences between the skilled and the unskilled or between the adaptable and the non-adaptable. Ganguli and Terrell (2005, 2006) examine changes in wage inequality in Ukraine from 1986 to 2003. Applying the DiNardo, Fortin, and Lemieux (1996) counterfactual decomposition method, they assert that changes in the wage structure explain almost the entire rise in inequality. Although less important

[9] According to Luttmer (2001), these numbers may be overestimated by 10-45 percent because of measurement errors and otherwise noisy data. On the other hand, they also may have been underestimated before—see the previous footnote.

in its impact, changes in the composition of the labor force also affected inequality in Ukraine: they contributed to a reduction in the overall wage inequality of men and also to an increase in inequality in the top half of the women's wage distribution.

Rising educational premia played a much less prominent role in the CIS than in Central Europe, according to Alam et al. (2005), Lindauer (1998), Münich, Svejnar and Terrell (2005), and Yemtsov (2001), among others. Pastore and Verashchagina (2006b), on the contrary, find high returns to education in Belarus, which is a-typical for a transition country—yet another peculiar feature of Belarus. In other CIS countries, education explains only a small share of observed wage inequality, which could be interpreted as reflecting the low market value of the stock of education inherited from the Soviet Union. Aivazian and Kolenikov (2001) assert that the shifts of human capital and skills demand during the transition have ousted the "Soviet middle class", i.e., relatively qualified and more educated workers, who have had to look for other, usually less profitable, income sources. This search has been affected adversely by low labor mobility (primarily, geographical) typical for Russia. Brück, Danzer, Muravyev, and Weißhaar (2010) find a substantial level of extreme poverty in Ukraine in the middle of the 1990s and greater poverty among households with children and with less education. When comparing the years 1996 and 2004, Brück et al. find a decline in both poverty and inequality over the eight-year period, especially when measured by income. On the other hand, they document an increase in socioeconomic stratification over time and across space.

Government transfers and taxes are another key factor. In many countries— the Czech and Slovak Republics, Estonia, Hungary, and Poland, for example—they have played a significant equalizing role, alleviating the effect of rising earnings inequality. In other countries (e.g. the Baltic states), such transfers have had almost no effect. In still others, most notably in Russia and to a lesser extent in other CIS countries, they have actually contributed to increasing inequality since government size and transfers have declined sharply (World Bank, 2000).

Another possible factor is put forward by Berkowitz and Jackson (2006) who attribute the differences in the evolution of Polish and Russian income distributions during the transition to different rates of entry of new enterprises. According to the authors, Poland's greater success in *de novo* firm entry contributes to its more equitable income distribution. Berkowitz and Jackson find that new firm creation is associated with both higher income and a larger portion of income distributed to the lower quintiles, decreasing both poverty and inequality.

In general, the countries that implemented quicker and more determined reforms saw the smallest increases in overall inequality. The countries that have lagged in reforms, or undertaken reforms in an incomplete and inconsistent manner, have experienced the biggest increases in inequality.[10] The World Bank (2000, pp. 163-164) summarizes the root causes by citing three interrelated institutional factors: (1) a failure to implement "the policies and institutions needed to allow product and factor markets to operate effectively"; (2) the "co-opting of national governments by vested interests ... that have blocked reforms"; and (3) the "widespread rent-seeking behaviors and corruption in public administration".

1.3 Economic background in Belarus

After the collapse of the USSR in 1991, all ex-Soviet republics experienced severe macroeconomic instability and sharp output declines. In Belarus, this fall was deepest in 1992–94; this also was the period of some initial and indecisive market reforms. Since the mid-1990s, the country tried to re-establish centralized state control over the economy. So in the first years of transition, Belarus essentially followed the same transition path as other countries in the region did, but since 1995 they diverged. While several reform measures were undertaken (notably, the lifting of price controls and the elimination of most, but not all, energy cross-subsidization), Belarus' economy remains highly regulated and very strictly state controlled. The share of the private sector in

[10] This is why Belarus immediately stands out as a very particular case. It is one of the least reformed post-Soviet countries, yet has low inequality typical of the most advanced transition countries of Central Europe.

GDP is only 25%, the lowest among all transition economies except Turkmenistan (IMF, 2005). The majority of the population still works at state-owned enterprises (SOEs): according to the National Statistical Committee of the Republic of Belarus, in 1995 this share was almost 60%. While it has been decreasing since, to circa 50% in 2008,[11] large post-communist enterprises still employ virtually as many workers as they did during the Soviet era.

The Belarusian government brought down inflation only by the beginning of the 2000s (see Figure A1 in Appendix), not by the mid-1990s as most other transition countries. The 1998 Russian financial crisis was a major shock to the Belarusian economy because of the tight economic links between the two countries.[12] Inflation in Belarus (measured by the CPI) reached 182% p.a. in 1998 and 251% p.a. in 1999. Even in 2008, 17 years after the start of transition, inflation was more than 12% p.a. While this is very low by Belarusian standards, it is still high compared with other transition economies. Inflation was accompanied by a rapid depreciation of the national currency; the latter, but not the former, halted in 2003. The exchange rate of the Belarusian ruble was pegged *de facto* to the US dollar until the very end of 2008.[13]

Unlike other transition economies, Belarus managed to overcome the initial GDP decline very quickly (at least, according to the official data). The country enjoyed steady GDP growth from the mid-1990s, which sometimes reached 10% p.a. However, this growth did not have much effect on real wages. After the 1998 crisis, wages fell to 40 USD per month on average but then slowly recovered to 100 USD (a symbolic bar set by the Belarusian government long before) only in 2003, accelerating their growth to 200 USD in 2005, 300 USD in 2007 and 400 USD in 2008.

Unemployment has stayed low during the whole transition period, but again this

[11] Retrieved from http://belstat.gov.by/homep/en/indicators/labor.php on April 28, 2011.

[12] At that time, Russia accounted for almost 2/3 of Belarusian exports and more than 1/2 of imports. The situation has reversed since—Belarusian exports became more diversified, while the reliance on Russian raw materials and other supplies increased.

[13] As suggested by Randall K. Filer, inflation can have a direct effect on inequality measures because high and low income consumers buy different product bundles and therefore are not affected by the changes in prices of different products in the same way. Unfortunately, no separate data on those price changes are available.

figure is from the official data, which do not take into account hidden unemployment and workers employed at the mostly inefficient and over-staffed large state-owned enterprises.

Overall, the Belarusian transition path was similar in many respects to Russia's and Ukraine's, with comparable inflation, depreciation, and wage levels. However, the three Soviet republics that had the lowest inequality levels in 1990—Belarus, Russia, and Ukraine—have seen very different changes in inequality during their transitions (see Figure 1.1). In Russia and Ukraine, inequality doubled by the mid-1990s, while in Belarus it increased only slightly, remaining very low at the level of the most successful and advanced transition countries of Hungary and the Czech Republic.

1.4 Methodology and data description

Studies of inequality in Russia and other post-Soviet countries using income data are made difficult by the expansion of wage arrears and by the increasing importance of informal economic activities in the 1990s (the income from these activities is very unlikely to be reported truthfully). Therefore, I apply the standard inequality measures (see the Appendix for a description) and their decompositions both to expenditure and to income inequality (in order to make cross-country comparisons possible).

Unfortunately, there are no reliable and consistent data on inequality in Belarus for the first few years of transition (1991-1994). Only from 1995, when the Belarusian Household Budget Survey[14] (BHBS) was started, can one construct adequate measures of inequality among the Belarusian population. This yearly survey is designed to be representative of the total Belarusian population (excluding only students living in dormitories, soldiers in barracks and homeless people), unlike the Soviet surveys that usually included only full-time workers. Each observation includes sampling weights inversely proportional to the probability of being sampled and corrections for unit non-

[14]This project was established with assistance from the World Bank and the Statistical Office of the European Commission (Eurostat); the quality of the data is at the level of similar surveys in other European countries. The results are published on a regular basis, see, e.g., http://belstat.gov.by/homep/en/publications/1-09n.htm and http://belstat.gov.by/homep/en/publications/2-11n.htm

response to the interview. Therefore the survey replicates the structure of Belarusian population very well, e.g., it very slightly undersamples the unemployed (6.1% of the economically active population versus 6.2% in the results of the 1999 census) and people with secondary education (69% of population older than 15 versus 71% in the census) but oversamples the rural population (31.8% versus 30.7%).

The data used in this essay are pooled cross-sections from 1995 to 2008 obtained from the National Statistical Committee of the Republic of Belarus. Each cross-section contains approximately 5,000 households representing the whole population of Belarus. Each observation includes detailed information about the household and its members, a breakdown of income[15] and expenditures by categories, more detailed data on food consumption, and information about dwellings. The data on income and expenditure are monthly averages for a given year. They are collected quarterly using a diary completed by households and survey questions asked by interviewers.

I also use data on individuals that form the households in question (approximately 14,000 observations for each yearly cross-section), including their age, socioeconomic status, wages and other sources of income, number of children, information on their education, work experience, and health.

This dataset has only been used very little in the Western scientific literature, though there are some papers written in Russian by local researchers. The only articles in which it is used are written by Pastore and Verashchagina (2005, 2006a, 2006b, 2011), studying the returns to human capital and the gender wage gap in 1996 and 2001.

The data are in nominal terms, which in the Belarusian case complicates the comparisons with other countries and between different years mainly because of high inflation in 1991-2001 and the *de facto* pegged exchange rate in 2004-2008. Therefore neither the use of CPI nor the exchange rate (market or PPP) lead to absolutely consistent and convincing figures in real terms. While inequality measures are relative

[15]The total income as defined by the National Statistical Committee of the Republic of Belarus includes the "receipts from sale of real estate" and other similar items (e.g. loans and operations with shares and other securities) that are more related to assets than to income. To obtain a better and more methodologically sound estimate of inequality, I subtract those sources from income and expenditure. All graphs and tables in this paper contain the updated estimates.

and thus do not depend on the choice of base year or exchange rate, to study poverty (a phenomenon closely linked with inequality) in Belarus one needs to convert all the data properly into real terms. Because this methodological problem has not yet been solved, in this essay I study inequality only.

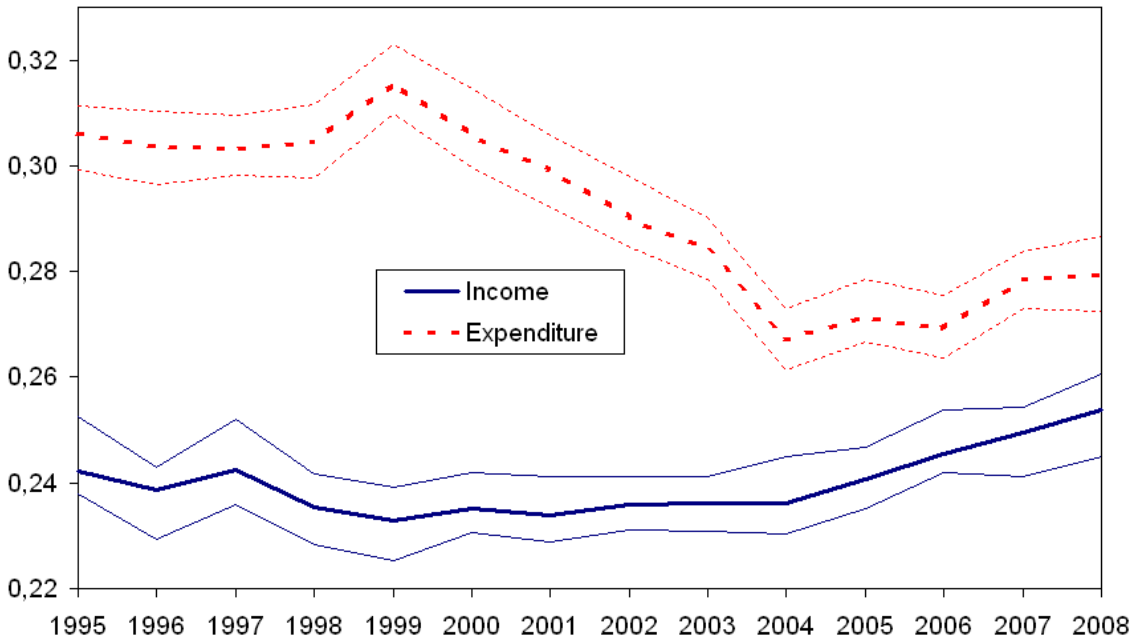
The data used for Ukraine come from a similarly constructed Ukrainian Household Budget Survey with the same variables, but have a larger number of observations (approximately 9,000 households versus 5,000 for Belarus) that account for the bigger population of Ukraine.

1.5 Inequality evolution and its decomposition

Income inequality in Belarus reached its peak in the mid-1990s (see Figure 1.1). After 1995, it stayed at a low and quite stable level[16] (as Figure 1.2 shows) as measured by both the Theil and Gini indices. Expenditure (but not income) inequality rose in 1999, just following the Russian financial crisis, and continued to fall thereafter. The downward trend reversed in 2004 when both income and expenditure inequality started to rise, albeit slowly. It is not clear whether this change continued beyond 2008 as the Belarusian Statistical Office refuses to share (or even sell) the BHBS data for 2009 and 2010, and what factors are driving it.

[16] These results are consistent with the data from the other sources, e.g. the TransMONEE Database (UNICEF IRC, Florence), where data are "...collected directly from National Statistical Offices using a standardized template" (http://www.transmonee.org/). There are some minor discrepancies (still within the 95% confidence interval) that most probably are due to differences in equivalence scales and sampling weights, but the overall trend clearly is the same.

Figure 1.2. Evolution of the Gini index in Belarus



Source: Author's own calculations based on the BHBS.

Note: Thin lines show 95% confidence intervals calculated with bootstrapping (100 repetitions). Constructed in Stata using the ineqerr .ado module. Other inequality indices (Theil, Varlogs, and coefficient of variation) follow exactly the same pattern.

Remarkably, in Belarus the inequality of expenditure is much higher than theinequality of income (I consider this atypical phenomenon in more detail in Section 1.5.3). Nevertheless, both inequality measures still are lower than in other post-Soviet countries[17].

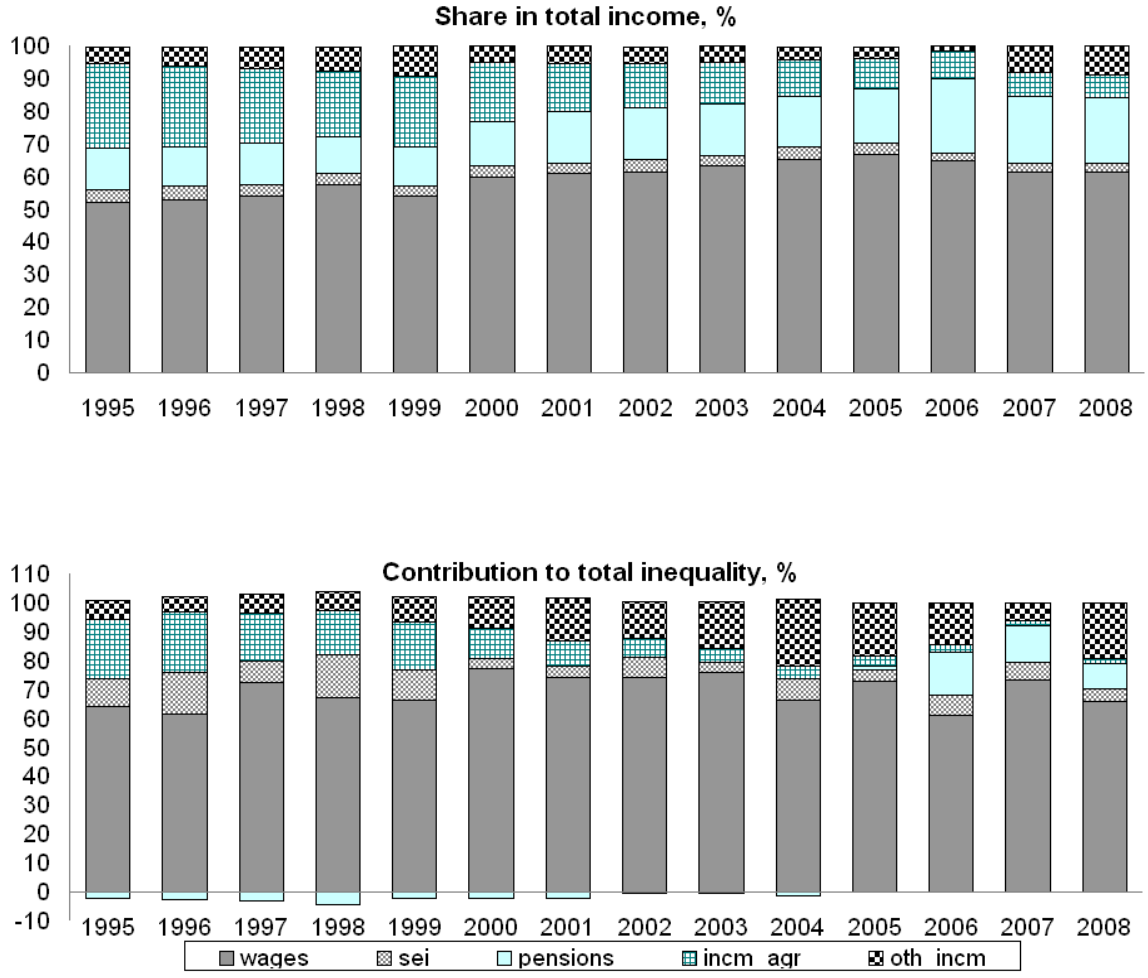
Income inequality in Belarus is spread almost uniformly across regions, with no significant difference in the various regions' contributions to inequality. The country-wide changes in inequality levels over the years are due mainly to changes in inequality in the capital city of Minsk. This city also has a slightly higher inequality level compared to other regions (these results are available upon request).

[17]Unfortunately, unlike income inequality, expenditure inequality indices are not collected using comparable methodologies nor reported by international organizations.

1.5.1 Inequality decomposition[18] by sources

As shown in Table 1.1, wages are by far the most important source of income in Belarus. Income from small land plots (both monetary and in-kind) was the second most important income source in the mid-1990s, but its share has been decreasing steadily ever since. The share of pensions (retirement benefits), on the contrary, is rising (see also the first graph of Figure 1.3). This may be one of the factors keeping overall inequality low, since the contribution of pensions to total inequality is much smaller than the pensions' contribution to total income (Table 1.2)—a sign of the importance of government transfers.

Figure 1.3. Inequality decomposition by income sources



[18] **Performed in Stata using the ineqfac module—for details see Appendix.**

Source: Author's own calculations based on the BHBS.

Note: The decomposition by income sources was performed in Stata using the ineqfac .ado module; sei = self-employment income; incm_agr = income from sale of agricultural products from small land plots plus income in kind; oth_incm includes dividends, unemployment benefits; child allowances, other state subsidies, financial assistance received from friends and relatives. The contribution of pensions is negative except for 2005-2007.

Table 1.1. Share in total income, %

income source	1995	1999	2003	2007
wages	52.3	54.0	63.5	61.5
self-employment income	3.6	3.3	3.1	2.6
pensions	12.9	11.8	15.6	20.5
income from small land plots	25.6	21.6	12.6	7.2
other	5.1	9.2	5.0	8.3
Total	100.0	100.0	100.0	100.0

Table 1.2. Proportionate contribution to total inequality, %

income source	1995	1999	2003	2007
wages	64.3	66.2	75.8	73.4
self-employment income	9.5	10.4	3.6	5.9
pensions	-2.0	-2.2	-0.4	12.7
income from small land plots	20.6	16.9	5.0	1.8
other	6.5	8.5	16.0	6.2
Total	100.0	100.0	100.0	100.0

Source: Author's own calculations based on the BHBS.

Note: "Income from small land plots" includes both the sales of agricultural products and income in kind; "other" includes dividends and unemployment benefits, child allowances, other state subsidies, and financial assistance received from friends and relatives but excludes receipts from personal and household property sale and receipts from the sale of real estate. Both share and contribution of dividends and unemployment benefits, taken separately, are insignificant. Individual values may not sum up to 100% due to rounding.

Note that the contribution of pensions to inequality is negative until 2005, meaning that this source of income has had an equalizing effect. This contribution is positive from 2005 onwards when there was a change in the retirement law (the size of pensions was increased, but they became less egalitarian with amounts more linked to the

previous wages of the retiree). At the same time, Belarus saw a small rise in income inequality (Figure 1.2), and pensions explain much of this increase. Notice also that the contributions to inequality and the shares in total income of "Income from small land plots" and "Self-employment income" decreased from the mid-1990s.[19]

1.5.2 The Russian financial crisis of 1998 and its effect on Belarus

The crisis of 1998 did not have a large effect on inequality in Belarus although it affected many other economic indicators dramatically (see Section 1.3). For example, GDP growth[20] remained positive but was the lowest since 1995. Income inequality did not change at all (and was remarkably stable in subsequent years), and expenditure inequality rose only slightly and then declined thereafter (see Figure 1.2).

1.5.3 Income versus expenditure inequality

One of the striking features of inequality in Belarus is that the inequality of income is lower than the inequality of expenditure, while studies of other transition economies (e.g., Yemtsov, 2001 for Georgia) usually find the opposite mainly because low-income households tend to borrow to sustain a higher consumption level.[21]

In the absence of the underreporting of income and consumption, these differences in inequality would imply a very different "propensity" for savings along income levels as, in principle, the equality $savings = income - consumption$ should hold. Indeed in general, the poor save less in absolute terms, but they save a higher fraction of their income than the rich. However, this fact does not suffice to explain the higher expenditure inequality in Belarus. Many of the (very) poor have negative savings,

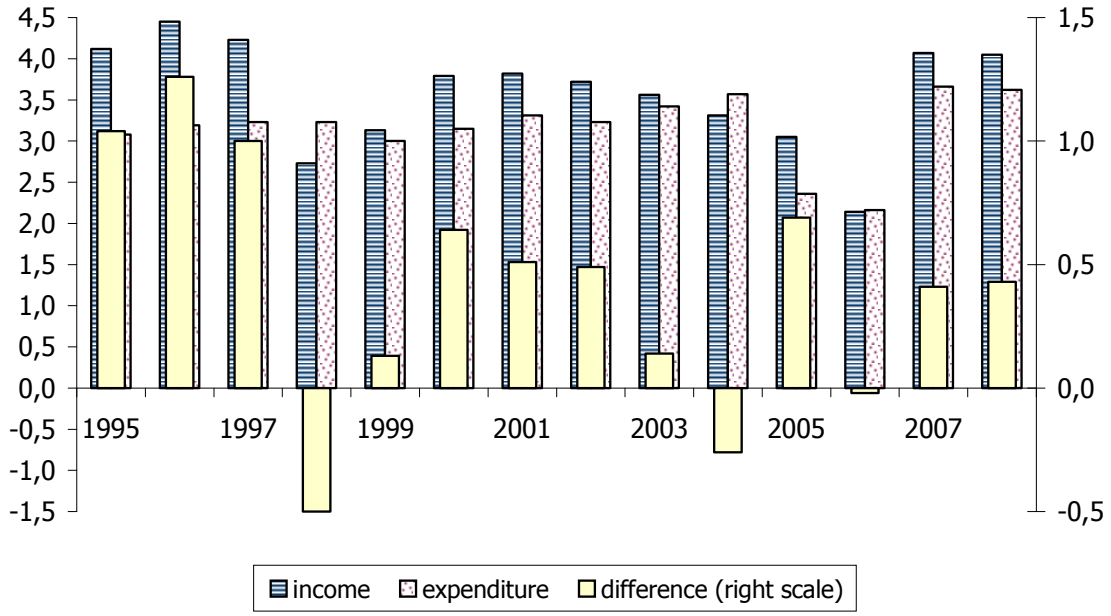
[19] The share of this income source remaining stable, the decrease in its inequality contribution may be explained by the fact that while in the 1990s the self-employed usually had higher than the average income, in the 2000s their income became virtually the same as employed workers.

[20] Despite the extensive literature on inequality and growth, the exact nature of this relationship is still disputed. Some studies (e.g., Miyazawa, 2006; Sukiassyan, 2007) find that the relation is negative, while others assert it is positive (e.g., García-Peñalosa and Turnovsky, 2006; Lopez, 2007). In the case of Belarus, I did not find any significant relationship between them. The Gini index for income fluctuates within less than 1 percentage point for the whole 14 years of my sample, and its 95% confidence intervals hardly change at all (see Figure 2).

[21] To my knowledge, there are no theories that could explain the reversed situation in Belarus.

like in other transition countries, where the inequality of income is higher than the inequality of expenditure. Only the underreporting of expenditures could explain the differences of inequalities in Belarus. And underreporting is more prevalent among people with higher income. One reason is since there are higher prices and less choice of (high-quality) imported goods and services in Belarus, many Belarusians prefer to shop abroad, usually in Moscow, Kyiv, Vilnius, or Warsaw.[22] Of course, these are more affluent people, and the practice is virtually impossible to measure directly. The apparent convergence of income and expenditure inequality over the years (Figure 1.2) thus may mean that the underreporting of expenditures has increased, reaching the level of income underreporting. This phenomenon (when people not only have some "hidden" income, but also spend it secretly) again is virtually impossible to measure. Only some very rough indirect estimates could be constructed, e.g., by using the number of visas issued to Belarusians.[23]

Figure 1.4. Income and expenditure shares of the bottom decile, p.p.



[22] In 2008, Belarusians crossed the state border 12.7 million times for a population of slightly less than 10 million. (State Frontier Committee, retrieved from http://gpk.gov.by/ru-safety-osd/)

[23] Unfortunately, even these estimates necessarily will be biased downwards as Belarusian citizens do not need visas to visit Ukraine or Russia.

Source: Author's own calculations based on the BHBS.

Note: Negative values mean that the income share is lower than the expenditure share for the bottom decile. Any changes are relative to the position of other decile groups.

To shed more light on the possible underreporting of income and expenditures and changes in these practices over time, I decompose the income and expenditures of Belarusian households by income deciles. This decomposition, shown in Tables A2 and A3 (both in Appendix) and in Figure 1.4, reveals two interesting patterns.

First, the shares of decile groups are virtually constant during 1995-2007, with only three exceptions: (a) a huge drop in the *income* share of the poorest 10% of the population, concurrent with the 1998 Russian financial crisis (from 4.2% in 1997 to 2.7% in 1998 and 3.1% in 1999[24]). The poorest saw their income plummet, but managed to smooth their expenditures during the crisis by borrowing; (b) a drop in the expenditure share of the poorest decile from 3.6% in 2004 to 2.4% in 2005. In 2005, the retirement benefits were increased and many pensioners (who according to normal economic logic should be dissaving or at least less prone to save) left the bottom decile, so the number of "savers" among the poor increased; (c) a gradual decrease of the expenditure share of the richest 10% (but not of the corresponding income share). This is the primary reason for the overall decrease in expenditure inequality (Figure 1.2), but it may correspond to an increase in expenditure underreporting.

Second, except for the poorest 10% of the population (whose income and expenditure shares change considerably from one year to the next), the difference between income and expenditure shares decreases with the increase of income, but hardly changes over time. The poorest have income shares that are considerably higher than their expenditure shares, while the richest have expenditure shares that are higher but decreasing. Indeed this is a sign of income underreporting among richer Belarusians, but there is no sign that this practice is on the decline—on the contrary, it seems to be accompanied by a growing underreporting of expenditure.

[24] Taking into consideration the overall decrease of income, this relative drop is even higher in absolute terms.

1.6 Belarus versus Ukraine

1.6.1 Transition paths and inequality

Ukraine is the best "reference country" for Belarus—similar in many respects (e.g. the structures of the industry or the transition paths in the 1990s) different in others (e.g. the political situation and the government transfers). Belarus and Ukraine are also very close historically, culturally, and economically. To keep the comparisons simple and save space, I compare the "snapshots" of the two economies in 2002—by that time both countries had already undergone 10 years of transition, and the impact of the 1998 Russian crisis was already absorbed (all figures in this section are for the year 2002 and come from Belarusian and Ukrainian national statistical offices, unless explicitly noted otherwise).

Table 1.3. Inequality decomposition by income sources, % (in 2002)

income source	source's share		source's contribution to inequality (absolute)		source's contribution to Gini index	
	Ukraine	Belarus	Ukraine	Belarus	Ukraine	Belarus
wages	50.1	61.3	48.0	74.3	20.1	17.5
self-employment income	4.0	3.9	4.2	7.1	1.8	1.7
pensions	15.0	15.9	9.7	-0.4	4.1	-0.1
income from land plots	20.1	13.4	25.2	6.3	10.5	1.5
other	10.8	5.5	12.9	12.7	5.3	3.0
Total	100.0	100.0	100.0	100.0	41.8	23.6

Source: Author's own calculations based on the BHBS and the UHBS.

Note: The decomposition by income sources was performed in Stata using the ineqfac .ado module. Individual values may not sum up to 100% due to rounding.

Ukrainian households were getting a half of their income from wages, 4% from self-employment, 15% from pensions, stipends and other social security transfers, 20% from their land plots (both from sales and in-kind) and the rest from other sources, including 8.6% as "financial assistance received from relatives, friends or charitable

organizations". Overall, the income source shares are quite similar in both countries with two notable exceptions. In Belarus, wages play a more important role (more than 60%), while income from land plots is substantially more important in Ukraine both by share (20% vs. 13%) and inequality contribution (25% vs. 6%).[25]

It may appear that the social security systems are quite similar in both countries, but in fact they are not. The first reason is in Ukraine, the unemployed form 10.3% (official figure[26]) or 17.2% (my calculations from UHBS) of the economically active population, while in Belarus the corresponding estimates are only 3.0%[27] or 5.8% respectively. Yet the average shares and contributions of the unemployment benefits are very close in both countries meaning that in Belarus, unemployment benefits are more generous. The second reason is payment arrears are still widely spread in Ukraine as of 2002 (Berry and Schelzig, 2005) but virtually eliminated in Belarus (World Bank, 2004). Furthermore, the "financial assistance received from relatives, friends or charitable organizations" is very significant in Ukraine (8.6% of total income), while in Belarus it is not.[28]

As for the expenditures, Ukrainian households spent on average 123.5 USD[29] per month and per household, of which 59.1% was on food, while in Belarus households spent 154 USD and with the food share being only 43.9%, suggesting that Ukrainian households are on average poorer than Belarusian ones. Ukrainian households also spend more than they get (on average), which can be explained by borrowing and income underreporting.

I calculate the Gini and Theil indices for Ukraine using the micro-data from the

[25] I investigate the phenomenon of small land plots in more detail in the second essay of this dissertation.

[26] Retrieved from http://www.ukrstat.gov.ua/operativ/operativ2006/rp/prc_rik/prc_r/osp_rik_r.htm on April 28, 2011.

[27] Retrieved from http://www.belstat.gov.by/homep/ru/indicators/svodn_2000-2005.php on April 28, 2011.

[28] According to the Migration and Remittances Team (Development Prospects Group, World Bank), the officially recorded inflow of remittances in 2002 was 141 million USD in Belarus and 209 million USD in Ukraine, while the outflow was 68 million USD from Belarus and only 15 million USD from Ukraine. However, "the true size of remittances, including unrecorded flows through formal and informal channels, is believed to be larger." (World Bank, 2008)

[29] All conversions into USD were performed using the market exchange rate.

Ukrainian HBS and the same methods and formulas I applied to BHBS. The results for Ukraine are the following: Gini coefficients for income/expenditure are 0.418/0.411, and for Theil are 0.291/0.280. Note that the coefficients for income and expenditure are very close, in fact their 95% confidence intervals overlap. Note also that in Ukraine, the inequality of income is higher than the inequality of expenditure, which is more intuitive than in the Belarusian case.

Table 1.4. Decile shares of income and expenditure, % (in 2002)

Decile	Income share			Expenditure share		
group	Ukraine	Belarus	difference, p.p.	Ukraine	Belarus	difference, p.p.
bottom 10%	0.9	3.7	-2.9	1.3	3.2	-1.9
2	2.9	6.0	-3.0	2.9	5.1	-2.1
3	4.2	7.1	-2.9	4.3	6.2	-1.9
4	5.6	8.0	-2.4	5.8	7.2	-1.4
5	7.0	8.8	-1.8	7.2	8.3	-1.0
6	8.8	9.7	-0.9	8.8	9.4	-0.6
7	10.9	10.7	0.2	10.9	10.7	0.2
8	13.7	12.1	1.7	13.6	12.4	1.2
9	17.6	14.1	3.6	17.3	14.9	2.4
top 10%	28.4	20.0	8.4	27.9	22.7	5.2

Source: Author's own calculations based on the BHBS and UHBS.

Note: A negative difference means that the decile group in Ukraine is getting a lower income (expenditure) share than the same decile group in Belarus. The bigger the negative difference, the poorer the Ukrainian decile is relative to the Belarusian decile and vice versa. Individual values may not sum up to 100% due to rounding.

The comparison of decile shares for income and expenditure in Table 1.4 reveals additional interesting patterns. Income and expenditure decile shares are almost equal in Ukraine but very different in Belarus (see section 1.5.3 for a discussion). Nevertheless, the distribution of income is clearly more compressed in Belarus.

A World Bank (2007) country brief characterizes Belarus as having a "...compre-

hensive social security and good basic health and education services [that] have been sustained since independence and remain available." Another World Bank (2004) report states that "...the Republic of Belarus has a well-developed system of social support. More than 14% of GDP or 31% of the consolidated budget expenditure in 2002 was channeled to social assistance and insurance programs.[30] In addition, it is estimated that quasi-fiscal social transfers by enterprises were equivalent to about 2-3% of GDP" (p.59). As for Ukraine, a similar report (World Bank, 2005) explains: "The differences in coverage and on pension benefits across income groups result in a regressive incidence. Pension benefits are similar across beneficiary households, with the poor earning 8 percent lower pensions compared to the better off. These smaller pensions, combined with [a] slightly lower coverage of pensions among the poor result in an unequal distribution of benefits... There are major gaps in terms of coverage and targeting of the poor" (p. 45). This explains why pensions played an important role in reducing inequality in Belarus, at least before 2005, but not in Ukraine.

On the other hand, the share of people working at state-owned enterprises is high in Belarus, decreasing from 60% in 1995 to circa 50% in 2008. In Ukraine, this share was much lower already in 1999, reaching only 31%.[31] Because wages are by far the most important sources of income and contribute to inequality in both countries, this should explain, at least partially, the lower inequality levels in Belarus.[32]

My overall conclusion about the transition paths of the two countries is that they started their transition with the same initial conditions (including very similar income distributions), and by 2002 they had grown apart in some features (e.g. employment at state-owned enterprises and social transfers), but remained close in others (e.g. weak development of self-employment and unnaturally low official levels of unemployment).

[30] However, among all social security transfers, only pensions play a significant role, while all other transfers (e.g., unemployment benefits) are negligible and received by few households.

[31] Retrieved from http://www.ukrstat.gov.ua/druk/katalog/kat_e/cat8_e.htm on April 28, 2011.

[32] Confirming this conclusion, Pastore and Verashchagina (2006b) document a dominant role of the Belarusian state in the distribution of wages.

1.6.2 DFL Counterfactual Kernel Densities

The decomposition of inequality by income sources provides some explanation of different inequality levels in Belarus and Ukraine, but what factors are more important in accounting for these differences: (1) differences in the income structure or (2) differences in the distribution of characteristics of the people?

The most common approach used to compare and decompose gender and other earning differentials is the Oaxaca (1973) decomposition. This approach, however, is limited to explaining differences in *means* of wages and mean characteristics. DiNardo, Fortin and Lemieux (1996), hereafter DFL, have developed a methodology for decomposing *the entire densities*. They present a way of studying the effect of changes in structural variables on the distribution of income (wages, expenditure, etc.) and in particular on income inequality. Their semiparametric approach is based on the construction of counterfactual densities by re-weighting the original population according to the changes in underlying characteristics, generalizing the ideas of Oaxaca. The DFL procedure allows us to refer to the distribution as a whole, instead of focusing on specific aggregate measures.

The DFL methodology can be presented as follows: Each individual observation is viewed as a vector (w, z, t), where w is the wage (or income/expenditure), z is the vector of individual attributes, and t is the date. The joint distribution of wages and attributes conditional on the date can be defined as $F(w, z|t)$. The density of wages at some time, $f_t(w)$ is then expressed as the integral of the density of wages, conditional on some individual attributes and on the date t_w, $f(w|z, t_w)$, over the distribution of individual attributes $F(z|t_z)$ at date t_z, or:

$$f(w; t_w = t, t_z = t) = \int_z dF(w, z|t_{w,z} = t), \tag{1.1}$$

where the set of wages w come from period t_w, and the set of characteristics z come from period t_z.

The counterfactual for z from τ, $f(w; t_w = t, t_z = \tau)$, can be expressed as re-

weighted actual

$$f(w; t_w = t, t_z = \tau) = \int_z f(w|z, t_w = t)\Psi_z(z)dF(z|t_z = t), \tag{1.2}$$

where

$$\Psi_z(z) = \frac{dF(z|t_z = \tau)}{dF(z|t_z = t)} \tag{1.3}$$

Instead of two different dates, one can use other binary criteria, say women/men, employed/unemployed, etc. or compare the populations of two different countries.[33] The continuous version of the DFL method was implemented in Stata software (starting from version 9.0) by de Azevedo.[34]

Using the semi-parametric procedure from DFL, I develop counterfactual densities of total income[35] of Belarusian and Ukrainian populations in 2002. In particular, I estimate the density that would have existed in Belarus if the distribution of demographic and other characteristics of the population was as in Ukraine:

$$f(w; t_w = Belarus, t_z = Ukraine) = \int f(w|z, t_w = Belarus)\Psi_z(z)dF(z|t_z = Belarus) \tag{1.4}$$

and $\Psi_z(z)$ is a "reweighting" function, where

$$\Psi_z(z) = \frac{dF(z|t_z = Ukraine)}{dF(z|t_z = Belarus)} = \frac{Prob(t_z = Ukraine|z)}{Prob(t_z = Belarus|z)} \frac{Prob(t_z = Belarus)}{Prob(t_z = Ukraine)}. \tag{1.5}$$

The weight $\Psi_z(z)$—the probability of living in country t, given an individual's characteristics z—is estimated using a logit[36] or probit model, which predicts the probabil-

[33] Data comparability across countries might be a problem, but not in this case as I am using the data from two identically constructed household budget surveys.

[34] His `.ado` code is based on the original DFL paper and on Van Kerm (2003).

[35] I also construct the counterfactual densities of expenditure. Because the demographic and other characteristics of the population affect income more directly, the distributions of expenditure in the two countries are much closer to each other than the distributions of income. Still, both the actual density for Ukraine and the counterfactual density for Belarus have lower mean and higher variance than the actual density for Belarus.

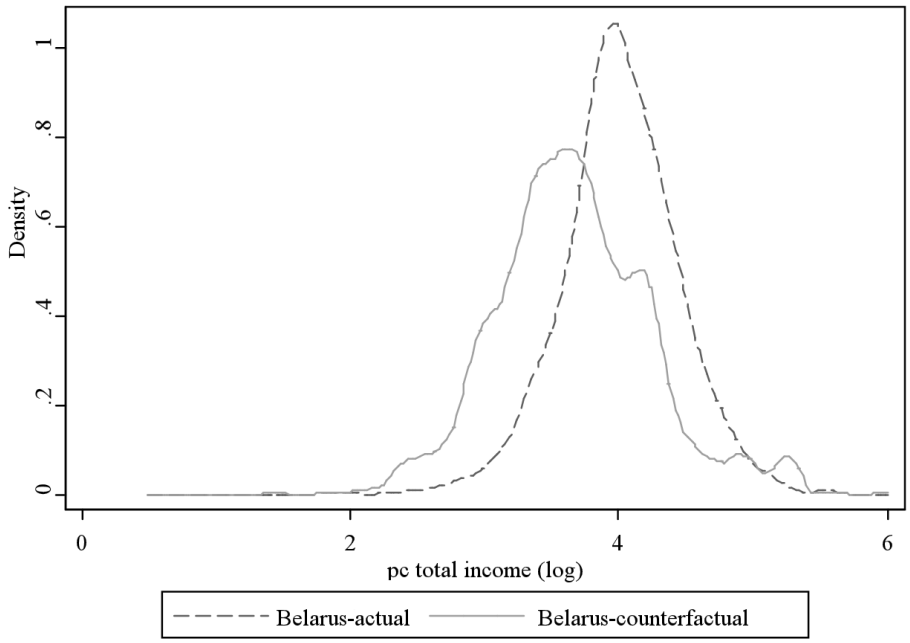
These additional results are available upon request.

[36] The logit model I use is of the form $p(Ukraine = 1) = exp(\beta_0 + \beta_z Z)/(1 + exp(\beta_0 + \beta_z Z))$. The re-weight is created by multiplying the sample weight by $p/(1-p)$, where p is the predicted probability from the logit model.

ity $Prob(t_z = Ukraine|z)$ and $Prob(t_z = Belarus|z)$ for each individual in the sample. Using the re-weighted sample, I then calculate the counterfactual measures of income levels and use kernel density estimates to draw their counterfactual densities. These counterfactual density functions show the income density that would have prevailed in Belarus if the distribution of demographic and other characteristics (age, gender, place of residence: capital/city/town/village, land plot ownership, number of children, education, employment status[37], and socio-economic category: student, retired, self-employed, blue- and white-collar worker) there was as in Ukraine.[38]

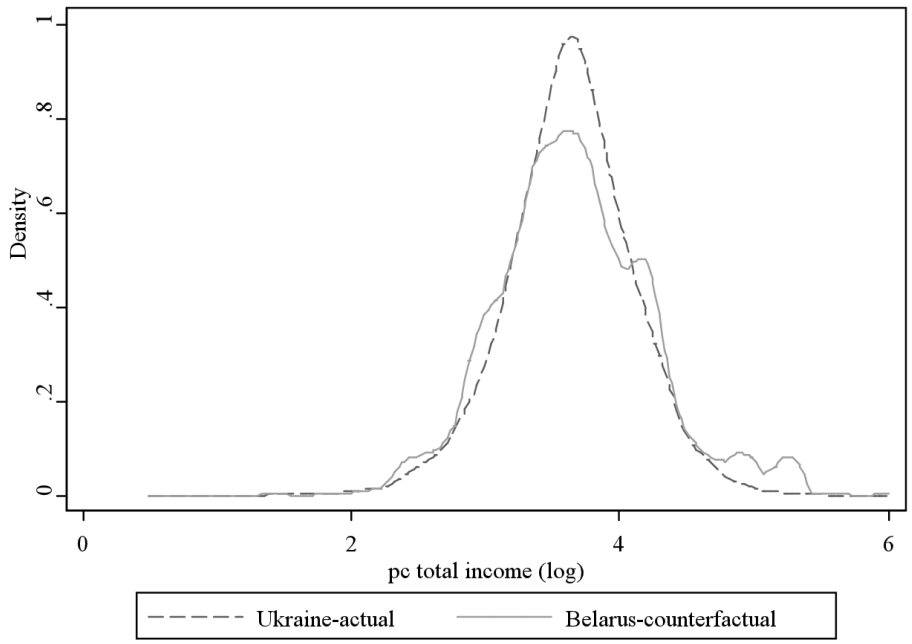
The application of the DFL Counterfactual Kernel Densities method to Belarus and Ukraine in 2002 yields the following results seen in Figure 1.5.

Figure 1.5. The DFL Counterfactual Kernel Densities estimation



[37] Because of very low offcial levels of unemployment in both countries, this factor turns out to be non-significant.

[38] Unfortunately, both HBS do not contain data on whether the respondents work on private or state-owned entreprises.



Source: Author's own calculations based on the BHBS.

Note: Constructed in Stata using the dfl .ado (written by de Azevedo, University of Newcastle).

The first graph compares the actual distribution of income of Belarusians with the counterfactual distribution ("if Belarusians were Ukrainians"). The counterfactual density has a lower mean and a higher dispersion, meaning that if Belarusians were living under Ukrainian circumstances, they would have lower income but higher income inequality (what we do observe in reality). The second graph compares the counterfactual distribution for Belarus with the actual distribution for Ukraine. The two densities are much closer than on the first graph, meaning that the differences are mainly due to different βs (government and labor market conditions) than to different zs (demographic and other characteristics).

The differences in inequality between Belarus and Ukraine should thus be attributed to the different policies of their governments, not to different characteristics of their people as on average both populations have similar education, work experience, age, and other characteristics. The growing share of retirement benefits in the income of Belarusians (see Section 1.5.1, Table 1.1, and Figure 1.3) would suggest that inequality

in Belarus was preserved at low levels (compared to Ukraine) by keeping many of the old Soviet social security features (and government transfers) in Belarus and dismantling/reducing them in Ukraine, but also because most people in Belarus still work at large SOEs.

1.7 Conclusions

Using the data from the Belarusian and Ukrainian Household Budget Surveys (BHBS and UHBS), I find that inequality in Belarus was low and virtually stable in 1995-2008, with a small rise in 1998 due to the Russian financial crisis and a weak upward trend since 2004. This result is the same whether I use Gini or Theil indices and whether I calculate them for income or expenditures.

The inequality decomposition by income sources shows that the income sources with the highest share (wages, pensions, income from the land plots, and self-employment income) have the highest contribution to total inequality, with the share and contribution of wages growing over time and those of self-employment income and income from small land plots decreasing.

The two Soviet republics that had the lowest inequality levels in 1990 have seen a very different evolution of inequality during the transition period: In Ukraine, it almost doubled, in Belarus it remained very close to the pre-transition level. The application of the DFL method to both countries shows that (in 2002) their populations on average had the same demography, employment and other characteristics, and the observed differences in inequality levels are likely due to government policies, such as keeping many of the old Soviet social security features (and government transfers) in Belarus and dismantling/reducing them in Ukraine and by keeping large Belarusian SOEs unprivatized. Another important factor is pensions: they are an important income source in both countries, but in Belarus they contribute to equality, in contrast to Ukraine.

The overall conclusion is that the Belarusian government was quite successful in keeping an egalitarian society as economic growth (6% p.a. on average during the last decade, IMF, 2006) didn't result in a significant increase of income inequality among

people; however, expenditure inequality was noticeably higher.

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Appendix

Inequality measures

There are many measures of income/expenditure inequality[39]; the most popular and widely used is the Gini index[40], which is easily available for virtually all countries and for many years, making possible cross-country and inter-temporal comparisons. It can be calculated for any type of income/wealth as well as for expenditure/consumption, the second option is more preferable because of the systematic under-reporting of income in the surveys in post-Soviet countries (for discussion see, e.g., Yemtsov, 2001). To overcome this drawback, I calculate and report inequality indices for both income and expenditure.

The Gini coefficient is calculated (for the whole population) using the following formula:

$$G = \frac{1}{n}\left(n + 1 - 2\frac{\sum_{i=1}^{N}(n+1-i)\,y_i}{\sum_{i=1}^{N} y_i}\right), \text{ where } y_i \leq y_{i+1}. \tag{1.6}$$

The smaller the coefficient, the less unequal the distribution. When it equals 0, meaning perfect equality, everyone has the same income or consumption, when it equals 1, meaning total inequality, one person possesses all the income.

For a random sample S of size n with the values of y_i ($i = 1$ to n) that are ranked in non-decreasing order, the statistic

$$G(S) = \frac{1}{n-1}\left(n + 1 - 2\frac{\sum_{i=1}^{N}(n+1-i)\,y_i}{\sum_{i=1}^{N} y_i}\right) \tag{1.7}$$

is a consistent estimator of the population Gini coefficient.

The Gini coefficient is the most popular and widely used inequality measure, but unfortunately it is not directly decomposable even though various indirect methods of

[39] They date back to the seminal work of Dalton (1920) and the works of Gini and other Italian researchers.

[40] The Gini index is the Gini coefficient expressed as a percentage.

decomposition exist, e.g., the one proposed by Shorrocks (1982). The contribution of any income source to overall income inequality is:

$$s_k(I) = \frac{S(Y^k, Y)}{I(Y)} = \frac{cov(Y^k, Y)}{\sigma^2(Y)} \text{ for all } Y \neq \overline{y}, \tag{1.8}$$

where Y_i^k denotes the income of the individual i $(i = 1, \ldots, N)$ from the source k $(k = 1, \ldots, K)$; $Y = (Y_1, \ldots, Y_N) = \sum_k Y_k$ represents the distribution of total incomes; $S_k(Y_1, .., Y_k; K)$ represents the absolute contribution of the source k to the total inequality. This decomposition does not depend on the choice of inequality measure, but is usually applied to the Gini index.

Foster, Greer, and Thorbecke (1984) proposed a set of decomposable inequality and poverty measures which allows for the analysis of the relation between poverty and specific household characteristics. One of the special cases of their measures is the Theil Index. This summary statistic measures income inequality based on information entropy. It is similar to, but less commonly used than the Gini coefficient. The Theil index can be expressed as:

$$T = \sum_{i=1}^{N} \left(\frac{y_i}{\sum_{j=1}^{N} y_j} \ln \frac{y_i}{\overline{y}} \right). \tag{1.9}$$

The first term inside the sum stands for the individual's share of aggregate income, and the second term is that person's income relative to the mean. If everyone has the same income, then the index equals 0 (perfect equality). If one person has all the income, then the index equals $\ln(N)$.

The advantage of this inequality measure over the Gini is that the underlying population can be divided into groups using any criteria (regional, demographic, socio-economic etc.), and the Theil index for the whole population will (by construction) be equal to the weighted sum of Theil indices for groups plus the Theil index for inequality between groups, so the Theil index is directly decomposable without any special methods. The Theil index for a country with the population of N people living in K regions can be decomposed into 2 parts:

$$T_{country} = T_{within\_regions} + T_{between\_regions}, \text{ where} \tag{1.10}$$

$$T_{within\_regions} = \sum_{l=1}^{K} \left[\frac{N_l}{N} \sum_{i=1}^{N_k} \left(\frac{y_i}{\sum_{j=1}^{N_k} y_j} \ln \frac{y_i}{\overline{y}} \right) \right] \tag{1.11}$$

(each region K has a population N_K), and

$$T_{between\_regions} = \sum_{l=1}^{K} \left(\frac{y_l}{\sum_{j=1}^{K} y_j} \ln \frac{y_l}{\overline{y}} \right) \tag{1.12}$$

(derived from Conceição and Ferreira, 2000).

Another commonly used inequality measure is the coefficient of variation which is a measure of dispersion of a probability distribution. It is defined as the ratio of the standard deviation σ to the mean μ:

$$c_v = \frac{\sigma}{\mu}. \tag{1.13}$$

The coefficient of variation is a dimensionless number. For distributions of positive-valued random variables, it allows a comparison of the variation of populations that have significantly different mean values. It is often reported as a percentage by multiplying the result of the calculation by 100. The absolute value of the coefficient of variation expressed as a percentage is often referred to as the relative standard deviation (RSD or %RSD).

Apart from the Gini and Theil indices and the coefficient of variation, there are other insightful but less commonly used inequality measures which include the Kakwani measure and Atkinson's social-welfare measures (Atkinson, 1970; Kakwani, 1979, 1981).

Inequality decomposition by factors

The Stata module `ineqfac` provides an exact decomposition of the inequality of total income into inequality contributions from each of the factor components. Shorrocks (1982) proved that there was a unique "decomposition rule" for which inequality in total income across observations could be expressed as the sum of inequality contributions

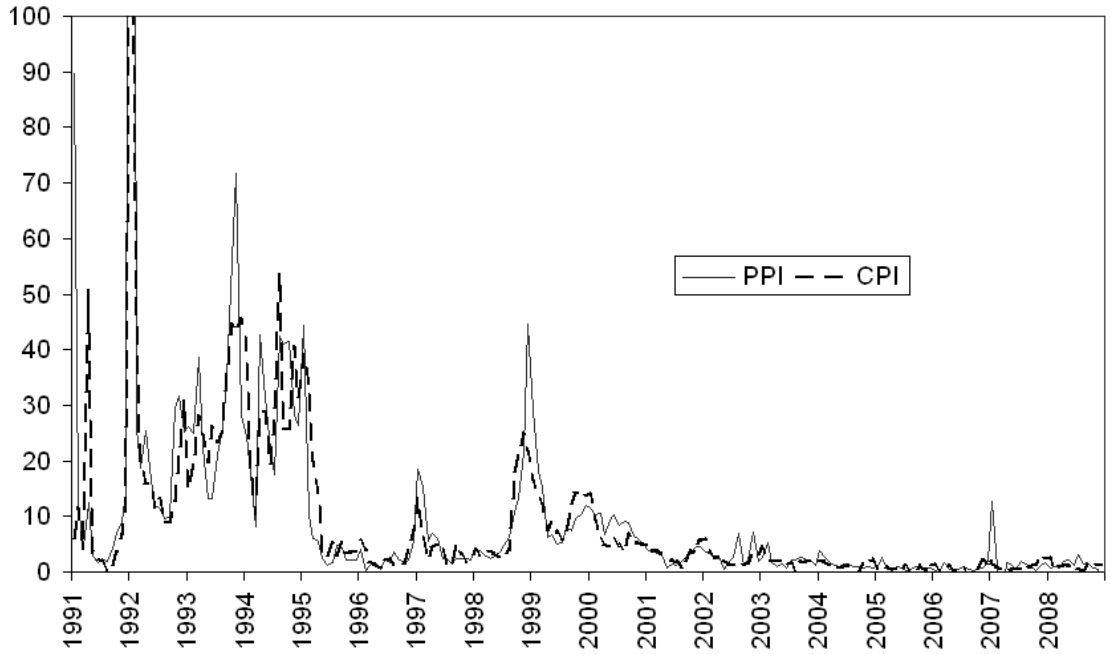
from each of the factor components. The decomposition rule is the "proportionate contribution of factor f to total inequality":

$$s_f = \frac{\rho_f sd(\text{factor}_f)}{sd(total\_income)}, \tag{1.14}$$

where ρ_f is the correlation between f and total income, and $sd()$ is the standard deviation. (Equivalently, s_f is the slope coefficient from the regression of factor f on total income.) For each observation $\sum s_f = 1$. Factor components with a positive value of s_f make a dis-equalizing contribution to total inequality, those with negative values make an equalizing contribution.

Shorrocks showed that the choice of the decomposition rule does not depend on which inequality index is used.

Figure A1. Monthly price indices in Belarus (in %)



Source: IPM Research Center (Minsk, Belarus; http://www.research.by).

Note: In January 1992, when the major wave of price liberalization took place, the CPI and PPI rose 159% and 383% (per month) respectively. This peak is not shown on the graph to keep all other peaks visible.

1.7.1 Table A1. Descriptive macroeconomic statistics

	1995	1999	2003	2007
GDP growth, % p.a.	-10.4	3.4	7.0	8.2
PPI, % p.a.	117.6	245.0	28.1	17.2
CPI, % p.a.	244.0	251.2	25.4	12.1
Market exchange rate, BYR per USD, mid-year	11.5	542.5	2,045	2,140
Exchange rate change, % p.a.	37.6	142.7	12.4	0.3
Average wage, USD	65.2	40.4	123.5	323.0
Registered unemployment, percentage of economically active population	2.2	2.1	3.3	1.2

Source: IPM Research Center (Minsk, Belarus; http://www.research.by); the National Statistical Committee of the Republic of Belarus.

Note: For figures in USD, the market exchange rate is used.

Table A2. Decile shares of income, %

decile group	1995	1999	2003	2007
bottom 10%	4.1	3.1	3.6	4.1
2	6.0	6.1	6.0	5.7
3	6.9	7.1	7.0	6.8
4	7.8	8.0	7.9	7.7
5	8.6	8.9	8.8	8.6
6	9.5	9.8	9.7	9.5
7	10.6	10.8	10.7	10.6
8	12.0	12.1	12.1	12.1
9	14.0	14.0	14.2	14.4
top 10%	20.5	20.1	20.0	20.6

Table A3. Decile shares of expenditure, %

decile group	1995	1999	2003	2007
bottom 10%	3.1	3.0	3.4	3.7
2	4.8	4.7	5.2	5.2
3	5.9	5.8	6.3	6.4
4	7.0	6.9	7.3	7.3
5	8.2	8.0	8.3	8.3
6	9.4	9.2	9.3	9.4
7	10.7	10.6	10.7	10.6
8	12.6	12.5	12.3	12.2
9	15.2	15.3	15.0	14.8
top 10%	23.3	24.1	22.2	22.1

Source: Author's own calculations based on the BHBS.

Note: The tables give the shares of income (expenditure) by population income (expenditure) deciles.

Chapter 2

Second agriculture in Belarus and Ukraine: subsistence or leisure?[1]

Abstract

In many post-Soviet countries, more than half of all urban households use small land plots to produce significant agricultural output even though their members have paid jobs or collect state pensions. Existing studies suggest that in Russia such "second agriculture" helps smooth consumption during times of economic uncertainty. Using household budget survey data, I study the role of "second agriculture" in Belarus and Ukraine, two countries that differ significantly in the coverage of their social safety nets. I find that in both countries most urban households use their small land plots for leisure, and since the mid-1990s, they tend to move away from this activity. The Ukrainian urban poor indeed use the "second agriculture" to substitute for the lack of social transfers, while in Belarus the poor are better covered and for them it is more of a leisure activity.

Keywords: Belarus, Ukraine, transition, social security, second agriculture, small land plots, consumption smoothing

JEL classification: D13, H55, I32, I38, J43, Q12

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2.1 Introduction

In times of economic uncertainty that are characterized, among others, by high inflation and real price adjustment periods, formal social safety nets in less developed countries often fail to provide adequate coverage, so people have to turn to various informal mechanisms of insuring their consumption levels. One of these mechanisms is known as the "second agriculture".[2] In many transition countries of Central and Eastern Europe and the former Soviet Union, more than half of all households are involved in this "second agriculture"[3], and this activity is widely spread not only among rural (as in the developing countries), but among urban households as well. Existing studies, which are mainly focused on Russia, suggest two main reasons for the existence of "second agriculture" in transition countries: (1) it serves as a consumption smoothing mechanism during the times of economic crises—to complement or sometimes even substitute for the inefficient formal social security systems—and (2) it is a cultural and historical phenomenon (this includes all non-economic reasons to use small land plots).

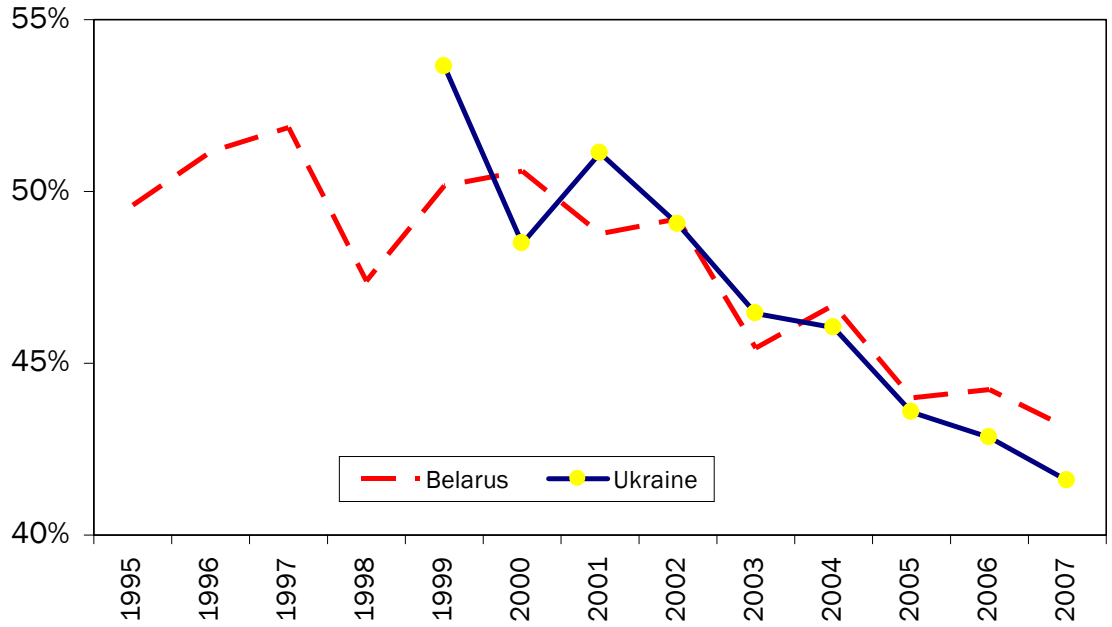
Unfortunately, there is almost no research on "second agriculture" and its effect on poverty or inequality in post-Soviet countries other than in Russia, mainly due to the lack of suitable data. This gap in the research is important as post-Soviet governments often differ dramatically in their ability to provide income insurance and social guarantees to their citizens. A case in point is the comparison of Belarus and Ukraine: two countries that have tight economic, historical, and cultural links and have started their transition from very similar initial conditions, but have had quite different transition paths, including the social security systems they have built. A

[2] The second agriculture is the home production of food on small land plots, as opposed to the "first" industrial - agriculture that is large-scale agricultural production for the market. It is also called *independent agriculture*, *individual agriculture*, *subsistence agriculture*, *household agriculture*; *family farming*; *home gardening*, *agricultural home production*, and *household food production*. The parcels of land used in the process are called *small land plots*, *household plots*, *personal subsidiary plots*, *home gardens*, *garden plots*, *private plots*, *plots of rural households (LPH)*, and *dachas*, gathered together in *subsidiary farms* or *horticultural associations*.

[3] My estimates from Belarusian and Ukrainian Households Budget Surveys show that approximately two-thirds of all households use small land plots in those countries, which is consistent with the data provided by the national statistical offices. In Russia, according to the Goskomstat (the State Statistical Committee of Russia), this figure is lower but still greater than 50%.

World Bank (2007) country brief characterizes Belarus as having a "...comprehensive social security and good basic health and education services [that] have been sustained since independence and remain available." In Ukraine, on the other hand, "the set of government transfers still require better coverage of [sic] the poor and [a] better targeting of transfers... (p. XVIII) There are major gaps in terms of coverage and targeting of the poor" (World Bank, 2005, p. 49). These differences in social security systems could imply that "second agriculture" plays different roles in Belarus and Ukraine, providing more consumption-smoothing insurance in Ukraine, where social safety nets are less comprehensive. However, the general evolution of the share of urban households that use small land plots suggests otherwise.

Figure 2.1. The share of urban households that use small land plots (SLPs) in Belarus and Ukraine



Source: Author's own calculations based on the Belarusian and Ukrainian Household Budget Surveys (the BHBS and the UHBS).

Belarus and Ukraine have roughly the same share of urban households that use[4]

[4]They can own or rent them, though neither Belarus nor Ukraine has a real market for (agricultural) land. Numerous obstacles, mostly administrative, prevent land plots from being sold and bought freely. It is especially difficult to "convert" the land defined as "agricultural" to any other use.

small land plots (SLPs thereafter) and this share goes down with time, as Figure 2.1 shows. Almost all rural households (97-98%) use SLPs and this figure does not change over the years. However for the poor, the effect of social transfers on SLPs is different:[5] in Ukraine the correlation is negative, meaning that SLPs are used as a substitute for the gaps in social security. In Belarus it is positive, implying that the poor use the income from SLPs to complement other sources of income and for leisure.

In this essay, I use household budget surveys from Belarus and Ukraine to quantify and explain the roles of the "second agriculture" in both countries. The structure of the essay is as follows: Section 2.2 reviews the literature; Section 2.3 describes the data used; Section 2.4 discusses the results, and Section 2.5 concludes.

2.2 Literature review

There is extensive literature on livelihood sustainability and consumption smoothing under conditions of economic uncertainty. This literature (including Rosenzweig, 1988; Deaton, 1989 and 1992; Paxson, 1992 and 1993; Townsend, 1995; Udry, 1995; Ersado, 2006; Kazianga and Udry, 2006; and many others) concludes that most households try to avoid extended periods of dependence on only one source of income, suggesting that income diversification is the key way of *ex ante* (e.g. self-insurance against risks in the context of missing insurance and credit markets) or *ex post* (e.g. extra jobs taken on to make up for the decline in income) risk management for those households that anticipate or face adverse economic conditions. This literature is especially large for developing countries, and it mostly focuses on rural areas, estimating the share and explaining the significance of non-farm income.

There are also studies of consumption smoothing and social safety nets in Russia[6]

[5] Yet another difference between Belarus and Ukraine is that in Belarus, second agriculture appears to have an equalizing effect. The inequality of income and expenditure is almost always higher among the households who do not use small land plots than among those who do. The differences are the biggest during the crisis of 1998, when small land plots seem to have had an equalizing effect. In Ukraine, SLPs have a much higher contribution to total inequality—25% versus only 6% in Belarus in 2002 (see the first chapter of this dissertation, published as a CERGE-EI WP in 2008).

[6] To my knowledge there are no analogous, or even similar, studies for the post-Soviet countries other than Russia probably because such very rich data sets as the RLMS do not exist for the other

(e.g. Lokshin and Ravallion, 2000; Buckley, Cartwright, Struyk, and Szymanoski, 2003; Lokshin and Yemtsov, 2004; and others) and in some Central and Eastern Europe countries (Kostov and Lingard, 2002; Mathijs and Noev, 2004).

Kostov and Lingard (2002) study subsistence agriculture in Bulgaria. They find that its existence is largely non-commercial, but of what they call "a general economic nature" (p. 93) due to a long tradition of the "household food self-sufficiency" (p. 91). They argue for creating mechanisms to increase the market orientation (that already existed before the transition) and the market efficiency of SLPs, and to speed up the process of their "commercialization". Mathijs and Noev (2004) study SLPs in Albania, Bulgaria, Hungary, and Romania. They also look for explanations of why these small-scale farms are virtually not included in the market. They find that social security systems would play a key role in solving the subsistence problem, but again improvements in the land markets are necessary in all four countries.

Studies of the effect of the 1998 crisis in Russia on the Russian population find that SLPs did play a role as a consumption smoothing mechanism. Gerry and Li (2007) and Stillman (2001) estimate models of consumption smoothing in Russia. They find that home production does play an important insurance role for the poorest and most vulnerable households. Southworth (2006) asserts that in Russia, SLPs are more of a survival mechanism than a leisure activity of the rich. He shows that urban households turn to home agricultural production in times of economic uncertainty and that their SLPs are profitable. Lokshin and Yemtsov (2004) confirm that Russian households increased their home agricultural production during the crisis. However, they also find that many of the poor did not use SLPs at all, and households from a higher decile seemed to use their land more (mainly because owning land is expensive). Notten and de Neubourg (2007) confirm the role of SLPs as a consumption smoothing mechanism but do not find any differences in agricultural home production across income quantiles. They explain this finding by cultural aspects (such as preferences on leisure activities) and by the suggestion that SLPs in Russia are used more as "an income smoothing

countries of the region.

strategy as opposed to a specific risk/shock response strategy" (p. 41).

These papers find that the Russians tend not to rely much on the government in times of economic uncertainty. Lokshin and Yemtsov (2004) quote the survey data from the 1990s, where only 4-5% of households "would primarily rely for help in need" on the state social security. A partial explanation for this result is arrears in payment of government transfers (including pensions), very prevalent in Russia in the 1990s but virtually non-existent in Belarus. Lokshin and Ravallion (2000) document that while on average government transfers fell by 18% between 1996 and 1998, their targeting improved.

Some other articles consider "second agriculture" in the former Soviet Union as mainly a cultural phenomenon. This stream of (mostly sociological) articles includes Wegren (1994, 1996); Buckley and Gurenko (1997); Ioffe and Nefedova (1998); White (2000); Lovell (2002); Koenker (2003); and Zavisca (2003). Their main premise is that SLPs in the former USSR are used mostly for leisure.

My contribution to these streams of literature is not only in studying countries not previously described in the literature, but also in contrasting the roles of "second agriculture" in two countries with quite different social safety nets.

2.3 Data

The data used for this essay are pooled cross-sections from annual household budget surveys: the Belarusian Household Budget Survey (BHBS) from 1995 to 2008 and the Ukrainian Household Budget Survey (UHBS) from 1999 to 2007, obtained from the national statistical offices of both countries. Since both household budget surveys use the same methodology, the data are sufficiently comparable. Each cross-section contains approximately 5000 (for Belarus) or 9000 observations (for Ukraine) representative of the population of the respective country. Each observation includes detailed information about the household and its members; a breakdown of income and expenditures by categories; detailed data on food consumption; and information about their dwellings. The data on income and expenditure are monthly averages for a given year. They are

collected quarterly using a diary completed by household and survey questions asked by interviewers.

These are arguably the best datasets to study and compare different aspects of income and consumption in Belarus and Ukraine. However, for the purposes of this research the data have some drawbacks:

(1) We cannot follow the same households over time and observe the changes in use of individual SLPs.

(2) For those people who work for wages, there is no information on whether they are employed by a state-owned or a private enterprise.

(3) There is no information on hours worked either on the SLPs or on the main jobs.[7]

(4) There is no data on the size of the SLPs, only the number of them (if a household uses more than one).

(5) The survey in Ukraine started only in 1999; there is no pre-crisis data.

Nevertheless, these household budget surveys data are the best available for Belarus and Ukraine; they are sufficient to reach meaningful conclusions.

The descriptive statistics are reported in Tables 2.1.A and 2.1.B.

[7]Such data exist, but the Belarusian statistical office decided not to make them available to outside researchers.

Table 2.1.A Descriptive statistics, Belarus

Variable	N	Mean	SD	Min	Max
Residence: city	150346	0.32	0.47	0	1
Residence: capital	150346	0.13	0.34	0	1
Male HH head	150346	0.52	0.50	0	1
Age of the HH head	150346	49.32	14.25	18	99
HH head - Incomplete secondary education or less	150346	0.19	0.39	0	1
HH head - Higher (university) education or more	150346	0.17	0.37	0	1
Blue-collar worker HH head	150346	0.40	0.49	0	1
Retired HH head	150346	0.21	0.41	0	1
Unemployed HH head	150346	0.02	0.14	0	1
Self-employed HH head	150346	0.03	0.16	0	1
Wages	150346	112900.7	119689.9	0	1136774
Self-employment income	150346	4748.73	28196.87	0	1062891
Pensions	150346	28533.65	45911.16	0	509543.9
Social support	150346	3149.77	10280.19	0	325238.7
Assistance received by HH	150346	6762.55	19631	0	1138482
Male	150346	0.41	0.49	0	1
Age	150346	45.23	17.44	18	129
Incomplete secondary education or less	150346	0.20	0.40	0	1
Higher (university) education or more	137651	0.16	0.37	0	1

Source: Author's own calculations based on the Belarusian Household Budget Survey (the BHBS).

Note: All income variables are in Belarusian roubles and on the household level, normalized using CPI and the base year 2000.

Table 2.1.B Descriptive statistics, Ukraine

Variable	N	Mean	SD	Min	Max
Residence: city	150770	0.31	0.46	0	1
Residence: capital	150770	0.04	0.20	0	1
Male HH head	150770	0.48	0.50	0	1
Age of the HH head	150770	54.18	15.89	18	101
HH head - Incomplete secondary education or less	150746	0.26	0.44	0	1
HH head - Higher (university) education or more	149435	0.17	0.37	0	1
Blue-collar worker HH head	150770	0.47	0.37	0	1
Retired HH head	150770	0.21	0.41	0	1
Unemployed HH head	150770	0.04	0.21	0	1
Self-employed HH head	150770	0.05	0.50	0	1
Wages	150770	3545.16	5770.61	0	194465.6
Self-employment income	150770	382.82	2803.30	0	351255.8
Pensions	150770	1881.08	2772.42	0	45195.6
Social support	150770	158.76	684.65	0	30796.8
Assistance received by HH	127332	487.41	1586.20	0	124000
Male	150770	0.42	0.49	0	1
Age	149674	48.30	17.92	18	106
Incomplete secondary education or less	150770	0.15	0.36	0	1
Higher (university) education or more	140922	0.16	0.37	0	1

Source: Author's own calculations based on the Ukrainian Household Budget Survey (the UHBS).

Note: All income variables are in *hryvnyas* and at the household level, normalized using CPI and the base year 2000.

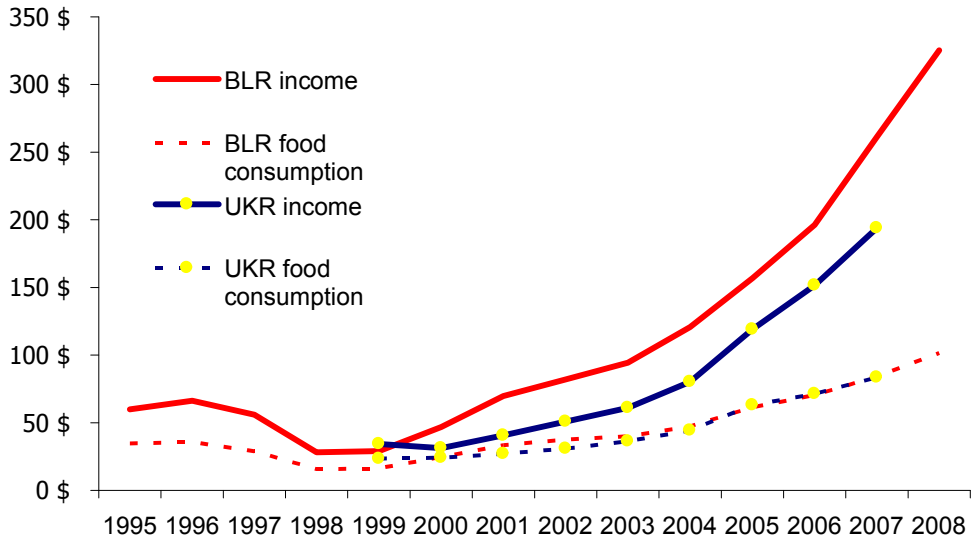
2.4 Small land plots in Belarus and Ukraine

This section is structured as follows. First in Section 2.4.1, I consider the effect of the 1998 Russian crisis on income and consumption in Belarus and Ukraine and the role of the government in alleviating the crisis. In Section 2.4.2, I present the general evolution of SLP usage in Belarus and Ukraine over the years. Then in Section 2.4.3, I study the effect of various factors on SLP usage among the urban poor. Finally in Section 2.4.4, I analyze the consumption-smoothing role of SLPs.

2.4.1 Income and consumption after the crisis of 1998

Before considering second agriculture in Belarus and Ukraine, I need to give some details that will help to see the full extent of the 1998 Russian crisis and its effect on income and consumption in the two countries.

Figure 2.2. Average income and food consumption in Belarus and Ukraine, per household per year, USD market exchange rate



Source: Author's own calculations based on the BHBS and the UHBS.

The crisis noticeably reduced the average income, but the poor were hit the hardest: in Belarus, their income went down three times, from 63 USD per month per household

to only 21 USD.[8] While for Ukraine the HBS data exist only from 1999 onwards, the situation there was similar, except Ukrainians had on average lower income than Belarusians, while spending virtually the same amounts of money on food. This higher share of food expenditures is another sign that Ukrainians are poorer on average.[9]

The share of income going for food consumption that for the bottom deciles was already large (around 60-70%), skyrocketed during the crisis, exceeding 120% for the bottom decile in 1998-1999, meaning that the Belarusian poor did not have enough income even to cover their food expenditures, so they had to borrow or sell their assets. (Another explanation could be an increase in the "shadow economy", not present in the official data, including in the household budget surveys.) In Ukrainem the situation was even worse: not only the bottom but even the second decile had to borrow to buy food up until 2004. The effect of the 1998 crisis on Ukraine in general and on the Ukrainian poor in particular was lasting much longer than in Belarus.

The social support[10] in Belarus was not adequate during this time, though it was better targeted on the poor than the pensions.[11] In Ukraine this support was virtually nonexistent, but pensions were relatively more generous. While government support relative to food expenditure was increasing over the years, especially for the bottom decile (both in Belarus and in Ukraine), during the crisis of 1998 it did not play any significant role—the state was not helping the poor to cover their food consumption. Overall, government transfers in Belarus seem to be more or less adequately targeted on the poor, but still they did not help them sufficiently during the crisis of 1998. In Ukraine they did not help at all.

The crisis also widened the income gap between the poorest and the richest in Belarus. In 1998 and 1999, the bottom decile of Belarusians received more than 10

[8] The market exchange rate was used to convert all numbers from local currencies into USD.

[9] Inequality in Ukraine is much higher than in Belarus—see the first chapter of this dissertation.

[10] I define it as the sum of all government transfers except pensions because the latter are covered by separate legislation in both countries. Pensions are usually paid in full and without arrears because the retired tend to take part in elections very actively, so the governments of post-Soviet countries try not to "disappoint" this part of their electorate.

[11] Pensions (at least in the developed countries of Western Europe) are meant to be a type of social support as State provides some kind of minimal income/services to those who are unable to earn it on their own, e.g. because they are too old to work.

p.p. less income (relative to the top decile) than in 1997. In Ukraine, the gap was even wider, almost reaching 85% in 1999. For the second and the third decile, the gap stayed virtually constant during these years, again pointing to the fact that the crisis of 1998 was particularly difficult for the poorest.

2.4.2 General evolution over the years

The evolution of Belarusian and Ukrainian data related to small land plots over the years of transition show some interesting patterns.

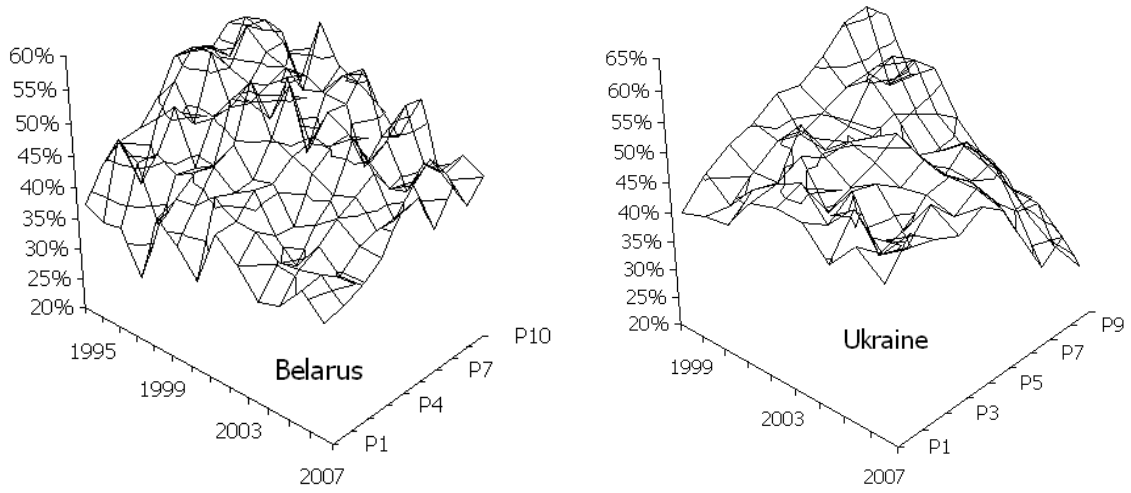
While the share of all households using small land plots decreases by 10 p.p. from almost 70% from 1995 to 2008 in Belarus and from 1999 to 2007 in Ukraine, virtually all (97-98%) rural households use small land plots and this share does not change over the years. The most plausible explanation is that different mechanisms[12] work for urban and rural households in this case. Because of these differences, in the remaining of this section, I will follow only urban households, unless explicitly noted otherwise.

Both capitals, Minsk of Belarus and Kiev of Ukraine, have the lowest shares of households using small land plots (not more than 35%). Other large cities have a higher share (from 40% to 46%), while in small towns it is the highest (from 58% to 73%). Based on Figure 2.1, it may seem that contrary to the predictions of the literature on consumption smoothing, this share *decreased* in Belarus in 1998—the year of the Russian financial crisis that was a major hit to the Belarusian economy, but because of timing this is not true. The crisis started in August 1998, when that year's crop had already been planted and almost completely harvested, so no adjustments could be made and the decrease of SLP use in 1998 in Belarus should be attributed to some downward trend from previous years. In 1999 the share went up, in full accordance with the consumption smoothing premise. The lack of pre-1999 data on Ukraine does not permit one to check whether the same is true for Ukraine as well, but this hypothesis will be testable when (or if) the UHBS data for 2009 and 2010 become available.

[12] In both countries, almost all rural people work in collective farms, or *kolkhozes*—the "first agriculture", so on their SLPs they perform the same activities as at their usual jobs, while all urban workers have jobs other than in agriculture.

While Minsk has the lowest share of households that use small land plots, the inhabitants of Minsk mainly own them, while in other cities and towns households tend to rent instead. In 1998-1999, the share of renters went down in Minsk, which, combined with the overall decrease of small land plot use, would mean that during the crisis those who rented their small land plots were more likely to give them up.

Figure 2.3. The share of urban households that use SLPs in Belarus and Ukraine by income deciles



Source: Author's own calculations based on the BHBS and the UHBS.

While the inhabitants of bigger cities, who in both countries are richer than their compatriots, tend to use SLPs less, the direct relationship between the income and the use of SLPs is the other way round. Figure 2.3 shows that in Belarus it actually goes up with income (in Ukraine the connection is less clear, it changes in the opposite directions for the rich and for the poor).

2.4.3 SLP usage among the urban population

As there can be at least two reasons for a household to use an SLP, one needs a way to distinguish them. The data from both budget surveys contain a variable "*How is the plot (first one) mostly used?*". Unfortunately, it is not very informative as almost all households have chosen the answer "*Grow food not for sale (for family)*".

To be able to distinguish the different purposes of SLPs, I estimate the following

model for all urban individuals older than 18 in Belarus and Ukraine, controlling for time and region fixed effects:

$$slp_{ijt} = \beta' X_{ijt} + \beta'_t t + \beta'_j j + \varepsilon_{ijt}, \tag{2.1}$$

where slp is the dummy variable = 1 if the household uses a small land plot and = 0 otherwise, t is year, j is region, and X includes various explanatory variables.[13]

The regression gives the following coefficients.[14]

[13] Many otherwise relevant characteristics of the household, e.g. the number of children or the number of earners, are correlated with the amount of social transfers and other income variables, so they have to be excluded to avoid multicollinearity.

[14] I speak only about the signs of the effects because the coefficients themselves vary too greatly for any meaningful conclusions from their values.

Table 2.2.A The effect of various factors on the propensity to use SLPs in Belarus by income deciles, 1995-2008 (SLP, probit, urban households, age≥18)

Variable	deciles 1-2	deciles 3-4	deciles 5-6	deciles 7-8	deciles 9-10
Residence: city	-0.712***	-0.726***	-0.698***	-0.569***	-0.525***
Residence: capital	-1.399***	1.77	-1.137***	-1.049***	2.1
Male HH head	0.121***	0.048**	0.032	0.016	0.03
Age of the HH head (*1000)	47.310***	65.219***	99.703***	93.247***	105.329***
Age of the HH head squared (*1000)	-0.369***	-0.464***	-0.760***	-0.717***	-0.796***
HH head - Incomplete secondary education or less	0.084	0.017	-0.072	-0.093*	-0.042
HH head - Higher (university) education or more	0.133**	0.062	-0.056	-0.013	0.105***
Blue-collar worker HH head	-0.152***	-0.083***	-0.046	-0.146***	-0.167***
Retired HH head	-0.089*	-0.224***	-0.093**	0.016	-0.012
Unemployed HH head	-0.201***	-0.044	0.023	-0.222**	-0.182**
Self-employed HH head	-0.087	0.007	-0.011	-0.14	-0.258***
Wages (*1000000)	1.723***	2.948***	1.311***	1.644***	1.525***
Self-employment income (*1000000)	2.322***	2.907***	1.557**	2.290***	1.269***
Pensions (*1000000)	3.811***	5.713***	6.269***	3.774***	3.118***
Social support (*1000000)	**0.177**	**2.960*** **	2.441**	0.657	-0.043
Assistance received by HH (*1000000)	**1.574**	**-0.096**	-1.132	1.037	-1.226***
Male	0.034	0.044*	0.058**	0.048**	0.060***
Age (*1000)	3.399	6.668	8.167*	13.239***	4.381
Age squared (*1000)	-0.021	-0.068	-0.102**	-0.093*	-0.006
Incomplete secondary education or less	0.079	0.072	0.064	-0.015	0.011
Higher (university) education or more	0.017	0.016	0.079**	0.033	0.011
Year effect	yes	yes	yes	yes	yes
Region effect	yes	yes	yes	yes	yes
Observations	12023	17699	16934	14603	20925
Pseudo R-squared	0.113	0.254	0.165	0.138	0.243

Source: Author's own calculations based on the Belarusian Household Budget Survey (the BHBS). CPI data from the BelStat.

Note: * p < 0.1, ** p < 0.05, *** p < 0.01. HH = household. All income variables are at the household level, normalized using CPI and the base year 2000.

Table 2.2.B The effect of various factors on the propensity to use SLPs in Ukraine by income deciles, 1999-2007 (SLP, probit, urban households, age≥18)

Variable	deciles 1-2	deciles 3-4	deciles 5-6	deciles 7-8	deciles 9-10
Residence: city	-1.120***	-1.072***	-1.216***	-1.297***	-1.477***
Residence: capital	-3.026***	-2.298***	-2.228***	-2.577***	-2.722***
Male HH head	0.368***	0.207***	0.182***	0.244***	0.104***
Age of the HH head (*1000)	13.166***	49.342***	48.984***	49.429***	71.030***
Age of the HH head squared (*1000)	0.024	-0.266***	-0.314***	-0.313***	-0.561***
HH head - Incomplete secondary education or less	0.183***	0.238***	0.424***	0.402***	0.591***
HH head - Higher (university) education or more	-0.099***	-0.083***	-0.008	-0.235***	-0.309***
Blue-collar worker HH head	-0.210***	-0.280***	-0.029	-0.195***	-0.191***
Retired HH head	-0.165***	-0.244***	-0.067	-0.112	-0.136**
Unemployed HH head	-0.140**	-0.256***	-0.197**	-0.144*	0.001
Self-employed HH head	-0.136**	-0.233***	-0.06	-0.189***	-0.151***
Wages (*1000)	-0.208***	-0.393***	-0.289***	-0.177***	-0.013***
Self-employment income (*1000)	-0.356***	-0.419***	-0.198***	-0.181***	-0.010***
Pensions (*1000)	-0.228***	-0.426***	-0.274***	-0.182***	0.006*
Social support (*1000)	**-0.386*** **	**-0.320*** **	-0.192***	-0.140***	0.01
Assistance received by HH (*1000)	**-0.455*** **	**-0.637*** **	-0.382***	-0.235***	-0.023***
Male	0.006	-0.02	-0.002	0.008	0.014
Age (*1000)	2.186	-1.4	6.615	-2.493	10.605***
Age squared (*1000)	-0.019	0.008	-0.065	0.019	-0.086**
Incomplete secondary education or less	0.093**	0.04	0.100**	-0.069	0.03
Higher (university) education or more	0.01	-0.096***	-0.056*	-0.027	-0.059**
Year effect	yes	yes	yes	yes	yes
Region effect	yes	yes	yes	yes	yes
Observations	24036	24076	23811	24532	24093
Pseudo R-squared	0.264	0.327	0.372	0.401	0.374

Source: Author's own calculations based on the Ukrainian Household Budget Surveys (the UHBS). CPI data from the UkrStat.

Note: * p < 0.1, ** p < 0.05, *** p < 0.01. HH = household. All income variables are at the household level, normalized using CPI and the base year 2000.

In both countries, the age, gender, and education of an individual have relatively less importance for the use of SLPs (the coefficients are almost always non-significant) than the age, gender, and education of the household head because the decision of using an SLP is made at the household, not the individual level.[15] If the head is male, the household is more likely to use an SLP (think of single mothers that have no time, money nor other resources for second agriculture). The relationship with the age of the head has an "inverted-U" shape. In Ukraine, less educated people are more likely to live in a household with an SLP; on the other hand, households with white-collar workers as head are more likely to use SLPs than other households. In Belarus, most of the coefficients on education and socio-economic status variables are not significant.

Those living in big cities tend to use SLPs less than those from small towns, the residents of the capitals, even less. Various factors could explain this. For the subsistence use of SLPs, it is the distance to reach the plot which is the larger for bigger cities. For leisure use, it is the wider choice and availability of other leisure activities in bigger cities.

The variables of the most interest are various sources of income. Note that in Belarus they are correlated positively and in Ukraine negatively (almost all of them), but not all of the coefficients are significant. Social transfers are correlated negatively with SLPs in Ukraine, and the coefficients decrease with the increase of income, meaning that the Ukrainian poor use second agriculture as a substitute for insufficient social security. This is further confirmed by a positive (and relatively large) coefficient for the assistance received from relatives and friends. In Belarus, the coefficient at social transfers is positive, meaning that in Belarus, SLPs are more of a leisure activity, than of subsistence, even for the poor. As for the coefficient for assistance, it is statistically non-significant for the Belarusian poor.

[15] In addititon, household members usually share their food and use their dwellings together.

2.4.4 Small land plots and consumption smoothing

SLPs provide a unique opportunity to households to grow their own food, thus reducing their vulnerability vis-a-vis macroeconomic shocks. Their role decreases with income and with time: in the 1990s in Belarus, up to 60% of the food consumption of households in the bottom quintile (almost 75% for the bottom decile) was covered by the crop from the small land plots (for those households that use them). By the middle of the 2000s, this share was cut by half. For the richest quintile, it went down from 50% to almost 20%.

In Ukraine this share was already lower in 1999 (for all quintiles), and since then it went down significantly. Note that for the poor, the share is actually *lower* than for the rich (in Belarus it is vice versa).

It should be noted that in Belarus for the bottom quintile (deciles d1 and d2) the importance of SLPs for food consumption went down abruptly from year 1998 to 1999. The crisis struck in August 1998, when the current year's crops were almost completely harvested. The poor did not increase their use of SLPs in 1998; quite the contrary, they reduced it. On the other hand, the use of SLPs went down for all quintiles in 1998 and up again in 1999 (Figure 2.1). It looks like the poor who already had SLPs when the crisis struck used them very heavily or at least as usual, but for the next year, the share of households using SLPs increased (consistent with consumption smoothing behavior); at the same time, the output of the SLPs went down (probably because the households could not invest enough).

The importance of SLPs is higher for richer Ukrainians than for the poor, but only until the mid-2000s; after 2004, this importance is now the same for all quantiles (quintiles or deciles). This result means that urban households with SLPs get significant output from them, which is consistent with the finding reported in the first chapter of this dissertation: In 2002, income from small land plots contributed 25.2% to the total inequality in Ukraine (10.5 Gini points) and only 6.3% in Belarus (1.5 Gini points).

To study the effect of various factors on the importance of SLPs for food consump-

tion, I estimate the following model for all city-dwellers older than 18 in Belarus and Ukraine, controlling for time and region fixed effects:

$$ilp\_vs\_food_{ijt} = \beta' X_{ijt} + \beta'_t t + \beta'_j j + \varepsilon_{ijt}, \tag{2.2}$$

where ilp_vs_food is defined as the income from SLPs[16] (both in natural produce and monetary form) divided by the expenditure on food, t is year, j is region and X include various explanatory variables. (Many characteristics of the household, e.g. the number of children or the number of earners, are correlated with the social transfers and other income variables, so they have to be excluded, as in the previous sub-section.)

The coefficients obtained from the regression are presented in the following table.

[16] Naturally for the households that do not use SLPs, this income will be zero, so the Tobit model is used.

Table 2.3.A The effect of various factors on the relative importance of income from SLPs for food consumption in Belarus by income deciles, 1995-2008 (ILP vs. food expenditure, tobit, urban households, age≥18)

Variable	deciles 1-2	deciles 3-4	deciles 5-6	deciles 7-8	deciles 9-10
Residence: city	-0.201***	-0.178***	-0.173***	-0.151***	-0.190***
Residence: capital	-0.262	-0.269***	-0.253***	-0.208	-0.256***
Male HH head	0.024***	0.021***	0.003	0.011**	0.034***
Age of the HH head (*1000)	-3.042*	1.215	1.771	0.751	-0.432
Age of the HH head squared (*1000)	0.009	-0.024*	-0.037***	-0.037***	-0.032
HH head - Incomplete secondary education or less	-0.006	0.008	-0.006	-0.002	0.086***
HH head - Higher (university) education or more	0.009	-0.025***	-0.028***	-0.008	-0.005
Blue-collar worker HH head	-0.016*	-0.002	-0.018***	-0.028***	-0.009
Retired HH head	-0.054***	-0.094***	-0.026***	0.051***	0.105***
Unemployed HH head	0.070***	0.037**	0.043**	0.074***	0.015
Self-employed HH head	-0.090***	-0.090***	-0.082***	-0.068***	-0.166***
Wages (*1000000)	-0.431***	-0.343***	-0.262***	-0.271***	-0.228***
Self-employment income (*1000000)	-0.656***	-0.294*	-0.294**	-0.212*	0.024
Pensions (*1000000)	-0.565***	-0.556***	-0.178***	-0.153**	-0.214**
Social support (*1000000)	**0.394**	**1.899*** **	1.538***	0.605**	0.518
Assistance received by HH (*1000000)	**1.988*** **	**1.265*** **	0.829***	0.818***	0.454***
Male	0.014*	0.014***	0.008*	0.013**	0.008
Age (*1000)	2.689*	-0.255	-0.259	1.997*	-0.416
Age squared (*1000)	-0.038**	-0.006	-0.01	-0.028***	0.002
Incomplete secondary education or less	-0.012	-0.019*	0.008	0.017	0.025
Higher (university) education or more	-0.022	-0.007	-0.001	-0.004	0.009
Year effect	yes	yes	yes	yes	yes
Region effect	yes	yes	yes	yes	yes
Observations	12029	17699	16934	14618	20925
Pseudo R-squared	0.175	0.25	0.384	0.297	0.078

Source: Author's own calculations based on the Belarusian Household Budget Survey (the BHBS). CPI data from the BelStat.

Note: * p < 0.1, ** p < 0.05, *** p < 0.01. HH = household. All income variables are at the household level, normalized using CPI and the base year 2000.

Table 2.3.B The effect of various factors on the relative importance of income from SLPs for food consumption in Ukraine by income deciles, 1999-2007 (ILP vs. food expenditure, tobit, urban households, age≥18)

Variable	deciles 1-2	deciles 3-4	deciles 5-6	deciles 7-8	deciles 9-10
Residence: city	-1.761***	-0.194	-0.087	3.327***	1.106***
Residence: capital	-4.689***	-0.744	1.904***	7.455***	6.005***
Male HH head	1.595***	1.717***	0.947***	4.504***	0.458**
Age of the HH head (*1000)	10.165	56.596***	240.964***	955.303***	148.955***
Age of the HH head squared (*1000)	-0.068	-0.197	-2.058***	-7.565***	-1.289***
HH head - Incomplete secondary education or less	1.127***	1.774***	3.594***	19.362***	4.252***
HH head - Higher (univ.) education or more	0.767***	1.557***	2.635***	10.196***	1.459***
Blue-collar worker HH head	-0.38	-0.843***	-0.916***	-5.473***	-1.370***
Retired HH head	0.271	0.085	-0.041	-6.212***	-0.724
Unemployed HH head	-1.109***	-2.297***	-2.787***	-12.958***	-1.969***
Self-employed HH head	-0.763***	-1.102***	-0.835***	-5.747***	-0.978***
Wages (*1000)	-1.822***	-2.010***	-1.494***	-2.969***	-0.259***
Self-employment income (*1000)	-1.678***	-2.288***	-1.642***	-3.039***	-0.296***
Pensions (*1000)	-3.788***	-4.301***	-3.486***	-7.519***	-0.857***
Social support (*1000)	**-2.915*** **	**-3.025*** **	-3.314***	-3.776***	-0.057
Assistance received by HH (*1000)	**-3.934*** **	**-3.341*** **	-2.078***	-4.147***	-0.325***
Male	0.194**	0.019	0.455***	0.308	0.003
Age (*1000)	4.672	-40.892**	-27.661	-304.248***	-24.698
Age squared (*1000)	-0.213	0.15	0.223	2.745**	0.27
Incomplete secondary education or less	-0.310*	-0.354*	-0.543**	-3.097***	-0.923***
Higher (university) education or more	-0.019	0.474***	0.032	0.506	-0.078
Year effect	yes	yes	yes	yes	yes
Region effect	yes	yes	yes	yes	yes
Observations	24036	24076	23811	24532	24093
Pseudo R-squared	0.04	0.095	0.139	0.144	0.309

Source: Author's own calculations based on the Ukrainian Household Budget Survey (the UHBS). CPI data from the UkrStat.

Note: * p < 0.1, ** p < 0.05, *** p < 0.01. HH = household. All income variables are at the household level, normalized using CPI and the base year 2000.

Similar to SLP use, age and education of individual household members have little importance for the importance of SLPs for food consumption, relative to age and education of the household head, especially in Belarus. Again, the relationship with age is shaped as an "inverted-U". In Ukraine, those with less education are using their SLPs more "heavily", with a higher importance on food consumption. As for the socio-economic status of the household head, the importance is the highest for the unemployed.

The correlation of ilp_vs_food with wages, self-employment income, and pensions is negative in both countries, while for social support and assistance from relatives and friends in Belarus it is positive, again implying that their SLPs are not used as a substitute for social security. In Ukraine it is negative, meaning exactly the opposite, especially for the poor, for whom the coefficients are the largest.

My overall conclusion would be that relative to Ukraine, in Belarus, SLPs are more of a leisure activity than a consumption smoothing mechanism, even for the poor. In Ukraine for the poor, the use of SLPs for subsistence is relatively more widespread mainly because of insufficient social transfers, while the rich gradually move away from this as a leisure activity.

2.5 Conclusions

Using data from the Ukrainian and Belarusian Household Budget Surveys (the UHBS and BHBS), I find that in both countries many of the rich use their small land plots for leisure, but they gradually switch away from this activity. As for the poor in Ukraine, some use SLP as a substitute for insufficient social transfers, while others cannot afford them at all. In Belarus, the situation is less dramatic as the poor use the income from SLPs to complement other sources of income.

Compared to Russia, where government transfers did not play a significant role in the 1990s because of payment arrears but whose targeting was improved during the crisis, the poor in Belarus did not get much help from the state in 1998-1999 (this could be one of the reasons that prevented them from using of SLPs more widely for

consumption smoothing), and in Ukraine the state was virtually completely absent.

Paying state subsidies to the poor to run their SLPs could be a way to help them cope with the crisis as this assistance would provide them with both an occupation and some insurance towards their food consumption.

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Chapter 3

Evidence from the Chernobyl accident: the effect on schooling, labor market and health outcomes in Belarus[1]

Abstract

The Chernobyl nuclear accident of 1986 had deleterious health consequences for the population of Belarus—in particular, thyroid malignancies, especially for children below 4 years of age at the time of the disaster. This essay utilizes the natural experiment generated by this accident, which produced a sizable increase in radiation levels in several regions of Belarus irrelative of any other factors. Using the 2001-2008 waves of the Belarusian Household Budget Survey, we estimate the effect of radiation on schooling, labor market and health outcomes among the cohorts and regions that varied in the amount of exposure. We find that younger children coming from the more contaminated regions had more job-related health issues and lower wages than those who were older at the time of the accident or who came from the less contaminated regions. While we do not find an effect on education, this absence could be caused by special privileges for the applicants from the contaminated regions.

Keywords: Chernobyl, Belarus, schooling, education, cognitive, wage, income, employment

JEL classification: I18, I20, Q53, J24

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3.1 Introduction

In less than 20 years of its modern history, the Republic of Belarus experienced several major external shocks that had a serious impact on its economy. Before the ongoing world economic crisis that started in 2008, the Russian crisis of 1998, and the collapse of the Soviet Union in 1991, there was another shock that happened even before Belarus regained its independence: the Chernobyl[2] disaster in 1986. Almost 25 years later, this event still affects the Belarusian economy, and there is an on-going debate over the socioeconomic consequences of this radioactive catastrophe. The goal of this essay is to investigate its long-term impact on health, education, and wages in Belarus.

On April 26, 1986, reactor number four of the Chernobyl nuclear plant at the border of the Soviet republics of Belarus and Ukraine exploded. A series of subsequent explosions and the resulting fire sent clouds of highly radioactive particles into the atmosphere and resulted in radioactive fallout over an extensive geographical area. Large areas of Belarus, northern Ukraine, parts of the Russian Federation were contaminated; radioactive clouds later reached Scandinavia and Western Europe. According to various estimates, up to seventy percent of all radioactive substances has fallen on Belarus, and almost a quarter of its territory has been affected (Reiners et al., 2008). While the medical and physical consequences of the Chernobyl accident have been widely documented in the literature, the long-term socioeconomic consequences of the accident have received little attention with a few exceptions (Almond et al., 2009; Lehmann and Wadsworth, 2009). As many countries increasingly rely on nuclear power as a source of energy and as radioactive waste storage expands and ages, it is important to learn about the possible socioeconomic consequences of potential radiation accidents, including explosions and leakages. Such accidents require a large diversion of state resources to deal with the consequences, and the knowledge of the relationship between radiation, public health, and socioeconomic development will allow the formulation of a more efficient policy response. Examining the links between radiation exposure,

[2]The Ukrainian spelling "Chornobyl" is used less frequently.

health, and labor market outcomes will provide the estimates of the direct and indirect costs of such accidents.[3]

In this essay, we study the relationship between the exposure to radiation in childhood due to the Chernobyl accident and the subsequent health, education, and labor market outcomes using the available nationally representative samples from Belarus. We treat radiation exposure as an exogenous shock because the radiation fallout was distributed randomly enough across Belarus according to the distance to the reactor, the prevailing wind patterns, differential rainfall levels, and local topography. Conditional Independence Assumption for the fallout is satisfied by the nature of this event, as it was completely independent from any future education and labor market outcomes for several reasons: 1) Chernobyl happened long before these outcomes were determined; 2) Chernobyl was not located in the Homyel region of Belarus, but in Ukraine[4] (the exact spot for the nuclear plant was picked by civil engineers according to land structure that is unrelated to the socioeconomic situation of the area); and 3) Wind patterns that determined the fallout were certainly not determined by the socioeconomic situation in Belarus around 1986.

We start our analysis by examining the relationship between the extent of irradiation in the region of residence for persons who were 1 to 10 years old at the time of the accident and sets of health, education, and labor market measures 15 and more years later. We use the differences in radiation dosage by region and by age at exposure to identify the causal effect of the accident on educational attainment, labor market performance, and health using a differences-in-differences estimation. We look at the long-term impact of the radiation on self-reported health measures, education, and labor market performance 15 and more years after the accident by utilizing the variation across regions and birth cohorts. We try to strengthen the validity of our results by

[3]The Chernobyl disaster proved to be the worst nuclear accident ever, to be matched only by the very recent crisis at the Fukushima powerplant in Japan.

[4]There are no nuclear power plants in Belarus, but numerous reactors of the same type RBMK were built in the USSR, some close to Belarusian borders: Apart from Chernobyl, these are Ignalina (Lithuania) to the North-West, Kursk (Russia) to the South-East, and Smolensk (Russia) to the East. ("Russian Federation: Nuclear Power Reactors", Power Reactor Information System - PRIS at http://www.iaea.org/cgi-bin/db.page.pl/pris.db57.htm, accessed August 11, 2010.)

accounting for a range of confounding factors.

Our results suggest that persons living in the affected regions and of younger age at the time of the Chernobyl accident have lower wages. As for the educational outcomes, they are less conclusive possibly due to the privileges that applicants from the affected regions have in the education system of Belarus. We also find an effect on job-related health issues but not on self-reported health status or hospitalization measures. The identification is not 100% clear though, mainly because of the deficiencies in the data, as we use a household budget survey not specifically designed to address our particular research question. To the best of our knowledge, this is the first study to quantify the impact of the Chernobyl disaster on education and labor market outcomes in the Republic of Belarus, the most heavily affected among all countries.

The rest of the essay has the following structure. Section 3.2 summarizes the literature on radiation-induced health effects. Section 3.3 describes the consequences of the Chernobyl accident for Belarus. Section 3.4 describes the data, and Section 3.5 discusses the methodology and identification strategy for estimating the effects of radiation with these data. Section 3.6 presents the results from the reduced-form estimates of the effects of radiation on outcomes. Section 3.7 offers conclusions and a discussion of the results.

3.2 Literature review

Social sciences have long recognized a large positive correlation between health and socioeconomic outcomes such as education, wages, and employment. The link between poor health experienced in childhood and poor education and socioeconomic outcomes in adulthood has been widely documented in the research (Case, Lubotsky, and Paxson, 2002; Case, Fertig, and Paxson, 2005). However, understanding the long-term consequences of a negative health shock received in childhood has presented serious challenges in empirical work due to the endogeneity that arises from the omitted variables and measurement error in the measure of health. Unobservable factors that lead to both poor health and poor economic performance would result in a downward bias

in the OLS estimates of the effect of poor health on socioeconomic outcomes. While the majority of existing empirical studies report only correlational relationships between health and socioeconomic outcomes such as education and income (see literature surveys in Grossman and Kaestner, 1997; Strauss and Thomas, 1998), a growing literature attempts to establish a causal link between poor health and socioeconomic outcomes.

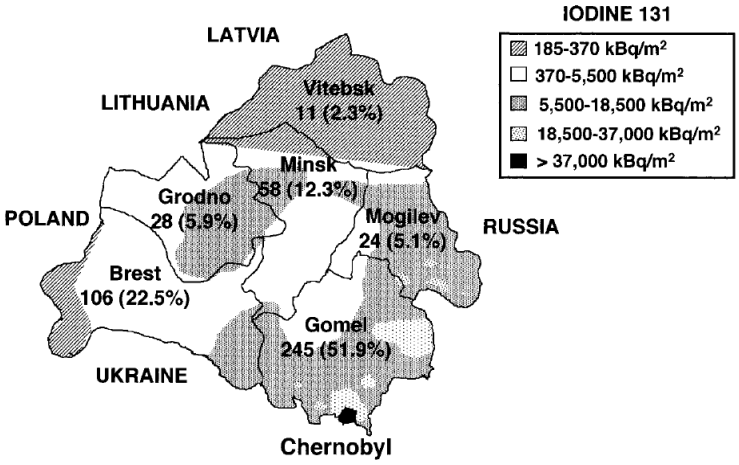
Empirical research that has attempted to estimate this causal effect utilized various strategies, including instrumental variables, within-family comparison using twins and siblings, experimental and quasi-experimental approaches, and generally found a negative impact of poor health on educational and economic outcomes. For example, Kremer and Miguel (2004) use a randomized assignment of a deworming treatment to primary schools in Kenya and find a significant reduction in school absenteeism but no gains in academic performance as a result of treatment. Bleakley (2007) exploits the differential timing of exposure of different birth cohorts to a large-scale public health intervention against hookworm in children in the American South circa 1910 and finds improvement in health, larger gains in income, and higher rates of return to schooling as a result of treatment. Maccini and Yang (2009) use geographical variation in rainfall around the time of birth of Indonesian adults born between 1953 and 1974 and find that higher early-life rainfall has large positive effects on the adult socioeconomic status of women, but not of men, with the benefits mediated by improved schooling attainment. Fletcher and Lehrer (2008) exploit the differences in genetic inheritance among children within the same family and find evidence of poor mental health having a large impact on academic achievement.

Several studies use environmental shocks to identify the effect of health on the socioeconomic status and labor market performance. Almond (2006) exploits the 1918 influenza pandemic and finds that cohorts *in utero* during the pandemic displayed reduced educational attainment, lower income, and lower socioeconomic status later in life. Meng and Xiang (2006) use regional variation in famine intensity in China and find that childhood exposure to famine had significant adverse effects on adult health and work capacity. Reyes (2007) makes use of state-specific reductions in lead exposure

that resulted from the removal of lead from gasoline under the Clean Air Act and finds that the reduction in lead exposure in childhood in the late 1970s and early 1980s was responsible for the significant declines in violent crime in the 1990s.

In the context of literature relying on natural experiments, the Chernobyl accident can be viewed as an exogenous environmental shock to health with an influence that varies by the extent of irradiation. Evidence suggests that exposure to the radiation varied geographically (see Figure 3.1), by age at exposure, and by population density (Lehmann and Wadsworth, 2009). This type of exogenous variation was used in the previous literature to identify the causal effect of health on education and labor market outcomes. Almond, Edlund, and Palme (2009) the utilize variation in radiation fallout in Sweden by region and find the cohort *in utero* during the Chernobyl accident had worse school outcomes than adjacent birth cohorts, and this deterioration was the largest for those exposed approximately 8-25 weeks post conception. Lehmann and Wadsworth (2009) use the variation in the local area level of radiation fallout from the Chernobyl accident as an instrument to establish the causal impact of poor health on labor force participation, hours worked, and wages in the Ukraine and find a positive association between the local area-level radiation dosage and a health perception based on a self-reported poor health status but only a weak effect of poor health on labor market performance.

Figure 3.1. Degree of radioactive contamination and number of post-Chernobyl thyroid cancer cases in children and adolescents in various regions of Belarus



Source: Pacini, Vorontsova, Molinaro, Kuchinskaya, Agate, Shavrova, Astachova, Chiovato, and Pinchera (1998).

Note: The number of cases and percentage of all cases are indicated for each region. Belarus has two official languages: Belarusian and Russian. So, the names of Belarusian cities can have different spellings in English: Homyel/Gomel, Mahilyow/Mogilev, Vitsyebsk/Vitebsk, and Hrodna/Grodno correspondingly.

In this essay, we argue that radioactive fallout from the Chernobyl accident produced disparities in health by age at exposure and region of residence. The magnitude of radioactive contamination was the highest in Belarus compared to any other country due to predominantly southeastward winds at the time of the accident. The most heavily contaminated areas of Belarus are in the Homyel/Gomel[5] region (oblast) followed by Mahilyow/Mogilev and Brest regions. However, certain parts of the country, notably the Vitsyebsk/Vitebsk region and most of the Hrodna/Grodno region, suffered very little. Moreover, Belarus is a relatively homogeneous country with some minor historical and cultural differences along an East-West dimension, but not North-South. A very wide range of radiation dosage across the regions should make identification of the ef-

[5]Belarus has two official languages: Belarusian and Russian. So the names of Belarusian cities can have different spellings in English: Homyel/Homiel/Gomel, Mahilyow/Mogilev, Vitsyebsk/Vicebsk/Vitebsk, and Hrodna/Grodno correspondingly.

fects of radiation more precise. In addition, the effect of radiation was age-specific with children ages 14 and below being more vulnerable and ages 0-4 especially vulnerable to radiation due to radioactive iodine-131 (^{131}I), which concentrates in the thyroid gland (Bespalchuk, Demidchik, Demidchik, Gedrevich, Dubovskaya, Saenko, and Yamashita, 2007; Farahati, Demidchik, Biko, and Reiners, 2000; Reiners, Demidchik, Drozd, and Biko, 2008; IAEA, 2005; Balonov, 2007; WHO, 2006).

3.3 Background on the health effects of Chernobyl in Belarus

3.3.1 Thyroid malignancies

One of the principal radioactive elements released during the Chernobyl accident was iodine-131 (^{131}I), and its release was significant for the first few months. The thyroid gland accumulates iodine from the blood stream as part of its normal metabolism. Iodine-131 was absorbed by the thyroid gland and caused internal irradiation in the vast majority of Belarus inhabitants through inhalation and ingestion of foodstuffs, especially milk, containing high levels of ^{131}I. Among those exposed, children and adolescents received maximum doses. Drinking milk from cows that ate contaminated grass immediately after the accident is considered one of the main reasons for the high doses to the thyroid of children. Consumption of food contaminated with radioactive iodine resulted in significant doses to the thyroid as well.

Even though in 1986 the entire population of the Republic of Belarus was exposed to radioactive ^{131}I, the thyroid doses varied in a wide range, according to age, level of ground contamination with ^{131}I, and the milk consumption rate. Reported individual thyroid doses reached 50 Gy, with average doses in contaminated areas being about 0.03 to few Gy, depending on the region where people lived and on their age.

Childhood thyroid cancer caused by radioactive iodine fallout is one of the main health impacts of the accident.[6] The thyroid gland is one of the organs most susceptible

[6]Reiners et al. (2008) summarize the impact as follows: "Proven radiation related increase of thyroid cancer incidence in children and adolescents (total number of cases approximately 5.000,

to cancer induction by radiation. Children were found to be the most vulnerable population, and a substantial increase in thyroid cancer among those exposed as children was recorded after the accident (IAEA, 2005). Thyroid cancer in children occurs rarely in most countries around the world except for the Republic of Belarus (International Agency for Research on Cancer (IARC) of WHO and the International Association of Cancer Registries, 1998). A strongly age-dependent risk for thyroid cancer was also observed in the Japanese population after the atomic bomb explosions with the highest risk in the group of children below the age of 10. After the Chernobyl accident, children from Belarus living in highly exposed regions received mean thyroid doses by radioactive fallout approximately twice as high as compared to the survivors of the atomic bomb explosions in Japan (Reiners et al., 2008).

There is little doubt in the literature that the Chernobyl accident was responsible for the abnormal increase in thyroid cancer incidence in the affected areas. According to Bespalchuk et al. (2007), three major factors are indicative of the radiogenic nature of thyroid cancer. The first is the high prevalence of the disease; before the Chernobyl accident, the incidence of thyroid cancer was very low both in children and in adults. The second factor is geographical: the majority of children and adolescents diagnosed for thyroid carcinoma lived in the southern areas of the Belarus located close to the place of catastrophe. The third factor is the detected "dose–effect" correlation.

In certain parts of Belarus, an estimated 36.4 per cent of children who were under four when the accident occurred can expect to develop thyroid cancer. Farahati et al. (2000) studied the association between disease severity and age at radiation exposure in a cohort of 483 patients younger than 8 years at the time of the Chernobyl accident who have been diagnosed with thyroid carcinoma. The majority of patients were from the Homyel region and the south-eastern parts of the Brest region. Younger age at the time of the Chernobyl accident was associated with greater cancer complications. Compared with patients who were 6.1–8 years old at the time of the accident, patients who were younger than 2 years had significantly more cancer complications.

highest incidence in age-group 0-4). No difference in risk between males and females".

The researchers believe that the rapid cellular growth that occurs in children under 2 facilitated a quicker and broader development of the cancer. By 2008, radiation was linked to an increase of thyroid cancer incidence in children and adolescents amounting to approximately 5000 cases with the highest incidence in the age group of 0–4 years in 1986 (Balonov, 2007; Reiners et al., 2008).

In addition to cancer, the exposure to Chernobyl's radioactive iodine caused children to have more antithyroid antibodies than other children. These antibodies may cause the children to develop hypothyroidism later[7] (Pacini et al., 1998). Ostroumova, Brenner, Oliynyk, McConnell, Robbins, Terekhova, Zablotska, Likhtarev, Bouville, Shpak, Markov, Masnyk, Ron, Tronko, and Hatch (2009) conducted a study to quantify the risk of hypothyroidism prevalence in relation to ^{131}I doses received because of the Chernobyl accident. They found a significant relationship between the prevalence of hypothyroidism and individual ^{131}I thyroid doses due to environmental exposure. In several studies conducted in Belarus and Ukraine, a significant increase in the rates of juvenile hypothyroidism was reported in children living in radionuclide-contaminated areas compared with children from uncontaminated areas (Goldsmith, Grossman, Morton, Nussbaum, Kordysh, Quastel, Sobel, and Nussbaum, 1999; Quastel, Goldsmith, Mirkin, Poljak, Barki, Levy, and Gorodischer, 1997; and Vykhovanets, Chernyshov, Slukvin, Antipkin, Vasyuk, Klimenko, and Strauss, 1997).

3.3.2 Other health effects of Chernobyl

While thyroid cancer is the most demonstrable health impact of Chernobyl, a number of other illnesses, including lung diseases, digestive and blood disorders, birth defects, fertility problems, and immune deficiencies have a greater incidence in the radiation-affected areas (UNDP 2002). Acute Radiation Syndrome was the most immediate

[7] "Hypothyroidism is an underactive thyroid gland, meaning that the gland cannot make enough thyroid hormone to keep the body running normally. When thyroid hormone levels are too low, the body's cells cannot get enough thyroid hormone and the body's processes start slowing down. As the body metabolism slows, the patient gets becomes tired more easily, becomes forgetful and depressed, and gains weight." Definition taken from the American Thyroid Association, 2010, http://www.thyroid.org/patients/patient_brochures/childhood.html

effect of irradiation due to the release of radioactive particles, which primarily consisted of isotopes of uranium and plutonium (the most toxic), iodine-131, strontium-90, and cesium-137, but it affected relatively few people, mostly those who directly participated in the liquidation of the effects of the disaster on the powerplant itself.

Later on, high levels of radioactive cesium in milk and meat as well as in "wild foods" (e.g. berries and mushrooms) caused major radiological problems. However according to Balonov (2007), since 1986, radiation levels in the affected environments have declined several hundred times because of the natural processes of radioactive decay and countermeasures by the authorities. Therefore, many of the previously contaminated territories are now safe for settlement, agriculture, and other economic activities. Most of the 600,000 emergency and recovery operation workers and five million residents of the contaminated areas in Belarus, Russia, and Ukraine received relatively minor radiation doses, higher but comparable with the natural background levels.

However, apart from the dramatic increase in thyroid cancer incidence among those exposed at a young age, there is no clearly demonstrated increase in the incidence of solid cancers or leukemia due to radiation in the general public in Belarus. Several studies cited a notable increase in psychological problems among the affected population, compounded by insufficient communication about radiation effects and by the social disruption and economic depression that followed the break-up of the Soviet Union (see Lehmann and Wadsworth 2009). Some studies cited "Chernobyl AIDS", which is characterized by a weakened immune system and a susceptibility to cardiac conditions and common infections (bronchitis, tonsillitis, and pneumonia). There have been reports of the effects of Chernobyl on mental health manifested in anxiety and depression. A number of studies have found reduced cognitive functions due to prenatal radiation in the high fallout areas of Ukraine, Belarus, and Russia, e.g., Nyahu, Loganovsky, and Loganovskaja (1998); Kolominsky, Igumnov, and Drozdovitch (1999); and Loganovskaja and Loganovsky (1999). Almond et al. (2009) provide an extensive literature review on the cognitive damage due to the exposure to radiation.

3.4 Data

Our empirical analysis is based on 2001-2008 waves of the Belarusian Household Budget Survey (BHBS). BHBS was started in 1995, and a random sample of approximately 5,000 households are interviewed every year. BHBS represents the most reliable and comprehensive[8] source of micro-data in Belarus. In addition to various demographic and labor force variables, it contains information on self-assessed health status and hospitalizations.

We use two age groups: people born in 1982-1985 (treatment) and in 1976-1979 (control), who are 16-32 years old in 2001-2008. In total, there are 13,441 individuals in the 8 years of data we use, but not all information is available for all of them (see Table 3.1). Because the first half of the 1980s was the time of the highest birth rates in Belarus, the treatment group represents 56% of the data versus 44% for the control group.

Table 3.1. Descriptive statistics, analysis sample

Variable	N	Mean	SD	Min	Max
Rural	13441	0.25	0.43	0	1
City >100,000	13441	0.51	0.5	0	1
Male	13441	0.44	0.5	0	1
Age	13441	23.53	4	16	32
Year born	13441	1980.9	3.19	1976	1985
Year dummy	13441	2004.43	2.3	2001	2008
Young (born in 1982-1985)	13441	0.56	0.5	0	1
High Fallout: Homyel	13441	0.16	0.37	0	1
youngXHigh_Fallout	13441	0.09	0.28	0	1
Medium Fallout: Minsk city, Brest, Mahilyow	13441	0.45	0.5	0	1
youngXMedium_Fallout	13441	0.26	0.44	0	1

[8]Still, the geographic breakdown is by regions (oblasts) only. Unfortunately, BHBS data with a finer breakdown by districts (raions) do not exist.

Variable	N	Mean	SD	Min	Max
Secondary education +	10276	0.99	0.07	0	1
University diploma	10276	0.15	0.36	0	1
Currently employed	8979	0.85	0.35	0	1
Monthly wage, main job (2001 BYR)	8026	12551.14	8501.19	0.03	123000
Number of medical visits	11876	0.71	1.47	0	72
Poor health[9]	10489	0.03	0.17	0	1
Hospitalized	11872	0.14	0.34	0	1
Job health issues	11603	0.03	0.18	0	1
Moved in 1986	13441	0.06	0.25	0	1
Moved after 1986	13441	0.66	0.47	0	1

Source: The authors' own calculations based on the BHBS.

The descriptive statistics for our sample are reported in Table 3.1. Labor market and health variables are standard, but education outcomes need some special explanation. Our variable "Secondary education +" refers to any education[10] beyond basic education, and the variable "University diploma" refers to any diploma of higher education and above.

3.5 Methodology

Our empirical strategy is based on the observed geographic and age differences in irradiation. Given the evidence that southern and eastern regions (Homyel, Mahilyow, Brest) received more fallout than the northern and western regions (Vitsyebsk, Hrodna, Minsk) (see Figure 3.2), we exploit the regional differences in the amount of radiation dose.

[9] As pointed out by Lubomir Lizal, one could expect more people reporting poor health than being hospitalized, if the effects of hypohondria were widely spread. In this case, the higher number of hospitalizations could mean that young people indeed have poor health, but do not feel that way.

[10] School education in Belarus is divided into three levels: primary (4 years), basic (5 more years), and secondary (2 more years)—up to 11 years in total. A child can be admitted to school at 6 or 7 years of age. Primary and basic education are compulsory for all children. At the end of basic education, a Certificate of Basic Education is awarded. 9th grade graduates have three possibilities: 1) a third stage of school education (10-11th grades); 2) vocational/technical establishments; 3) technical schools. Secondary education starts at 15 and is provided by general secondary schools or gymnasiums (10-11th grades), lyceums and colleges (not to be confused with US-type colleges), as well as in first courses of specialized and technical schools. Since 1994, the higher education system includes: a diploma of higher education after 5 years of study (specialist diploma); a bachelor degree certificate after 5 years of study; and a master's after one additional year following the first degree.

Figure 3.2. Thyroid dose patterns for children aged 0–18 years

Source: Kruk, Pröhl, and Kenigsberg (2004), Fig. 13.

Given the higher impact of radiation at early ages, we exploit the variation in age at exposure (1986). Lehmann and Wadsworth (2009) have a similar strategy, they use an indicator for a child (under 13) at the time of the accident interacting with the dummy variable for residence in the affected areas. Almond et al. (2009) argued that young children and those in the womb appear to be more vulnerable to radiation, and used the variation in radiation across Swedish regions to compare the performance of those in utero to the performance of those born before and after 1986. We estimate the following empirical model for a difference-in-differences estimation of the effect of radiation:

$$\begin{aligned} y_{ijt} &= \beta_1' D(young)_{ijt} + \beta_2' High\_Fallout_j + \beta_3' Medium\_Fallout_j + \\ &+ \beta_4' D(young)_{ijt} * High\_Fallout_j + \\ &+ \beta_5' D(young)_{ijt} * Medium\_Fallout_j + \beta' X_{ij} + \beta_t' t + \varepsilon_{ijt}. \end{aligned} \tag{3.1}$$

Here, y_{ijt} is health, education or labor market outcome of person i living in region j in a year t. We consider educational outcomes (having at least secondary education, having a university diploma); labor market outcomes (being currently employed, wage

at the main job); and health outcomes (reporting poor health, reporting being hospitalized in the last 12 months, reporting job health issues, and/or reported number of medical visits in the last 3 months).

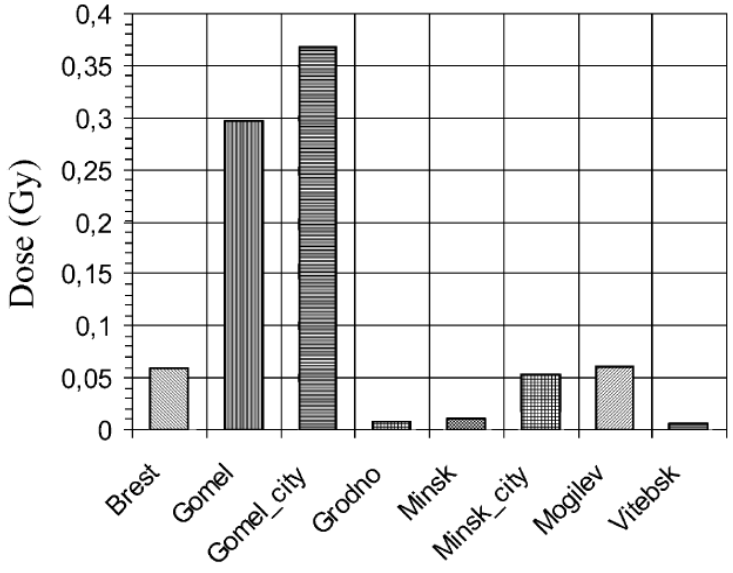
We only use people who were born before the accident. Further, we restrict the earliest year of birth in the analysis sample to be 1985 because we do not observe the exact month of birth and are therefore unable to distinguish between those born before and after April 26, 1986. In addition, since there was a major break in the labor markets in 1991 after the collapse of the Soviet Union, we do not include those who entered the labor force before 1991 and therefore faced similar labor market conditions.[11] Thus, $D(young)_i$ is an indicator variable =1 for a younger age in 1986 and =0 otherwise. Given that the most dramatic increase of thyroid cancer was in children who were under age 4 at the time of accident (Bespalchuk et al., 2007; Kruk et al., 2004; Reiners et al., 2008), we choose our "treatment" group to be 1–4 years old in 1986 (born in 1982–1985), and the "control" group as 7–10 years old in 1986 (born in 1976–1979).[12] The "young" dummy would capture any fixed differences in educational attainment and labor market experiences in a given year between people of different ages, as well as general economy-wide time trends that drive changes across cohorts.

The finest geographic unit available in the data is region (oblast); therefore, we are only able to compare the average radiation exposure across regions. The average thyroid dose received by residents of the Homyel region (0.3–0.35 Gy) was over 30 times the dose in the unaffected regions (Hrodna, Minks, Vitebsk), while the average thyroid dose in other affected regions (Mahilyow and Brest oblasts, Minsk city) was approximately 6 times the dose in the unaffected regions (See Figure 3.3).

[11] Assuming that labor market entry starts at age 16 (most people at this age still continue their secondary education, but some choose not to), we are left with ages 1–10 in 1986 (i.e. ages 6–15 in 1991 and 16–25 in 2001).

[12] We exclude those aged 5–6 during the disaster because there is no consensus in the medical literature about the exact effect of Chernobyl on this age group.

Figure 3.3. Average thyroid doses for the age group 0–18 years in all Belarus oblasts and in the cities of Homyel/Gomel and Minsk



Source: Kruk et al. (2004), Fig. 14.

Therefore, our geographic identifiers are:

$High\_Fallout_j$ is an indicator variable for the Homyel region that received the most radioactive contamination.

$Medium\_Fallout_j$ is an indicator variable for the group of other regions with elevated observed levels of radioactive contamination (Mahilyow and Brest oblasts, Minsk city[13]). These two indicators will control for any fixed differences that exist between the affected and non-affected regions.

Finally, X_{ij} include controls for demographic and socioeconomic characteristics available in the BHBS, such as gender and rural/urban dummy. Year dummies are included to control for general economy-wide trends.[14]

[13]The city of Minsk did not receive more radioactive fallout than the surrounding region, but tens of thousands of people from the most contaminated districts were relocated there, and more people moved there voluntarily from the moderately affected districts—see the next footnote.

[14]We also need to control for potential migration due to Chernobyl. If younger, more productive people migrated at higher rates from the affected regions, our estimate of the effect of Chernobyl, β_{dd} may pick up this phenomenon unless we control for the place of residence at the time of the accident. Migration data are not available in the BHBS, but appropriate questions have been included in the Census of 2009, as of April 2011, data still not available to outside non-governmental researchers.

Our main hypothesis is that the coefficients on interaction variables < 0, i.e. people who were younger in 1986 and lived in the affected regions have lower education, poorer health, and lower wages than those who were younger in 1986 in the non-affected regions, relative to their older counterparts.

3.6 Results

The descriptive statistics for the analysis sample are reported in Table 3.1.

A possible mechanism for the effect of radiation on education and labor market outcomes is through its effect on health. In order to explore this pathway, we look at the effect of radiation exposure on a series of self-reported health outcomes in Table 3.2.

Table 3.2. Regressions for self-reported health variables

Variable	Bad health, probit		Hospitalized, probit	
Young (born in 1982-1985)	0.013**	-0.006	-0.018*	-0.01
High Fallout: Homyel	0.030***	-0.011	0.019	-0.014
youngXHigh_Fallout	-0.006	-0.008	0.015	-0.019
Medium Fallout: Minsk city, Brest, Mahilyow	0.019***	-0.006	-0.009	-0.011
youngXMedium_Fallout	-0.005	-0.007	0.015	-0.015
Moved in 1986	-0.005	-0.006	-0.001	-0.015
Moved after 1986	-0.008**	-0.004	0.009	-0.007
Rural	0.006	-0.005	0.001	-0.009
City >100,000	0.005	-0.004	-0.021**	-0.008
Male	0.005	-0.003	-0.059***	-0.007
Year dummies	Yes		Yes	
Observations	10489		11872	
Pseudo R-squared	0.045		0.014	

Variable	Job health issues, probit		Ln(medical visits)	
Young (born in 1982-1985)	-0.011**	-0.005	-0.02	-0.067
High Fallout: Homyel	-0.001	-0.006	0.258***	-0.083
youngXHigh_Fallout	0.019	-0.011	-0.044	-0.113
Medium Fallout: Minsk city, Brest, Mahilyow	-0.027***	-0.005	0.106	-0.067
youngXMedium_Fallout	0.020**	-0.009	0.048	-0.087
Moved in 1986	0.005	-0.007	0.079	-0.091
Moved after 1986	-0.005	-0.004	-0.012	-0.045
Rural	0.027***	-0.006	-0.133**	-0.06
City >100,000	0.004	-0.004	0.184***	-0.051
Male	0.004	-0.003	-0.220***	-0.042
Year dummies	Yes		Yes	
Observations	11603		3987	
Pseudo R-squared	0.039		0.014	

Source: The authors' own calculations based on the BHBS.

Note: Significance levels: * p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, adjusted for arbitrary heteroskedasticity. For probit regressions, marginal effects are reported. Clustering errors by regions or using logit instead of probit had no effect on the results.

Before turning to our main results, we present a quick overview of the results on the control variables. There is no significant effect of living in a village or in a big city (versus a medium-sized town). *"Poor health"* (self-evaluation) is significantly higher among those from more or less affected regions (Homyel, Brest, Mahilyow, Minsk city) and for those born in 1982–1985. Similar to our finding, Lehmann and Wadsworth (2009) found a significant positive association between the self-reported measure of poor health and residence in contaminated areas in 1986 for all adults living in Ukraine in 2003 and 2004. The probability of *hospitalization* during the last year is hardly affected by any of the explanatory variables, except being born in 1982–1985, living in a big city, and being male (all three are correlated negatively). As for the *number of medical visits* during the last 3 months preceding the interview in December, people from big cities or from the most affected Homyel region had more of them.

The evidence for the effect of the accident on health is not conclusive.[15] The

[15]In the 1990s, the BHBS included a variable *"Chernobyl influenced"* (=1 if a person reported

interaction terms in the regression for *"poor health"* are negative and not statistically significant. On the other hand, the likelihood of reporting *"job health issues"* is higher for those born in 1982-1985 if they come from the regions affected by the Chernobyl disaster. The lack of the effect of Chernobyl on health outcomes and hospitalizations parallels the finding of Almond et al. (2009). However, the radiation doses received by the treated group in that study were an order of magnitude smaller than in Belarus.

Table 3.3. Regressions for educational outcomes

Variable	Secondary educ.+, probit		University dipl., probit	
Young (born in 1982-1985)	-0.002	-0.002	-0.165***	-0.012
High Fallout: Homyel	-0.003	-0.004	0.017	-0.012
youngXHigh_Fallout	-0.001	-0.003	0.016	-0.021
Medium Fallout: Minsk city, Brest, Mahilyow	-0.002	-0.002	0.044***	-0.009
youngXMedium_Fallout	0.001	-0.002	-0.021	-0.013
Moved in 1986	-0.001	-0.002	0.009	-0.015
Moved after 1986	0.004**	-0.001	0.025***	-0.007
Rural	-0.006**	-0.003	-0.066***	-0.007
City >100,000	0	-0.001	0.057***	-0.008
Male	-0.002	-0.001	-0.034***	-0.006
Year dummies	Yes		Yes	
Observations	10276		10276	
Pseudo R-squared	0.095		0.169	

Source: The authors' own calculations based on the BHBS.

Note: Significance levels: * p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, adjusted for arbitrary heteroskedasticity. For probit regressions, marginal effects are reported. Clustering errors by regions or using logit instead of probit had no effect on the results.

We follow by looking at the effect of Chernobyl on the educational outcomes (Table

being seriously or partially influenced by Chernobyl). This indicator may reflect, among other things, non-physical health issues related to Chernobyl, including psychological issues. We find a positive and highly statistically significant association between this variable and all indicators of poor health in the years 1999-2002 (results not shown). Unfortunately, this variable disappears from the BHBS after 2002; therefore we cannot use it.

The extent of the psychological effect on various generations is not totally conclusive: On the one hand, the old could more vulnerable psychologically as they were more aware of what happened at the time of the accident, as pointed out by one of the referees. On the other hand, the young are very perceptive to what they hear from their parents, which can result in a higher psyhological effect on them.

3.3). We do not find a statistically significant effect of exposure to radiation at a younger age on the probability of having at least secondary education (the effect may be biased downwards because some people in our "young" group may still be completing their secondary education). There is no significant effect of Chernobyl on university education either. However, we hypothesize that because of special privileges, applicants from affected regions have higher chances of being admitted to a university. This hypothesis is supported by the positive and significant coefficients for those living in Homyel oblast and in other affected regions. Of course, these privileges are not restricted to people of certain age, so the coefficient at $D(Young)*Medium\_Fallout$ is negative, meaning that those affected by Chernobyl in their early childhood have worse educational outcomes, in spite of the privileges; however, this effect is not statistically significant.

Table 3.4. Regressions for labor market outcomes

Variable	Currently empl., probit		Ln(wage on main job)	
Young (born in 1982-1985)	-0.051***	-0.013	-0.222***	-0.02
High Fallout: Homyel	-0.014	-0.015	-0.033	-0.025
youngXHigh_Fallout	-0.025	-0.024	-0.105***	-0.036
Medium Fallout: Minsk city, Brest, Mahilyow	-0.013	-0.012	0.013	-0.023
youngXMedium_Fallout	-0.016	-0.018	-0.024	-0.035
Moved in 1986	-0.002	-0.016	-0.007	-0.042
Moved after 1986	0.018*	-0.009	0.053**	-0.021
Rural	-0.021*	-0.011	-0.209***	-0.019
City >100,000	-0.003	-0.01	0.125***	-0.016
Male	0.024***	-0.008	0.264***	-0.016
Year dummies	Yes		Yes	
Observations	8979		8026	
R-squared			0.273	
Pseudo R-squared	0.022			

Source: The authors' own calculations based on the BHBS.

Note: Significance levels: * p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, adjusted for arbitrary heteroskedasticity. For probit regressions, marginal effects are reported.

Clustering errors by regions or using logit instead of probit had no effect on the results. Education attainments are not included in the wage regression because they constitute "bad controls", being themselves "outcome variables in the notional experiment at hand" (Angrist and Pischke, 2009); we are interested in the reduced effect of Chernobyl on earnings, including the part of that effect that goes via education.

We continue our analysis by looking at the labor market outcomes: the probability of being currently employed and wages in the current year (Table 3.4). We do not find a significant effect of the Chernobyl accident on the probability of being employed. We find a significantly negative effect on wages for the younger people from the most affected region (Homyel): The coefficient of -0.105 implies that their wages are lower by 10%.[16] Combined with a statistically significant effect of Chernobyl on *"job health issues"* (see Table 3.2) this could suggest that this variable is indeed one of the channels of the effect of Chernobyl on labor market outcomes. However, after adding the variable *"job health issues"*, the effect of *youngXHigh_Fallout* remains statistically significant in the wage regression. After putting this variable into the wage equation yields a coefficient of -0.186 (significant at 1% level), while the coefficient at *youngXHigh_Fallout* decreases at its absolute value from -0.105 to -0.090 (staying significant at 1% level), suggesting that at least 10% of the effect of Chernobyl on wages is accounted for by job health issues.

3.7 Conclusions and discussion

The Chernobyl nuclear accident of 1986 had deleterious health consequences for the population of Belarus (in particular, thyroid malignancies), especially for children below 4 years of age at the time of the disaster. This essay utilizes the natural experiment generated by this nuclear accident, which produced a sizable increase in radiation levels

[16] Pastore and Verashchagina (2006) use a dummy variable equal to one if a person declares that his health was seriously affected by the Chernobyl disaster as one of the explanatory variables in their wage regression. They find that the "Chernobyl wage gap ... was almost zero in 1996 and amounted to about 18% of the median wage in 2001." (p. 365) We can not replicate this result because of two reasons: 1) Our treatment group was still too young in 2001. 2) The question about the effect of Chernobyl on health disappears from the BHBS in 2002.

in Belarus irrespective of any other factors. Using the 2001-2008 waves of the Belarusian Household Budget Survey, we estimate the effect of radiation on schooling, labor market and health outcomes among the cohorts and regions that varied in the amount of exposure. We find that younger children coming from the more contaminated regions had more job-related health issues and lower wages than those who were older at the time of the accident and who came from the less contaminated regions. While we did not find an effect on education, this may be due to the special privileges for the applicants from the contaminated regions.

Our analysis finds some support for the hypothesis that the effect of radiation on education and labor market outcomes can be attributed to the effect of radiation on health based on the self-reported measures. If our hypotheses were supported, we would be identifying a more interesting relationship and answering a more general question: What is the causal effect of health on education and labor market outcomes?

There are several potential caveats to our analysis. First, a potential problem with the self-reported health measures is that individuals tend to assess their health by comparison to those in their immediate surroundings (parents, siblings, and friends). Therefore, children coming from affected families will likely answer that their health appears not too bad by comparison. A family fixed effects strategy could eliminate the measurement error due to such a pattern of health self-reporting.[17]

Second, there is a possibility of differential (and possibly non-linear) trends. Regions that were affected may have experienced pre-existing trends in development (health, education, and labor market) than non-affected regions. Even though Belarus has a relatively homogenous population, some regions may historically be less developed than other regions (in the case of Belarus, East versus West).

[17] The reported health status effect *may* be due to real impacts from exposure, but it also may be a self-fulfilling prophecy since those who were exposed *expect* to have negative impacts on their health and are so sensitive to every little ache and pain. This could also affect doctor visits. Since the most objective evidence is a real disease diagnosis, our measures "job health issues" and "hospitalizations" should better reflect the health effect of Chernobyl. An alternative explanation to our results consistent with Lehmann and Wadsworth (2009) is the psychological effect of disruption to family life of having relocation/refugee status for those living close to the site or even parental stress, which will impact younger children more than older ones.

Third, there may be differential effects on child mortality by level of exposure ("survivor bias"). One example of a bias is when wealthier people live farther from the plant and so their children were more likely to survive. This would bias the effect on labor market outcomes of children. In addition, higher mortality among the affected population would tend to bias our results towards zero. However, according to the medical literature (Bespalchuk et al. 2007, Farahati et al. 2000, Balonov 2007; Reiners et al. 2008), only a tiny fraction of the population developed thyroid cancer (only about 5000 cases per 10 million population by 2008), and very few of these patients died. Most other people develop intermediate stages of thyroid disease, which do not significantly impact mortality rates and only show up in higher morbidity rates. Therefore, survivor bias is unlikely to impact our results significantly.

Fourth, migration occurred within Belarus after the Chernobyl disaster. If those who migrated also had different characteristics related to education and labor market outcomes, then the estimated coefficient would pick up the effect of selective migration, biasing the effect of irradiation on the outcomes. However, it should be noted that migration in the USSR (especially in the rural areas) was strictly controlled by the government due to the institution of "propiska". This made migrating to another region very difficult. Also, immediately following the Chernobyl accident there was very little information released to the public on the adverse health effects of radiation.[18] Notably, there was a May 1st parade in Kiev held as usual right after the catastrophe on April 26 1986, some 90 km (about 56 miles) away from the burning power plant. In an attempt to evaluate the influence of selective migration on our results, we exploited migration variables available in the 1999 Belarus Census. In particular, we compared characteristics of migrants from the region of birth between the affected and unaffected regions (Appendix, tables A4 and A5). We did not find that migrants from the more affected regions (Homyel, Brest and Mahilyow) who migrated after 1986 are system-

[18] Medvedev (1990) documents in detail the widespread negligence and under-reporting after the catastrophe. For example, he writes that "the population of Pripyat was not warned about the accident nor was the civil defense headquarters informed. Since the civil defense staff had no information about the situation, they took no measures. As a result, the usual rhythm of life on Saturday proceeded ... The evacuation began only 36 hours later and was conducted according to a newly worked-out plan."

atically different in their observable socioeconomic characteristics from migrants from the less affected regions (Hrodna, Vitsyebsk, and Minsk) who migrated before 1986. Thus, to the extent that our radiation exposure variable is measured with a random error, our results would be conservative estimates of the radiation exposure.

Fifth, parents in more affected regions might had invested more resources in health and education in order to offset the effect of irradiation. If unaccounted for, differential investment by parents would tend to bias the estimated effect of irradiation towards zero.

Finally, there were government support programs for the population affected by Chernobyl. If unaccounted for, they would tend to bias the estimated effect of irradiation towards zero. Our finding of positive coefficients on the affected dummy in the regression for university diploma provides an indication of such possibility.

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Appendix

Table A4. Characteristics of out-migrants from the region of birth

Out-migrated on/after 1986			Out-migrated before 1986		
Born in Homyel	Mean	SD	Born in Homyel	Mean	SD
Secondary education	0.71	0.454	Secondary education	0.753	0.431
University degree	0.15	0.357	University degree	0.251	0.433
Professional occupation	0.194	0.396	Professional occupation	0.283	0.451
Employed	0.482	0.5	Employed	0.609	0.488
White collar occupation	0.001	0.038	White collar occupation	0.003	0.051
Age in 1999	32.517	18.777	Age in 1999	48.84	15.582
Male	0.467	0.499	Male	0.407	0.491
Married	0.517	0.5	Married	0.706	0.456
Number of children	0.9	0.918	Number of children	0.933	0.874
Rural	0.293	0.455	Rural	0.155	0.362
Big city	0.476	0.499	Big city	0.672	0.47
Born in Brest or Mahilyow	Mean	SD	Born in Brest or Mahilyow	Mean	SD
Secondary education	0.776	0.417	Secondary education	0.763	0.425
University degree	0.193	0.395	University degree	0.28	0.449
Professional occupation	0.222	0.415	Professional occupation	0.328	0.47
Employed	0.452	0.498	Employed	0.644	0.479
White collar occupation	0.002	0.049	White collar occupation	0.005	0.068
Age in 1999	29.54	17.397	Age in 1999	48.218	14.835
Male	0.462	0.499	Male	0.43	0.495
Married	0.469	0.499	Married	0.718	0.45
Number of children	0.736	0.86	Number of children	0.969	0.877
Rural	0.222	0.416	Rural	0.156	0.363
Big city	0.591	0.492	Big city	0.641	0.48

Out-migrated on/after 1986			Out-migrated before 1986		
Born in Hrodna, Minsk, Vitsyebsk	Mean	SD	Born in Hrodna, Minsk, Vitsyebsk	Mean	SD
Secondary education	0.734	0.442	Secondary education	0.751	0.433
University degree	0.185	0.388	University degree	0.241	0.428
Professional occupation	0.191	0.393	Professional occupation	0.293	0.455
Employed	0.437	0.496	Employed	0.61	0.488
White collar occupation	0.001	0.028	White collar occupation	0.001	0.033
Age in 1999	25.991	16.324	Age in 1999	47.208	16.219
Male	0.466	0.499	Male	0.41	0.492
Married	0.448	0.497	Married	0.704	0.456
Number of children	0.883	0.918	Number of children	0.885	0.892
Rural	0.256	0.436	Rural	0.185	0.389
Big city	0.469	0.499	Big city	0.559	0.496

Source: The authors' own calculations based on the Belarusian Population Census of 1999.

Table A5. Differences in the characteristics of migrants between affected and unaffected regions

	Born in Homyel		Born in Brest or Mahilyow	
	Coefficient	Std. Error	Coefficient	Std. Error
Secondary education	-0.026	0.014	0.029*	0.013
University degree	-0.045	0.027	-0.030	0.018
Professional occupation	0.014	0.024	-0.004	0.019
Employed	0.046	0.024	-0.018	0.019
White collar occupation	-0.001	0.001	-0.002	0.001
Age in 1999	4.894***	0.709	2.539***	0.499
Male	0.004	0.014	-0.023*	0.011
Married	0.068**	0.010	0.008	0.010
Number of children	-0.031	0.072	-0.231**	0.083
Rural	0.068***	0.015	-0.004	0.007
Big city	-0.105**	0.037	0.040	0.026

Source: The authors' own calculations based on the Belarusian Population Census of 1999.

Note: Coefficients and standard errors are estimated from a regression on the variable "Born in Homyel and out-migrated from Homyel" and "Born in Brest or Mahilyow and out-migrated from Brest or Mahilyow" each interacted with the indicator for having migrated after 1986 (omitted category is "Born in Hrodna, Vitsyebsk, or Minsk and out-migrated from Hrodna, Vitsyebsk, or Minsk"), where other regressors include the dummies "Born in Homyel and out-migrated from Homyel", "Born in Brest or Mahilyow and out-migrated from Brest or Mahilyow" and "Migrated after 1986". The estimation sample includes all migrants who left their region of birth.