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# **Anthropometric Dividends of Czechoslovakia's Break Up**

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## **Abstract**

Processes of transition to democracy and country break up stand out as ideal experiments to estimate the impact of wide institutional reform on well-being. Changes in population heights are regarded as virtuous pointers of well-being improvements in psycho-social environments, which improve with democracy. We analyzed a unique dataset containing individual heights in the Czech Republic and Slovakia to measure the retrospective well-being effects of the two transitions to liberal democracy and capitalism after the split up of Czechoslovakia. An additional year spent under democracy increases height by 0.286cm for Slovaks and 0.148cm for Czechs. Results were robust to using an alternative dataset and suggest that although transition paths differ across the two countries, the absolute height gap between Slovaks and the Czechs did not change. Slovaks benefited more than the Czechs in the bottom and mid tercile.

*Keywords:* height, democracy, transition, secession, Czechoslovakia, Blinder-Oaxaca decomposition, height dimorphism

## 1. Introduction

Physical stature is regarded a retrospective indicator of “how well the human organism fares during childhood and adolescence in its socio-economic and epidemiological environment” (Komlos & Snowdon, 2005). The latter has paved the way to an established research that substantiates the claim that human heights are a retrospective marker of wellbeing and living standards (Steckel, 2009). Although, calorie and protein intake during one’s childhood and youth are found to directly depend on disposable income and the cost of food, changes in adult height are thought of, more generally, as being physical returns to beneficial psycho-social environments (Steckel, 1995, 2009). That is, a child’s exposure to conditions that are less than optimal might impact its capacity to realize his or her height potential (Eveleth and Tanner, 1976). Some studies estimate that approximately 20 percent of variation in human height is due to ‘beneficial environmental’ factors (Silventoinen, Kaprio, Lahelma, & Koskenvuo, 2000; Stunkard, Foch, & Hrubec, 1986). However, we know relatively little about the potential pathways for such effects.

If social environment can be beneficial from an anthropometric standpoint, one can hypothesize that socio-political and economic shocks such as the meltdown of the Soviet bloc affected both the barriers to access to nutrition and more deeply, the institutional setting constraining individuals’ lives<sup>1</sup>. More specifically, institutional triggers (e.g., social norms, restrictions on freedom, etc.) might take a central stage (Sunder, 2003) in human anthropometry. A country’s liberal democratization can

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<sup>1</sup> For instance, Akresh *et al* (2012) find that ethnicity specific cohorts exposed to the Nigerian civil war 1967 exhibited lower stature.

potentially reshape the institutional framework (e.g., minority inclusiveness, perceptions of safety and rule of law, welfare programs etc) within which families manage their lives (North, 1991), which in turn can exert an influence in children. Institutional reforms such as a transition to a market economy engender substantive changes (Collins and Rodrik, 1991), and may lead to social changes including the stimulation of risk taking and the alteration of attitudes towards work all potentially exerting an influence on environmental health effects and ultimately can enhancing an influence on wellbeing in the long run (Costa-Font & Gil, 2008). More specifically, following the “fit *through* democracy” (Sen, 1999) hypothesis, democracy may lead to the inception of institutions that make children and adolescents’ existence safer and healthier, and thus are expected to be positively associated with height. Consistently, adverse socio-economic developments in society may result either in stagnation or, deterioration in human stature. However, it is important to note that such negative developments can also occur in democratic regimes (Komlos & Baur, 2004). The latter calls for empirical evidence to help to disentangle whether and when economic and political liberalization, exerts an effect on human heights.

Methodologically, the empirical identification of institutional changes in human heights can be controversial, hence the importance of “natural experiments” such as experiences of democratization that can be regarded as exogenous shocks to the majority of the population from which to learn more about the effects on heights. Among these experiments belong the processes of German reunification (Heineck, 2006; Hiermeyer, 2008; Komlos & Baur, 2004, Komlos & Kriwy, 2003). West Germans were found to be taller than East Germans (approx. 1cm) and, importantly, such a gap appears to have widened only after the Berlin Wall was built (Komlos &

Snowdon, 2005) which can be traced back to the standards of living of both children and youth in the West (Hiermeier, 2008; Komlos & Snowdon, 2005). Conversely, since unification there has been convergence in heights between East and West German males but, paradoxically not among females (Komlos & Kriwy, 2003). The latter is still a question to be better understood.

In contrast to the German unification example, the case of Czechoslovakia stands out as a unique institutional experiment whereby the processes of economic liberalization and the inception of a liberal democracy followed the set up of two independent states that followed different economic development institutional and policy priorities. The combination of economic and political liberalization on the one hand, and the secession of Slovakia on the other, is regarded as a “double bang”, namely a rare case in history where two large liberalization forces coincided (Bookman, 1992). However, whilst the effect of political and economic transition is expected to exert an expansion in heights, it is unclear whether the same applies to secession. Secession would be expected to reshape each country’s institutions so that they tailor their own specific pathways, accommodate minorities, reduce conflict and hence improve institutional quality (Bolton et al, 1996, Wittman, 1991, Friedman, 1977 ). Yet, whether the latter is indeed the case is an empirical question. Contentious issues include the following:

First, the benefits from transition to a liberal democratic society as well as separation of Czechoslovakia are likely to come with a lag, in part because the effect is intermediated by other reforms (e.g., the development of social protection, implementation of liberalization reforms etc). For instance, prior evidence reveals that

during the time of transition, a deterioration in living standards occurred in Eastern Europe before any visible improvements took place (Adeyi, Chellaraj, Goldstein, Preker, & Ringold, 1997; Garner & Terrell, 1998; Milanovic, 1998; Stillman, 2006; Svejnar, 2002). Height is increasingly used to assess the overall well-being in a country as it is considered to be the “mirror of the society” (Tanner, 1986). It has been used to assess the impact of political regime change in several countries, including East and West Germany or Spain.

Second, most of the existing literature combined the effects of democratization and secession together, which leads us to the problem of correctly identifying the effect of the break up from that of democratization. The Czechoslovakian case allows us to identify the trajectories before and after the break up. Just like the literature on secession, the evidence on the democratic transition and its effects is even more extensive, covering all areas from economic welfare to institutional changes (Hausner, Jessop, & Nielsen, 1995; Inglot, 2008, 2009; Kostecki, Zukrowska, & Goralczyk, 2000; Milanovic, 1998; Whitefield, 1993; Winiecki & Kondratowicz, 1993) to health effects (Bobak & Feachem, 1992; Cornia & Paniccìa, 2000; Ginter, Simko, & Wsolova, 2009; Lawson & Nemeč, 2003; Stillman, 2006). Broadly speaking, the evidence points to the difficult transition years with Czech Republic having performed better than Slovakia on a range of aspects. An inescapable issue lies in distinguishing the effects of economic liberalization which encompass reforms that improve access to food and new technologies from the introduction of democratic decision-making systems (Tavares & Wacziarg, 2001).<sup>2</sup> Prior to the transition, poor nutrition was a problem due to seasonal unavailability of certain foods and the

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<sup>2</sup> Indeed, while political liberalization is assumed to involve those individuals who uphold democratic values in collective decision-making, economic liberalization refers solely to the areas of economic activity and commerce.

opening of the borders enabled easier access to fruits and vegetable consumption (McKee, 2004). Difference by income quintiles would be expected to contain some information that allows us to ascertain whether one effect over the other prevailed. Eveleth and Tanner (1976) in their summary of growth studies suggest “*if a particular stimulus is lacking at a time when it is essential for the child...the child’s development may be shunted...*” (Eveleth & Tanner, 1976, p.222). However, there is evidence that for deprivation to have an effect on adult height, it has to be severe and long-term during key periods of growth as after short nutritional shocks normal height is usually restored (Steckel, 2009).

Finally, the effect of the break up is even more complex insofar as both Slovakia and the Czech Republic lost some scale and gained some homogeneity to overcome the complexities of public decision making in multinational environments (Alesina and Spolaore, 1997, 2003). However, given that transition implied a whole institutional build-up (Milanovic, 1998), the costs of break up at that transition point might have been mitigate. Hence, the direction of the effect is empirically contested. This paper attempts to shed some light on this question which has not received attention in the literature<sup>3</sup>.

This paper empirically examines the variation in heights across time to examine the potential ‘height effect’ effect of political and economic liberalization (the transition from communism to a liberal democracy and further country break up

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<sup>3</sup> The literature comparing Czech Republic and Slovakia post-secession focuses mainly on the degree of similarity or difference in the political context and economy (Bartosova & Zelinsky, 2013; Meszaros, 1999) as well as wellbeing (Potucek & Radicova, 1997).



of Czechoslovakia<sup>4</sup>) on human heights. More specifically, we are interested in understanding how institutional reforms have reflected in the expansion of overall standard of living measured by changed in heights, and how individual and political wellbeing fared in the institutions from Slovakia and the Czech Republic after secession. Given the nature of elitism democracy in Easter Europe (Przeworski, 1991), the rise of income inequalities and the reduction on gender inequality after 1989 (Heyns, 2005), we examine stature changes across age groups as well as by gender and income groups. The latter is expected to help to further identify who were the winners of the transition to a liberal democracy and market economy, as well quantify the magnitude of gender and social inequalities. The latter is a question that we believe can contribute to testing some of the contentious hypothesis of the effect of democracy and secession on wellbeing (Nobles, Brown, & Catalano, 2010).

The next section contains the background on the specific case study. Section three reports the data and methods. Section four contains the results, section five the robustness checks and a final discussion section concludes the paper.

## **2. Institutional Setting**

### *2.1 Liberalization and Reform*

After the II World War, in 1948 Czechoslovakia fell under the Soviet influence. The latter implied a ban on civil and political liberties alongside media

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<sup>4</sup> For simplicity purposes, in the remaining of the chapter we will be using the term “democracy” even though we are referring more broadly to political and economic liberalization.

ensorship and *economic dirigisme* with the implementation of production plans and quotas. To enforce such an institutional setting, penalties included forced labor camps and possibly execution for extreme cases (Janik, 2010). The regime lasted forty years until 1989 with only a small spell of the Prague spring<sup>5</sup> when reform was attempted. Although initially the steps taken in the two federations of Czechoslovakia were similar, in 1992 a peaceful secession process was designed by the two main community leaders to create two separate countries in 1993. The events of 1989 and 1992 can be regarded as a “double bang”, a rare case in history where two large forces coincided (Bookman, 1992). It was first a transition from centrally planned to a market economy and then the secession of Slovakia that happened virtually simultaneously. Some even suggest that it was a “triple transition”: democratization, marketization, and a national transformation (Leff, 1996).

After secession the form and speed of the democratization and liberalization reforms gradually began to differ. Czech Republic initially implemented aggressive economic reforms in combination with socio-economic entitlements and democracy. In contrast, in Slovakia the first years after the break-up were characterized by a continuation of an authoritarian rule which left the country economically and politically isolated (Inglot, 2009; Meszaros, 1999). Slovakia was severely disadvantaged throughout the 1990s in terms of policy leadership and necessary social expertise, coupled with rapid institutional changes departing from those of Czechoslovakia’s past and in search of its new social welfare model (Inglot, 2009; Potucek & Radicova, 1997). Nonetheless, by 1998 the rapid progress in Czech Republic slowed down and the reverse happened in Slovakia; it appeared that the Czech Republic was ready to join the EU while

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5 In 1968 the “Prague Spring” marked a short-lived period of liberalization and democratization with reforms but quickly ended with the Warsaw Pact troops’ invasion; any attempts for reforms were crushed and oppression under Soviet Communism continued for the next 20 years (Janik 2010).

Slovakia's chances appeared meagre. The period between 1989 and 2004 is characterized by some as the 'transformation shock' (Inglot, 2009). However, both countries reached an externally required level of political and economic transition and joined the European Union in 2004.

## *2.2 Centre Periphery Relations and Break Up*

The degree of decentralization in Czechoslovakia before the break up was limited (Bookman, 1992). Although it became a federation in 1969 with economic jurisdiction, as well as social policies shared between the regions and the center, in 1971 a new re-centralization process emerged and continued until 1990 when regional decentralization was enacted just before the break up in 1992. Some argue that the break up was primarily motivated by economic factors (Bookman, 1992; Pavlínek, 1995), while others consider history, political culture or ethnic nationalism (Innes, 2001; Kirschbaum, 1993; Olson, 1993) to be the important factors.

Already during the communist period, Czech Republic and Slovakia differed in their level of economic and social development. Life expectancy and mortality rate, suggest that despite both countries exhibiting improvements, Czechs continue to outperform the Slovaks even after the transition (Ginter, et al., 2009). The same is suggested by the Human Development Index (HDI) which also includes income and education in addition to life expectancy, and ranks Slovakia closely behind the Czech

Republic (United Nations Development Programme).<sup>6</sup> Overall, evidence suggests that the Czech Republic has been performing better during communism and has continued to outperform Slovakia in many wellbeing indicators. However, the initial years after the transition in both countries were painful and reflected in a decline of overall welfare (Cox & Mason, 1999; Milanovic, 1998)<sup>7</sup>.

### **3. Data and Empirical Strategy**

#### **Data and methods**

##### *Data and variables*

This study uses the data from the 2003 World Health Survey (WHS) which is the baseline household survey for health status of populations and outcomes related to investments and functioning of health systems. The survey identified all adult population over age 18 years old as the sample and employed a probability sampling design where every single person had a known non-zero chance of being selected into the survey sample; either with single or multi-stage random cluster sampling. Individual probability sampling weights were applied to adjust for the probability of selection into the sample (World Health Organization, 2003). According to the WHS

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<sup>6</sup> Indicators such as avoidable mortality that attempt to capture the changes in the quality and performance of the health care system suggest that before 1989 Czech Republic was doing better than Slovakia, but since the transition and independence, both countries' performance has improved; in a number of areas Slovakia has exceeded Czech Republic (Kossarova et al, 2012).

<sup>7</sup> Change in inequality between 1987-1988 and 1993-95 measured by the GINI coefficient showed that inequality increased in the Czech Republic but did not change in Slovakia. The shape of the change also differed: in Slovakia no income quintile gained or lost more than 1 percentage point; in the Czech Republic, the loss of 1-2 percentage points was concentrated in the bottom three quintiles, the fourth quintile experiencing a very small loss and the top quintile was the one benefiting. However, it has to be noted that given the overall income decline in both countries, the losers were losing more severely and the winners were not necessarily gaining in real income.

individual country reports provided by the WHO, the number of interviewed households was 935 (total 3913 - 24% of selected households) in the Czech Republic and 1811 (total of 2539 - 71% of selected households) in Slovakia; the number of interviewed individuals was 935 (total selected 949 – 99% of selected individuals) and 2461 (total selected 2471 – 99% of selected individuals), respectively. The household level figures for Czech Republic suggest that there may have been an important selection bias and therefore the sample may not correctly represent the Czech population. In particular, non-response bias may be the key concern where those who participated (potentially the healthier population) are different from non-participants (Delgado-Rodríguez & Llorca, 2004).

However, according to the official WHS country report of the Czech Republic, prepared by the Institute of Health Information and Statistics Czech Republic (Institute of Health Information and Statistics Czech Republic, 2004), the sample is representative of the population. The findings of the report were confirmed by the Director of the Institute through personal correspondence (Ing. Jiri Holub, March 14, 2014). According to this report, 1918 individuals were finally eligible and contacted, and responses were obtained from 935, resulting in a response rate of 55.1% (excluding individuals who could not be contacted for objective reasons), which is higher than the response rate in the report provided by the WHO. The same report states that while the structure of the respondents differs in some characteristics from the structure of the adult Czech population, it confirms previous findings and none of the important population groups were significantly under or overestimated. The following differences were identified when compared to the overall Czech population. With respect to sex, there were somewhat more women and less men in the sample

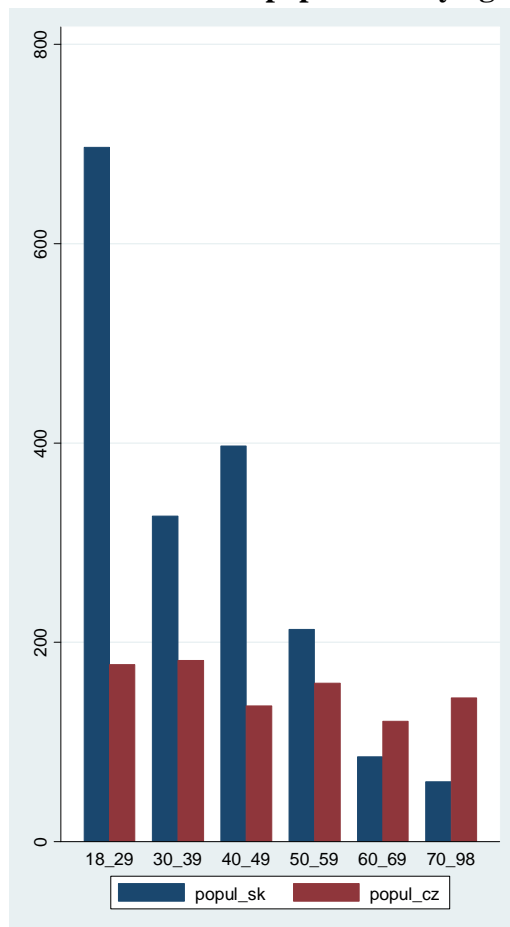
than the overall population (55.2% compared to 52% and 44.8% compared to 48%, respectively); with respect to age, women and men younger than 30 and men between 40-49 were somewhat underrepresented, while men over the age of 70 were somewhat overrepresented. Similarly, the report compares the WHS sample to the overall population for regional representation, ethnicity, family status, education, economic activity and employment, household composition and finds that the sample is broadly similar to the overall population. Perhaps, the most important finding is that lowest participation in the survey is seen by the least educated who may be suffering from worse health.

Furthermore, the report identifies the proportions of individuals out of a total of 1918 individuals who did not respond to the survey and the underlying reasons: the individual or the household was unwilling to participate (26.5%); the individual was not at home (13.2%); the individual was unsuitable (1.2%); the individual did not live at the address (6.2%); the individual could not be contacted (1%); the individual died (1.4%); and individuals were not contacted at all (1.8%). In addition, an analysis of homogeneity between the responders and the non-responders was carried out. More women, less men, more older people and citizens of smaller towns responded to the survey. While these differences can be adjusted for by using sampling weights, it remains difficult to adjust for other non-observable differences between respondents and non-respondents. For example, the healthiest or the least healthy may have been those who did not participate (Institute of Health Information and Statistics Czech Republic, 2004). In addition, the report notes that the complexity of the survey in terms of topics covered and time required to complete it, as well as implementation issues are potentially other relevant reasons for 26.5% unwilling to participate.

Therefore, the actual sample used in this study (after accounting for missing observations for height) contains 1806 Slovak and 920 Czech individuals.

Distribution by age groups can be seen in Figure 1.

**Figure 1. Distribution of the population by age categories**



The survey includes information on self-reported height of the individuals as well as information on other important variables that are controlled for including education, income, rural or urban location, employment and others. The control variables are based on the conceptual framework of determinants of height defined by Steckel

(1995). Table 1 below summarises the descriptive statistics for all the variables used in the analysis.

**Table 1. Variable description**

<i>Variable</i>	<i>Variable description</i>	<i>Obs</i>
height	=adult height in cm	2726
gend	=1 if male; 0 if female	2726
co	=1 if Czech Republic; 0 if Slovakia	2726
popul_cz	= number of Czechs	920
popul_sk	= number of Slovaks	1806
age70_98	=1 if the individual was born between 1910-1933; 0 otherwise	2726
age60_69	=1 if the individual was born between 1934-1943; 0 otherwise	2726
age50_59	=1 if the individual was born between 1944-1953; 0 otherwise	2726
age40_49	=1 if the individual was born between 1954-1963; 0 otherwise	2726
age30_39	=1 if the individual was born between 1964-1973; 0 otherwise	2726
age18_29	=1 if the individual was born between 1974-1985; 0 otherwise	2726
educ1	=1 if individual has primary education or less; 0 otherwise	2724
educ2	=1 if individual completed secondary education; 0 otherwise	2724
educ3	=1 if individual completed high school/equivalent education; 0 otherwise	2724
educ4	=1 if individual completed college or higher level education; 0 otherwise	2724
job1	=1 if individual is working; 0 otherwise	2702
income	estimated permanent income of individual	2596
qincome1	bottom income tercile	2596
qincome2	middle income tercile	2596
qincome3	top income tercile	2596
demage	Years spent under democracy before the age of 20	2726
indage	Years spent under independence before the age of 20	2726
demd	=1 if individual was raised at least 1 year under democracy before age 20; 0 otherwise	2726
indd	=1 if individual was raised at least 1 year in independent country before age 20; 0 otherwise	2726
dempolity	Years spent under democracy from 1993-2003, adjusted for the “quality of democracy” with the Polity IV democracy score	2726
language	=1 if individual reported a language; 0 otherwise	2726

Predicted permanent income (*income*) is used as a proxy for wealth or socio-economic development (Filmer & Pritchett, 1999; Komlos & Baur, 2004; Persico, et al., 2004) as the dataset did not contain other suitable income variable. A variable of *income* was created using factor analysis from a series of questions on the ownership of particular household objects (e.g. number of cars, TVs, rooms, ownership of phone, video camera, computer, access to internet etc.). Polychoric correlation was first



carried out as the variables are constructed as counts or dummies followed by factor analysis to reduce the several correlated variables into one variable. The key steps in factor analysis are choosing the relevant variables and determining the number of factors. The ownership of the following variables were used as these are expected to better predict income: car, television, bike, video player, stereo, DVD player, washing machine, dishwasher, vacuum cleaner, fridge, cell phone, computer and internet. Several other variables were excluded due to high uniqueness values or because there was very little variation. The predicted income variable was then standardised and converted into three income thirds (poorest third, middle third and rich third). Given that nutrition is a function of income, a positive association between height and income is expected; however, it should also be noted that the height-income relationship is not stable in the face of epidemiological conditions; at a given income, improvements in public health, personal life style and childcare practices, the prevalence of disease may be reduced and physical growth enhanced (Peracchi, 2008; Steckel, 2009). Furthermore, the literature suggests that there are diminishing returns to nutrient intake suggesting that the height of the rich is expected to increase by less than is the decline in the height of the poor; this results in a net negative effect where holding income constant, increased inequalities imply that average height diminishes (Komlos, 2009). Therefore, it can be expected that the richest individuals benefited less from the transition than the poorest group.

Education (*educ*) is used as a proxy of individual abilities and a predictor of an individual's efficiency in health production (Costa-Font & Gil, 2008; D.S. Kenkel, 1991). It is presented in four categories from those with less than primary education completed all the way to those with a post-graduate degree completed. In addition, we

control for urban and rural differences in height as those in urban areas are more likely to have easy access to resources (Costa-Font & Gil, 2008). The variable *job* captures the employment category of the individual which was aggregated into two major groups: employed and unemployed. A dummy variable was included to capture the country effect (*co*) – Slovakia and Czech Republic. Six age categories represent the effect of the different birth cohorts, where the 1974-1985 birth cohort was selected as the reference category. Finally, the variable *language* is a proxy variable for ethnicity. The variable cannot be interpreted as it stands given the large number of missing values which may not be missing randomly but instead may be capturing individuals belonging to one of the important ethnic minorities in Czech Republic and Slovakia (e.g. Roma, Hungarians). However, it was still considered important to be controlled for and was included as a dummy variable with the value of 1 if a language was reported by the individual and zero for all the missing values.

The key dependent variables are represented by the number of years a person has lived under democracy (*demd*) and independence (*indd*) before they reach 20 years of age. For democracy (1989), these are individuals aged 18 to 33 year in year 2003 (birth cohorts 1970 - 1985) who lived their first 20 years between 14 to 1 year under democracy (4 to 19 years under communism). All the older individuals lived all the years before they reach 20 years of age under communism. Similarly for independence (1993), individuals aged 18 to 30 in year 2003 (birth cohorts 1973-1985) lived their first 20 years between 11 to 1 year as part of an independent country (or 7 to 19 years as part of Czechoslovakia). These variables were first included as dummy variables with a value of 0 for those who were raised zero years under democracy (*demd*) independent (*indd*) country and 1 otherwise. The purpose is to see

whether being raised any amount of years under a democracy/ independence as opposed to none matters or it's rather the increasing number of years that has an impact.

Furthermore, the “quality” of the democratic years is also controlled for when an adjusted democracy variable is included to see whether the results are consistent. The type of democracy the two countries had immediately after the change of the regime versus several years later may change depending on the political situation and reforms implemented. Therefore the Polity IV <sup>8</sup> institutionalised democracy variable (*dempolity*) was used to adjust for the “quality” of the democratic years after 1993 for independent Slovakia and Czech Republic. In other words, whether someone was a child during the 1993-1997 democratic years may not be the same as growing up under the 2000-2003 democratic years and later. Under the Polity IV project, institutionalised democracy consists of three key elements: i) presence of institutions and procedures through which citizens can express effective preferences about alternative policies and leader; ii) the existence of institutionalized constraints on the exercise of power by the executive; iii) the guarantee of civil liberties to all citizens in their daily lives and in acts of political participation. Other aspects of plural democracy, such as the rule of law, systems of checks and balances, freedom of the press, and so on are means to, or specific manifestations of, these general principles (Center for Systemic Peace). The “Polity Score” ranges from -10 (hereditary monarchy) to 10 (consolidated democracy) in any given year and was used to weigh the years spent under democracy. Both for Slovakia and the Czech Republic the

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<sup>8</sup> The goal of the Polity IV project is to code the authority characteristics of states in the world system for purposes of comparative, quantitative analysis. It has become the most widely used resource for monitoring regime change and studying the effects of regime authority (Center for Systemic Peace).

scores were positive (7 and above) for the entire period under study so the weights used were between 0.7 and 1. These weighted years were then added up to obtain an adjusted democracy variable. For both types of democracy variables and independence variable a positive association with height was expected. However, as the independence and democracy variables are likely to be confounded and the changes that occurred as a result of one or the other transition cannot be appropriately controlled for, these are included in separate regressions.

Finally, the following interaction terms are also included: two-way interaction variables between country and years under democracy/independence, income and years under democracy/independence, income and country, as well as a three-way interaction between income terciles, years under democracy/independence. The goal is to see whether the effect of democracy was country or income group dependent, especially given the fact the Czech Republic was initially performing significantly better on many grounds than Slovakia. As the direct interpretation of three-way interactions is complicated, where the term is significant, additional visual analysis is carried out. This was done by graphing the slopes of height by one of the continuous variables, while allowing for the other two categorical variables to differ. Then the slopes were calculated followed by a test of differences in slopes (Institute of Research and Digital Education, 2013).

### *Methods*

A classical ordinary least squares (OLS) regression model is applied to identify the effect of democracy and independence on the mean height of the population, as well

as the other control variables on height. The model for the effect of democracy is as follows:

$$H = f(\text{democracy}, \text{gender}, \text{country}, \text{age}, \text{education}, \text{job}, \text{income}, \text{language})$$

Alternatively, for independence it is:

$$H = f(\text{independence}, \text{gender}, \text{country}, \text{age}, \text{education}, \text{job}, \text{income}, \text{language})$$

More specifically, the models can be expressed as:

$$\begin{aligned} \text{Height}_i = \beta_0 + \beta_1 \text{democracy}_i + \beta_2 \text{gend}_i + \beta_3 \text{age}_i + \beta_4 \text{educ}_i + \beta_5 \text{job}_i + \\ + \beta_6 \text{income}_i + \beta_7 \text{co}_i + \beta_8 \text{language}_i + \varepsilon_i \end{aligned} \quad (1)$$

Or

$$\begin{aligned} \text{Height}_i = \beta_0 + \beta_1 \text{independence}_i + \beta_2 \text{gend}_i + \beta_3 \text{age}_i + \beta_4 \text{educ}_i + \beta_5 \text{job}_i + \\ + \beta_6 \text{income}_i + \beta_7 \text{co}_i + \beta_8 \text{language}_i + \varepsilon_i \end{aligned} \quad (2)$$

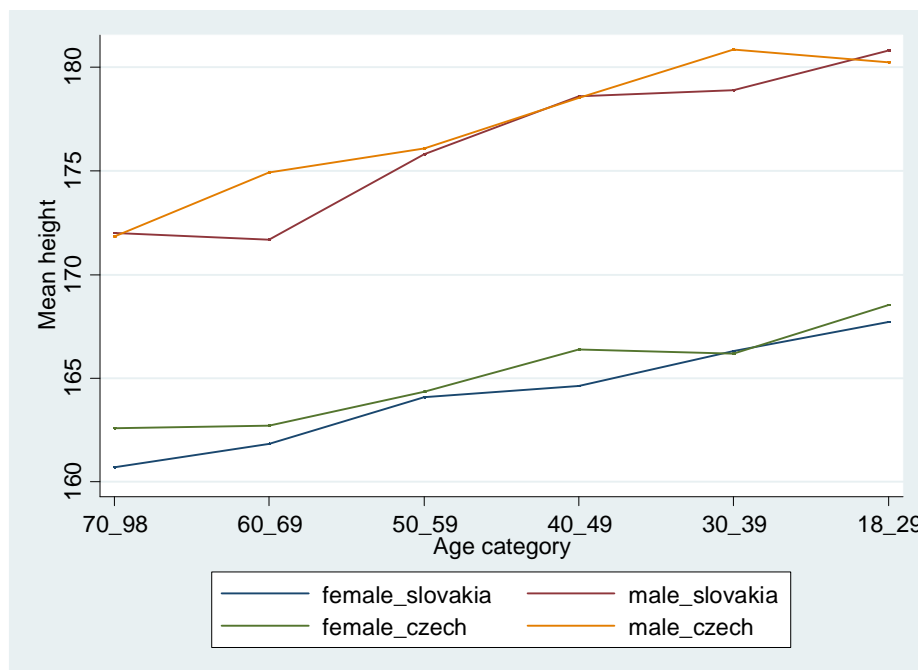
for observations  $i = 1 \dots n$ , where democracy and independence are either a continuous variable (*demage* or *indage*) or a dummy variable (*demd* or *indd*) as described above;

$\varepsilon_{it}$  is the unobserved random error which captures random factors that may affect height.

## Results

A height difference can be observed between males and females as well as between the Slovak and the Czech population by age cohorts (Figure 2). There is an increasing height trend across the age cohorts, where older generations are shorter than the younger ones. The largest difference between the two countries for males appears to be for those aged 60-69 (born between 1934-1943) and then again for ages 30-39 (born 1964-1973); for females it is ages 79-98 (born between 1905-1933) and ages 40-49 (born between 1954-1963). Overall, the difference over age cohorts appears to be more important than the difference between the two countries.

**Figure 1. Height by age cohorts, gender and country in 2003**



The average height figures by age groups, gender and country used in Figure 12 are presented in Table 2. The range for Slovak males between the oldest and the youngest age groups is as much as 8.79cm, followed by Czech males (8.41cm),

Slovak females (6.99cm) and Czech females (5.97).

**Table 2. Mean height by gender and country, 2003**

	<i>SLOVAKIA</i>		<i>CZECH</i>	
	Mean height	Std. Dev.	Mean height	Std. Dev.
<b>WOMEN</b>				
18_29	167.69	5.68	168.55	6.53
30_39	166.32	5.66	166.17	6.38
40_49	164.63	5.98	166.39	7.28
50_59	164.09	5.74	164.35	5.35
60_69	161.83	5.80	162.70	5.53
70_98	160.70	5.30	162.58	5.81
<b>MEN</b>				
18_29	180.79	7.44	180.24	7.46
30_39	178.88	7.27	180.84	6.95
40_49	178.61	6.85	178.52	7.45
50_59	175.82	5.67	176.09	6.51
60_69	171.67	9.67	174.92	6.16
70_98	172.00	6.91	171.83	6.14

Note: No adjustment with weights was carried out

The average height also differs across the income terciles within and across countries (Table 3 and Figure 3). The average height of the Slovak females in the lowest tercile is only 164.6cm, increasing to 166.1cm in the mid and top terciles. Slovak males' height gradually increases across tercile from 176.8cm to 178.6cm and 180.3cm respectively. Czech females are 164.4cm in the lowest tercile, 164.8cm in the mid and increases to 167.1cm in the top group. Finally, the poorest Czech males are 175.3cm, increasing to 177cm and 180.2cm in the mid and highest income terciles respectively.

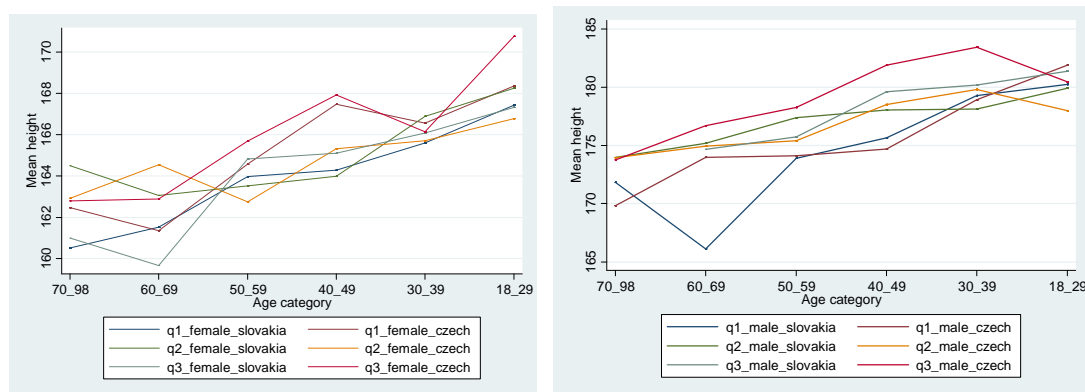
**Table 3. Average height by terciles, gender and country**

<i>Variable</i>	<i>Obs</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Min</i>	<i>Max</i>
q1_female_SK	408	164.6237	2.242089	160.5122	167.4286
q1_male_SK	143	176.7851	3.970725	166.125	180.2407
q1_female_CZ	190	164.4199	2.497327	161.3428	168.36
q1_male_CZ	133	175.2617	4.065685	169.8333	181.9
q2_female_SK	352	166.1261	2.048122	163.0667	168.2391
q2_male_SK	202	178.599	1.371597	173	179.9302
q2_female_CZ	185	164.82	1.472075	162.7586	166.7778
q2_male_CZ	140	177.014	2.228076	173.9583	179.8182
q3_female_SK	380	166.0745	1.223809	159.6667	167.6667
q3_male_SK	234	180.312	1.734207	174.6667	181.3617
q3_female_CZ	123	167.0809	2.448351	162.8	170.75
q3_male_CZ	130	180.2097	2.761017	173.7778	183.4333

Note: No adjustment with weights was carried out

Figure 3 plots the height difference across terciles by age cohorts where it can be seen that regardless of the income tercile, height increases from the oldest to the youngest generations. The graphs also suggest some variation in the mean height for males and females across the age cohorts and income terciles, with the richest Czechs being the tallest across cohorts.

**Figure 2. Height by income tercile, age group, gender and country, 2003. Poorest (q1), middle (q2), top (q3)**





First the results where the key independent variable democracy is included in the analysis as a dummy variable (=1 for those who spent at least 1 year growing up under democracy and zero otherwise) are presented (Table 4). It can be seen that the sign and the significance of the variable changes depending on the model specification but is only positively significant in Models 3 and 7, similarly to the country effect. However, there is a significant income, gender and age cohort effect in all the models. As expected, the results show that males are taller than females, older generations are shorter relative to the youngest generation and income has a positive effect on height. The cohort effects show that anyone born before 1973 is significantly shorter than the youngest cohort born between 1974 and 1985 that we used as the reference category. When income was studied in income terciles (Model 6), height of the respondents in the poorest tercile and mid tercile is 1.97cm and 2.23cm less than the height of the richest tercile. Next, a range of different interactions were included (Model 3-7). In Model 3 the interaction between country and democracy was studied and results show that for Slovaks, height for those who were raised under democracy as opposed to communism is 1.504cm more; for Czechs, on the other hand, the height of those raised under democracy is 0.4cm less than for those raised under communism.

In Model 4 the significant interaction between income and democracy was studied which shows that with a unit increase in income, height increases by 1.2cm for those under communism and only by 0.6 for those growing up under democracy; or that height is 0.3cm more for those growing up under democracy as opposed to communism when income equals zero and this difference decreases by 0.6 for each additional unit of income. These results suggest that while for a given income height

is more under democracy than communism, higher income benefits an individual more under communism. In Model 5 the interaction between income and country was studied and there was no significant effect. Finally, in Model 7 all the controls are included together and there is positive significant effect of democracy and country (Czechs), as well as gender, language, education and age cohorts, while the three-way interaction term is not significant. Increase in the years of education is associated with a significant increase in height when compared to the reference group of people with primary and less years of schooling. The log-likelihood ratio test comparing the restricted models to the less restricted models showed that adding interactions as well as controlling for education and employment resulted in a statistically significant improvement in the model fit compared to a model where only income is controlled for.

**Table 4. OLS regressions of years lived under democracy as a dummy variable on height with different controls**

VARIABLES	(1) Eq.1	(2) Eq.2	(3) Eq.3	(4) Eq.4	(5) Eq.5	(6) Eq.6	(7) Eq.7
demd	0.166 (0.558)	0.0363 (0.575)	1.504** (0.726)	0.268 (0.586)	0.0554 (0.575)	-0.0204 (0.573)	1.631** (0.742)
co	0.389 (0.291)	0.388 (0.296)	1.415*** (0.429)	0.356 (0.297)	0.288 (0.314)	0.481 (0.296)	1.641*** (0.433)
income		0.938*** (0.145)	0.912*** (0.145)	1.180*** (0.191)	0.744*** (0.248)		0.717* (0.388)
demd_co			-1.940*** (0.588)				-1.812*** (0.631)
demd_inc				-0.574* (0.293)			-0.831 (0.509)
inc_co					0.287 (0.298)		0.453 (0.434)
demd_inc_co							0.398 (0.619)
language							1.029 (4.310)
gend	13.19*** (0.249)	13.05*** (0.254)	13.01*** (0.254)	13.04*** (0.254)	13.04*** (0.254)	13.04*** (0.253)	12.59*** (0.251)
geog							0.232 (0.323)
age30_39	-1.364*** (0.456)	-1.266*** (0.467)	-1.039** (0.471)	-1.289*** (0.466)	-1.276*** (0.467)	-1.436*** (0.465)	-1.188** (0.471)
age40_49	-1.762*** (0.675)	-1.685** (0.692)	-1.428** (0.695)	-1.719** (0.692)	-1.678** (0.692)	-1.763** (0.691)	-1.325* (0.688)
age50_59	-5.323*** (0.697)	-5.148*** (0.716)	-5.042*** (0.715)	-5.095*** (0.716)	-5.131*** (0.716)	-5.256*** (0.712)	-4.838*** (0.704)
age60_69	-5.707*** (0.742)	-5.219*** (0.762)	-5.195*** (0.761)	-5.117*** (0.764)	-5.191*** (0.763)	-5.415*** (0.758)	-4.734*** (0.764)
age70_98	-7.588*** (0.704)	-6.836*** (0.727)	-6.833*** (0.725)	-6.707*** (0.729)	-6.800*** (0.728)	-7.083*** (0.721)	-6.015*** (0.736)
educ2							1.534*** (0.403)
educ3							1.376*** (0.391)
educ4							1.999*** (0.523)
job1							0.306 (0.313)
qincome1						-1.977*** (0.327)	
qincome2						-2.252*** (0.304)	
Constant	167.6*** (0.621)	167.3*** (0.641)	166.3*** (0.701)	167.2*** (0.641)	167.3*** (0.645)	169.0*** (0.664)	163.5*** (4.403)
Observations	2,726	2,596	2,596	2,596	2,596	2,596	2,572
R-squared	0.567	0.575	0.577	0.576	0.575	0.578	0.576

The complete sets of regressions where democracy is included as a continuous variable are summarised in Table 5. The results show that with an additional year spent under democracy while growing up there is a small significant positive association with height, contrary to the findings above where democracy was included as a dummy variable. The effect of the other variables (education, gender, income) is still significant in the same direction even though the size of the coefficients differs

somewhat. However, age cohort is only significantly negatively associated with the height of the youngest age cohort for individuals born before 1953. In other words, there is no significant difference in height between the three youngest cohorts, all of which grew up predominantly under communism. Again, the country effect is not consistently significant across the models and Model 6 shows that there is a significant effect by income terciles where the bottom and middle tercile are shorter than the top tercile. Also, there is a significant effect of job where those employed are significantly taller than the unemployed, and a significant education effect. Interactions are again included in models 3, 4 and 5 and only the interaction between country and democracy is significant (Model 3). Now democracy is a continuous variable so the interpretation is slightly different from before. With an additional year spent under democracy while growing up, height increases by 0.286cm for Slovaks and 0.148cm for Czechs. In other words, height is 1.141cm more for Czechs than Slovaks if a person spent zero years under democracy and this difference in height becomes smaller for each additional year under democracy ( $1.141 - 0.138 * \text{demage}$ ). Similarly as before, results indicate that democracy seems to be benefiting the Slovaks more than the Czechs. In Model 7 the three-way interaction is significant and the model is also preferred to the model with income only, based on the results of the likelihood ratio test.

**Table 5. OLS regressions of years lived under democracy as a continuous variable on height with different controls**

VARIABLES	(1) Eq.1	(2) Eq.2	(3) Eq.3	(4) Eq.4	(5) Eq.5	(6) Eq.6	(7) Eq.7
demage	0.264*** (0.0714)	0.217*** (0.0735)	0.286*** (0.0783)	0.221*** (0.0754)	0.222*** (0.0737)	0.202*** (0.0734)	0.432*** (0.110)
1.co#c.demage							-0.251** (0.105)
2.qincome							0.643 (0.840)
3.qincome							1.353 (0.843)
1o.co#1b.qincome							0 (0)
1.co#2.qincome							-0.135 (0.920)
1.co#3.qincome							0.358 (0.933)
2.qincome#c.demage							-0.291*** (0.112)
3.qincome#c.demage							-0.286** (0.111)
1o.co#1b.qincome#co.demage							0 (0)
1.co#2.qincome#c.demage							0.0340 (0.140)
1.co#3.qincome#c.demage							0.379*** (0.137)
gend	13.12*** (0.249)	12.99*** (0.254)	12.97*** (0.254)	13.00*** (0.255)	12.98*** (0.255)	12.98*** (0.254)	12.49*** (0.251)
language							1.065 (4.279)
geog							0.196 (0.322)
age30_39	0.933 (0.739)	0.662 (0.758)	0.521 (0.759)	0.668 (0.759)	0.685 (0.758)	0.390 (0.758)	-0.226 (0.756)
age40_49	0.822 (0.834)	0.535 (0.856)	0.394 (0.857)	0.542 (0.857)	0.572 (0.857)	0.357 (0.854)	-0.149 (0.855)
age50_59	-2.752*** (0.848)	-2.950*** (0.868)	-3.191*** (0.872)	-2.934*** (0.871)	-2.901*** (0.869)	-3.154*** (0.867)	-3.625*** (0.874)
age60_69	-3.145*** (0.882)	-3.036*** (0.902)	-3.330*** (0.909)	-3.013*** (0.906)	-2.974*** (0.904)	-3.324*** (0.901)	-3.417*** (0.945)
age70_98	-5.017*** (0.853)	-4.648*** (0.874)	-4.958*** (0.882)	-4.623*** (0.880)	-4.577*** (0.876)	-4.986*** (0.873)	-4.715*** (0.929)
educ2							1.505*** (0.405)
educ3							1.409*** (0.397)
educ4							2.063*** (0.528)
job1							0.630** (0.318)
dem_co			-0.138** (0.0543)				
co	0.458 (0.290)	0.458 (0.296)	1.141*** (0.400)	0.454 (0.297)	0.342 (0.313)	0.542* (0.296)	1.335** (0.637)
income		0.909*** (0.145)	0.894*** (0.145)	0.937*** (0.179)	0.679*** (0.248)		
dem_inc				-0.00755 (0.0284)			
inc_co					0.340 (0.298)		
qincome1						-1.924*** (0.326)	

When the regression is decomposed by sex, the effects are quite different for men and women (Table 6 and 7). The interaction terms were excluded for the purpose of

simplicity. For males, years under democracy is significantly associated with a height increase in all the models. The country effect shows that the Czech males are shorter than Slovak males. A large positive significant income effect both as a continuous variable and when included in income terciles can be noted, and there is significant positive education effect as years of completed education increase. However, the results for the birth cohorts show an important difference where actually the birth cohorts 1954-1963 and 1964-1973 are significantly taller than the youngest birth cohort 1974-1985; the oldest birth cohort is significantly shorter than the youngest birth cohort. In other words, there appears to be height gain between the youngest age cohort growing up under democracy and the previous generation.

**Table 1. OLS regressions of years lived under democracy on height with different controls – male**

VARIABLES	(1) Eq.1	(2) Eq.2	(3) Eq.3	(4) Eq.4
demage	0.428*** (0.125)	0.317** (0.127)	0.301** (0.127)	0.273** (0.134)
co	-1.538*** (0.539)	-1.729*** (0.537)	-1.592*** (0.531)	-0.785 (0.542)
income		1.968*** (0.251)		1.742*** (0.251)
geog				0.632 (0.597)
language				6.520 (7.379)
age30_39	3.473** (1.350)	3.238** (1.365)	3.039** (1.354)	2.253* (1.356)
age40_49	3.876*** (1.501)	2.989** (1.518)	2.727* (1.504)	2.584* (1.531)
age50_59	-1.816 (1.538)	-2.268 (1.552)	-2.452 (1.550)	-2.788* (1.584)
age60_69	-1.386 (1.637)	-1.384 (1.653)	-1.833 (1.644)	-1.485 (1.754)
age70_98	-4.168*** (1.520)	-3.565** (1.535)	-3.895** (1.525)	-3.087* (1.682)
educ2				2.277*** (0.753)
educ3				1.383* (0.720)
educ4				2.559*** (0.905)
job1				1.109* (0.573)
qincome1			-4.743*** (0.553)	
qincome2			-3.716*** (0.510)	

Constant	177.7*** (1.446)	177.8*** (1.475)	181.3*** (1.513)	168.1*** (7.592)
Observations	1,025	976	976	967
R-squared	0.222	0.266	0.284	0.261

For women (Table 7), years spent under democracy while growing up is not significantly associated with a height increase in any of the regressions, while again there is a significant country effect; however, it is the Czech women who are taller than the Slovak women. Education also has a significant effect on height but whether or not women are employed does not seem to affect height. Here income is not significantly associated with an increase in height and when included in income terciles, it is only the middle tercile that is significantly shorter than the top tercile. All the cohorts of women born before 1953 are significantly shorter than the youngest cohort but there is no significant difference between the youngest cohort and the next two older cohorts. So to summarise the gender specific results, it is democracy, income and job that matters for men while for women there is no income or democracy effect, but a strong country effect.

**Table 7. OLS regressions of years lived under democracy on height with different controls – female**

VARIABLES	(1) Eq.1	(2) Eq.2	(3) Eq.3	(4) Eq.4
demage	0.0967 (0.0824)	0.0851 (0.0849)	0.0971 (0.0847)	0.107 (0.0883)
co	1.725*** (0.319)	1.811*** (0.329)	1.894*** (0.329)	2.107*** (0.342)
income		0.0962 (0.167)		0.00384 (0.170)
geog				0.0157 (0.360)
language				-1.899 (5.031)
age30_39	-1.018 (0.820)	-1.123 (0.843)	-1.185 (0.842)	-1.066 (0.864)
age40_49	-1.493 (0.937)	-1.494 (0.962)	-1.357 (0.960)	-1.205 (0.990)
age50_59	-3.742*** (0.946)	-3.950*** (0.970)	-3.935*** (0.966)	-3.620*** (0.995)
age60_69	-4.861*** (0.973)	-4.915*** (0.997)	-5.062*** (0.993)	-4.543*** (1.063)
age70_98	-5.563*** (0.963)	-5.580*** (0.990)	-5.843*** (0.986)	-4.960*** (1.062)
educ2				0.884* (0.452)
educ3				1.710*** (0.438)
educ4				1.885*** (0.631)
job1				-0.153 (0.370)
qincome1			0.422 (0.381)	
qincome2			-0.775** (0.364)	
Constant	165.8*** (0.895)	165.8*** (0.921)	165.9*** (0.951)	166.1*** (5.185)
Observations	1,701	1,620	1,620	1,605
R-squared	0.131	0.133	0.140	0.141

Finally, the complete sets of regressions where democracy is included as a continuous variable adjusted with the Polity IV score are summarised in Table A1 in the Appendix. The results are very similar to those presented earlier without the adjustment. The significance of the coefficients does not change, only somewhat the magnitude depending on the Model.

The complete sets of regressions that look at the effect of years lived under independence are summarised in Table 8. The independence dummy (zero as opposed to at least 1 year spent in an independent country) does not have a significant effect on height in any of the models. A significant positive country effect can be



observed only in Models 3 and 7. Similarly to years spend under democracy, the results show that all the generations born before 1973 are significantly shorter than the youngest generation. With increased education, there is a significant positive effect on height, while job is not significant. There is a positive overall income effect on height (Model 2-5), as well as by income terciles where those in the bottom and mid terciles are significantly shorter than people in the top tercile. Only the interaction term between years under independence and country is significant (Model 3) and the three-way interaction between country, independence and income (Model 7). The interaction in Model 3 suggests that for Slovaks, height for those who were raised in independent Slovakia as opposed to Czechoslovakia is 0.8cm more; for Czechs, on the contrary, the height of those raised in independent Czech Republic is 1cm less than for those raised in Czechoslovakia. Another way of interpreting this interaction is to say that being raised in Czechoslovakia, height of Czechs was 1.23cm more than the height of Slovaks; for those who grew up in independent countries, height of the Czechs was 0.5cm less than the height of Slovaks. So again, as with democracy, the Czechs seem to have lost out more from independence than Slovaks. The significant interaction term between country, independence and income suggests that the slopes of height on income are not the same across countries and years under independence.

**Table 8. OLS regressions of years lived under independence as a dummy variable on height with different controls**

VARIABLES	(1) Eq.1	(2) Eq.2	(3) Eq.3	(4) Eq.4	(5) Eq.5	(6) Eq.6	(7) Eq.7
indd	-0.0933 (0.727)	-0.520 (0.746)	0.780 (0.863)	-0.394 (0.763)	-0.526 (0.746)	-0.764 (0.746)	0.888 (0.877)
co	0.393 (0.290)	0.389 (0.296)	1.230*** (0.408)	0.379 (0.296)	0.289 (0.314)	0.481 (0.295)	1.478*** (0.413)
income		0.944*** (0.145)	0.929*** (0.145)	1.029*** (0.181)	0.750*** (0.248)		0.838** (0.367)
indd_co			-1.753*** (0.587)				-1.857*** (0.642)
indd_inc				-0.237 (0.302)			-1.048** (0.502)
inc_co					0.288 (0.298)		0.141 (0.411)
indd_inc_co							1.279** (0.633)
gend	13.19*** (0.249)	13.05*** (0.254)	13.02*** (0.254)	13.05*** (0.254)	13.04*** (0.254)	13.03*** (0.253)	12.60*** (0.251)
language							0.805 (4.317)
geog							0.246 (0.324)
age30_39	-1.521** (0.702)	-1.709** (0.717)	-1.553** (0.717)	-1.690** (0.717)	-1.733** (0.717)	-2.052*** (0.717)	-1.726** (0.712)
age40_49	-2.021** (0.817)	-2.237*** (0.836)	-2.017** (0.838)	-2.224*** (0.837)	-2.256*** (0.837)	-2.503*** (0.836)	-1.950** (0.831)
age50_59	-5.583*** (0.834)	-5.699*** (0.853)	-5.599*** (0.852)	-5.655*** (0.855)	-5.706*** (0.853)	-5.990*** (0.850)	-5.465*** (0.844)
age60_69	-5.967*** (0.871)	-5.769*** (0.890)	-5.735*** (0.889)	-5.708*** (0.894)	-5.765*** (0.890)	-6.148*** (0.887)	-5.341*** (0.897)
age70_98	-7.848*** (0.839)	-7.384*** (0.860)	-7.368*** (0.858)	-7.315*** (0.864)	-7.373*** (0.860)	-7.815*** (0.856)	-6.634*** (0.875)
educ2							1.576*** (0.403)
educ3							1.346*** (0.392)
educ4							1.962*** (0.523)
job1							0.349 (0.314)
qincome1						-2.007*** (0.327)	
qincome2						-2.277*** (0.305)	
Constant	167.9*** (0.780)	167.8*** (0.799)	167.0*** (0.840)	167.8*** (0.801)	167.9*** (0.804)	169.8*** (0.831)	164.4*** (4.458)
Observations	2,726	2,596	2,596	2,596	2,596	2,596	2,572
R-squared	0.567	0.575	0.576	0.575	0.575	0.578	0.576

Results where independence is included as a continuous variable are summarised in the Appendix (Table A2). Again it can be seen that with an additional year spent in independent Slovakia or Czech Republic while growing up there is a significant positive effect on height, contrary to the earlier findings where independence was included as a dummy variable. These results resemble the results for democracy. The

interaction between independence and country in Model 3 shows that with an additional year spent in independent countries while growing up, height increases by 0.4cm for Slovaks and 0.2cm for Czechs. In other words, height is 1cm more for Czechs than Slovaks if a person spent zero years under independence and this difference in height becomes smaller by 0.153 for each additional year under independence ( $1-0.153*\text{indage}$ ). In Model 7 the three-way interaction is significant and the model is also preferred to the model with income only, based on the results of the likelihood ratio test.

When the regression is decomposed by sex, similarly to the case of democracy, the effects were quite different for men and women. For males, years under independence is found to significantly be associated with a height increase in all the models. The country effect shows that the Czech males are significantly shorter than Slovak males. In contrast, for women, years spent under independence is not significantly associated with a height increase in any of the models while a significant positive country effect with Czech women being taller than Slovak women in all models can be observed. There is again a significant education effect while job is not significant for females. Income is not significantly associated with height only when it is included as income terciles where the women in the middle tercile are significantly shorter than the top tercile. The effect of the birth cohort is the same as in the aggregate model where all the cohorts are significantly shorter than the youngest cohort.

#### *Robustness checks*

Two main robustness checks are carried out. First, a reduced sample excluding individuals who are over the age of 50 was analysed as at older ages people's height begins to shrink. As a result the coefficients obtained may have been overestimated. The older individuals are also those who grew up their entire childhood and youth under communism. This double effect may have been biasing the results. The results show that with every additional year growing up under democracy there is a small associated height increase, even when the older tail of the sample is excluded (Table 11). With every additional year growing up under democracy, there is between a 0.17 and 0.37cm height increase. As expected, the coefficients are somewhat lower in this analysis. Furthermore confirming our earlier results, while there is a small height increase with every additional year spent under democracy, there is no significant height difference between the youngest age cohort and the two oldest cohorts. The significance of all the other results is consistent with the main results and the magnitude is only slightly different.

**Table 9. OLS regressions of years lived under democracy as a continuous variable on height with different controls – individuals aged 50 and less**

VARIABLES	(1) Eq.1	(2) Eq.2	(3) Eq.3	(4) Eq.4	(5) Eq.5	(6) Eq.6	(7) Eq.7
demage	0.171*** (0.0294)	0.199*** (0.0762)	0.285*** (0.0828)	0.207*** (0.0781)	0.204*** (0.0762)	0.174** (0.0757)	0.356*** (0.123)
1.co#c.demage							-0.295** (0.125)
2.qincome							-0.497 (1.065)
3.qincome							0.822 (1.023)
1o.co#1b.qincome							0 (0)
1.co#2.qincome							-0.446 (1.255)
1.co#3.qincome							0.0390 (1.218)
2.qincome#c.demage							-0.188 (0.127)
3.qincome#c.demage							-0.233* (0.123)
1o.co#1b.qincome#co.demage							0 (0)
1.co#2.qincome#c.demage							0.0854 (0.163)
1.co#3.qincome#c.demage							0.397** (0.156)
gend	14.20*** (0.307)	14.09*** (0.315)	14.04*** (0.315)	14.10*** (0.315)	14.08*** (0.315)	14.13*** (0.312)	13.53*** (0.311)
language							1.019 (4.268)
geog							0.580 (0.406)
age30_39		0.717 (0.780)	0.563 (0.781)	0.727 (0.781)	0.744 (0.780)	0.294 (0.778)	-0.283 (0.780)
age40_49		0.478 (0.883)	0.348 (0.882)	0.488 (0.883)	0.517 (0.882)	0.257 (0.877)	-0.236 (0.886)
educ2							1.097* (0.614)
educ3							1.033* (0.601)
educ4							1.323* (0.764)
job1							0.578 (0.373)
dem_co			-0.160*** (0.0608)				
co	0.266 (0.323)	0.298 (0.333)	1.282** (0.500)	0.291 (0.333)	0.0177 (0.370)	0.385 (0.330)	1.657* (0.946)
income		0.884*** (0.171)	0.872*** (0.171)	0.964*** (0.237)	0.521* (0.272)		
dem_inc				-0.0156 (0.0320)			
inc_co					0.599* (0.349)		
qincome1							-1.203***

Data from the 2005 Eurobarometer survey (Eurobarometer 64.3: Foreign Languages, Biotechnology, Organized Crime, and Health Items, November - December, 2005) was used to see whether the results show largely similar effects (See Appendix B). The Eurobarometer (EB) survey is a series of cross-national and cross-temporal comparative social science research that started in the early seventies. Representative national samples are interviewed in the European Union member states twice a year. The goal of the EB is to provide data for monitoring of public social and political attitudes in the European Union<sup>9</sup> (Economic and Social Data Service, 2005). This round of the EB survey asked respondents on foreign languages, biotechnology, organised crime and corruption, health consciousness, smoking, AIDS prevention, medical errors, and consumer rights. For the purpose of the analysis, the relevant data came from the demographic and other background information section, including the respondents' self-reported height, age, gender, occupation and urban/rural residence. The variables included are similar to the variables used in the analysis; however there was no data that would allow for a better proxy of income or wealth of the individuals. As a result, only the results from the basic model (Model 1) will be compared. Descriptive statistics can be found in Appendix B. Below the main results are summarised.

In the model where democracy is included as a dummy variable again no significant relationship was identified. In this model gender has a strong significant relationship just like with the WHS data. Contrary to the WHS results, there is a positive

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<sup>9</sup> For more information see the Leibniz Institute for the Social Sciences, Data Archive for the Social Sciences (GESIS) Eurobarometer Survey Series web pages.

significant relationship for country in all the models, suggesting that the Czechs are taller than the Slovaks. When democracy is included as a continuous variable, there is again a positive significant association with height for every additional year lived under democracy. Confirming the main results, the age cohort effect is again only significant for the older generations starting for individuals born before 1955. Results were different in the analysis by gender where a significant height increase can be observed for women rather than men. When independence is examined, results follow the same pattern as for democracy with respect to the WHS results. Overall, the minor difference, especially the gender and the country effect, is likely to be explained by the difference in samples resulting from a different sampling method used by the EB survey where either multi-stage national probability samples or national stratified quota samples are implemented, as opposed to stratified random sampling in the WHS.

## **Discussion and conclusion**

This paper has looked at the changes in stature of the Czech and Slovak population after two important political, social, economic and institutional changes of the twentieth century Eastern Europe - the 1989 transition from the communist regime to democracy, and disintegration of Czechoslovakia in 1993 into two independent countries. Changes in height by gender groups were also examined and robustness was tested by examining a second dataset.

Overall, the following results emerge. First, there has been a significant height increase for every additional year spent under democracy (0.2-0.4cm; 0.18-0.36cm for sample younger than 50 to account for shrinkage) or as independent countries, and part of this effect can be attributed to the transition. Second, political and economic liberalization were directly beneficial, consistently with other studies in East and West Germany, and Spain among others (Costa-Font & Gil, 2008; Hiermeyer, 2008; Komlos & Kriwy, 2002; Komlos & Snowden, 2005). Our results suggest that the transition period did not have a detrimental effect on health and standard of living as heights have continued to increase in both countries. Third, although it was difficult to disentangle the effects of transition to democracy and the break up, most of the findings hold even when democracy is adjusted with the Polity IV index or the analysis is carried out with a different data set (Eurobarometer). Despite the existing evidence of an initial deterioration in the standard of living in the transition countries (Leff, 1996; Milanovic, 1998), our results demonstrate that starting from 1990 there continues to be a small positive effect on well-being as measured by an increase in height.

Finally, when examining the results by income terciles height increases from the poorest to the richest tercile, for both men and women, implying that similarly to Germany (Komlos & Kriwy, 2003), social differences in height exist in both the Czech Republic and Slovakia. These findings are also consistent with the extensive evidence suggesting that inequalities were present already under communism and continued to widen in both countries after 1989 (Cox & Mason, 1999; Milanovic, 1998; Simai, 2006; Szamuely, 1996). There is also a significant education and gender



effect. The level of education achieved is an important determinant of the individual's height. It is important to note that most of the height literature focuses on parental education as a key determinant (Christiaensen & Alderman, 2004; Fedorov & Sahn, 2005) so the education of the individual in this context was a proxy for the individual's capabilities and the importance of schooling on health behaviour (Costa-Font & Gil, 2008; Donald S. Kenkel, 1991). There is no consistent country effect across the models.

The statistically significant interaction between country and years spent under democracy implies that the democracy effect was not the same in the two countries. While the Czechs are on average taller, the Slovaks seemed to have benefited more from the transition to democracy. This result confirms the general hypothesis that the one performing worse has a bigger capacity to benefit. Slovakia was the poorer federation during communism and also had a rougher transition in the initial years under authoritarian rule (Meszaros, 1999). Nevertheless, the Slovaks seem to have benefited from this transition more than the Czechs, which over years has brought an increase in their well-being and standard of living as measured by height.

When comparing across countries by income distribution, the Slovaks benefited more than the Czechs in the bottom and mid tercile with no difference in the top group. Furthermore, with increasing number of years under democracy the poorest in Slovakia benefited more in height than both the mid and top tercile. In the Czech Republic, the bottom tercile benefited more than the middle, and the middle less than the top tercile. As noted above, evidence of inequalities and poverty since transition has been documented. The transition brought along significant social changes where

particular groups benefited – especially those who were benefiting under the previous regime – while others such as pensioners, workers, ethnic groups or women were able to benefit much less; the cost of transition weighed most heavily on ordinary citizens who felt that they had too little influence on the political decisions that affected them (Leff, 1996; Simai, 2006). While the transition years may have impacted negatively on the most disadvantaged, they were still able to benefit in terms height, and more so than the richer groups.

The analysis revealed interesting findings when carried out separately for women and men. For men, the years spent growing up under democracy are significantly positively associated with height, even after controlling for different factors; for women there is no significant effect. The lack of a significant democracy effect for women actually suggests that the institutional and environmental effects during the transition did not bring substantial improvements for women compared to their position in the society under communism; in fact, women felt the erosion of their economic position after the transition with unemployment disproportionately affecting the females (Leff, 1996). Finally, education was an important determinant for both males and females, while income and employment are only significant for men.

There are several limitations to this study. First, the low response rate in the WHS data used for the Czech population may have introduced bias in the results, as non-response bias where responders may be significantly different from non-responders, is difficult to account for. However, when the same results was carried out with Eurobarometer data we did not find significant differences. Second, as has already been discussed earlier, using self-reported height allows for reporting bias, which

limits the precision of the magnitude of our estimates. Thirdly, as has already been mentioned, it was not possible to disentangle the effects of the 1989 transition to democracy and the 1993 disintegration of Czechoslovakia, even though both appeared to have a positive effect on stature as no acceptable control group could be identified. Finally, it can be argued that height does not depend monotonically on health and wellbeing during the first 20 years of one's life, and that some specific years were more important than other. Hence, again the magnitude of the effect might be age specific rather than cohort specific.

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