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Returns to basic skills in Central and Eastern Europe: A semi-parametric approach

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**Returns to basic skills in Central and Eastern Europe:
a semi-parametric approach**

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Returns to basic skills in Central and Eastern Europe: a semi-parametric approach*

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Abstract

This paper uses semi-parametric econometric techniques to investigate the relationship between basic skills and earning in three post-communist countries: the Czech Republic, Hungary and Slovenia using the IALS dataset. While the large increases in the returns to education in the new market economies has been well documented in the literature, no study to date has examined the impact of basic skills and schooling on income. Estimating a Mincer human capital model we find that including a measure of basic skills reduces the returns to education. In addition, using a partial linear model in which log earnings is linear in schooling, but is an arbitrary function of basic skills, we find that this relationship is not well described by the common assumption of linearity at the tails of the distribution.

Keywords: Earnings, Education, Basic skills, Transition
JEL codes: J31

* Corresponding author: Kevin.denny@ucd.ie tel: (+353 1) 716 4632. fax: (+353 1) 716 1108. Address: Economics Department, University College Dublin, Belfield, Dublin 4, Ireland. The first author is also affiliated to the Institute for Fiscal Studies, London. Our thanks to Jan Fidrmunc and Belton Fleisher for comments. Material from the International Adult Literacy is used with permission of Statistics Canada who bears no responsibility for the calculations contained herein and any interpretation by the authors.

I. Introduction

Human capital endowments inherited from the communist regime largely determine the distribution of economic winners and losers in the new market economies of Central and Eastern Europe (see Doyle and Fidrmuc 2005). Those with higher levels of education in the post-communist period consistently display higher incomes, increased satisfaction with economic reforms, a lower incidence of unemployment and higher support for EU membership. Indeed, several studies have investigated the returns to education in the transition countries and all, to varying degrees, have found increases in the returns to education in the post-communist period¹. The majority of these studies however, fail to control for measures of ability or basic skills, which are often included in conventional Mincer human capital models. It has been argued that the type of education attained during the communist system may not be appropriate in a market economy as the school curricula are often outdated and place too little emphasis on problem solving and independent thinking². For this reason, basic skills such as literacy and numeracy may be especially valuable in a post-communist context. The aims of this paper, therefore, are to provide the first estimates of the returns to these skills in the Czech Republic, Hungary and Slovenia and to investigate the extent to which their omission biases the estimates of returns to formal education.

In order to achieve an egalitarian society, central planners under communism compressed the wage structure by implementing wage controls and fixing wages by industry and occupation³. While this essentially suppressed the movement of earning based on education or experience, returns to education under the communist system did exist, although they were typically below those of established Western economies. The inflexible wage structure resulted in a very low deviation between skilled and unskilled earnings. Munich, Svenjar and Terrell (1999) find that the ratio between the highest and lowest wage in the Czech Republic in 1984, was as low as 4.1. Consequently the returns to education were also low. According to Newell and O'Reilly (1997) estimates of approximately 4% and 5% for each additional year of education was common during the communist regime,

¹ For example, Flanagan, 1993; Chase, 1995; Filer, Jurajda and Planovsky, 1999; Munich, Svenjar and Terrell, 1999; Klazar, Sedmihradsky, Vancurova, 2001; Vercernik, 2001 for the Czech Republic. Campos and Jolliffe, 2003; Kertesi and Kollo, 2001 for Hungary. Stanovnik, 1997; Orazem and Vodopivec, 1997 for Slovenia. Bird and Wagner, 1994, for East Germany. Gorodnichenko and Sabirianova, 2004 for Russian and Ukraine. Newell and Reilly, 1997 for nine post-communist countries. Fleisher, Sabiranova and Wang, 2004 carry out a meta-analysis returns in 10 transition countries. For an overview of the evidence on access to education and the rôle of family background, see Micklewright (1999).

² Bal (2002)

³ Flanagan (1998) discusses the evolution of the communist wage grid in detail.

while the returns in market economies are estimated to vary between 6.6% in high income countries and 11.2% in low income countries.

At the start of the transition period it was uncertain whether the skills attained during the communist era would be valuable or redundant in the new market economy. The communist system placed greater emphasis on, and subsequently rewarded, low-skilled blue-collar workers with technical or manual training (see Filer, Juradja and Planovsky, 1999). Flanagan (1998) finds that the communist system over-valued vocational training and under-valued university education. The dismantling of wage controls and the shift in the structure of the economy from manufacturing intensive industries to a more service based economy in the post-communist period, therefore allowed the true value of education to be rewarded and a subsequent shift in demand from low to high skilled jobs.

While it has been quite common to augment Mincer type models with various measures of cognitive ability, the literature concerning the returns to education in post-communist studies, however, has yet to control for the effect of ability or basic skills on earnings. This paper attempts to fill this gap for the Czech Republic, Hungary and Slovenia.

Typically earnings are assumed to be log-linear in measured ability, however several studies (i.e. Tobias, 2003; Denny and O'Sullivan, 2004) have shown that this common assumption of linearity does not hold in the context of the ability/earnings relationship. They argue that there are no theoretical or empirical reasons to support such an assumption, and that such non-linearities may not be captured by simple parametric functional forms such as a quadratic or cubic. For this reason, this paper investigates the earnings/ability relationship using a semi-parametric estimator where the conventional part for the earnings equation is estimated parametrically by least squares and the earnings/ability function is estimated non-parametrically. Intuitively one might expect the returns to ability to vary, with high returns initially and low or zero returns at the top of the earnings distribution. By using a flexible method one can infer the nature of these returns without imposing any functional form.

Our independent variable of interest is a measure of basic skills which is based on tests of literacy and numeracy. This definition of basic skills is essentially data driven. It focuses on cognitive skills 'though one might reasonably argue that non-cognitive skills (such as motivation, reliability, perseverance) are also important in the labour market and

these might also be described as “basic”⁴. In addition one could argue that the ability to use computers is a skill in its own right and is likely to be increasingly important.

The basic skills variable used in this paper is based on tests taken at different ages. Since the regression sample only includes adults who have completed full time education their test scores may be influenced by their level of education. So it is not a pure measure of innate ability (nor was it designed to be) but the two are likely to be correlated⁵. This raises a number of issues: firstly, if it is a measure of innate ability then including it should reduce the coefficient on education due to the usual ability bias argument. If not, that is if it simply reflects another form of human capital, then it is unclear *a priori* what the effect on estimated schooling returns should be. Secondly, if education is endogenous, as is commonly argued in the literature, then any skills which are a function of education are likely to be so also. In the absence of plausible instrumental variables it is not possible to control for this. Thirdly, even those test scores which are considered to represent innate ability are still likely to reflect environmental factors such as family background, and education quality, so it may be difficult to ever derive a true measure of innate ability⁶. This paper therefore interprets the basic skills measure as a combination of innate and acquired ability as mirrored by other studies using the IALS and similar datasets.

In this paper we examine the returns to education and basic skills in three post-communist countries. The paper is organised as follows: Section II presents an overview of the returns to education in post-communist countries literature. Section III discusses the model estimation, section IV presents the data used in the analysis, while section V discusses the results and section VI formulates some conclusions.

II. Returns to Education in Post-Communist Countries

Since 1989 there has been an abundance of studies analysing the returns to education in Central and Eastern Europe. The majority of these studies are concerned with estimating the change in the returns to education between the pre and post-communist periods. In general they find that the returns to education in Central and Eastern Europe has doubled in the last decade, with the estimated returns to one year of education being

⁴ See for example Heckman and Rubinstein (2001) or Bowles, Gintis and Osborne(2001).

⁵ Hansen, Heckman and Milligan (2003) show, using the National Longitudinal Survey of Youth (NLSY) in the USA, that it is possible under certain circumstances to disentangle the effects of education, measured ability and innate ability on wages. These methods cannot be applied to the IALS.

⁶ See Cascio & Lewis (2005) for the NLSY. Magnuson, Ruhm and Waldfogel (2004) show how prekindergarten programs affect reading and mathematical skills at school entry.

approximately 7% (Campos and Jolliffe, 2003). In regards the Czech Republic, Chase (1998) finds that the added income from each additional year of schooling for men, doubled between 1984 and 1993. While Flanagan (1998) finds much smaller returns (3.4% in 1988 to 4.4% in 1993). Filer, Jurajda and Planovsky (1999) find that by 1997, each additional year of schooling increases male earnings by 9.4%. Munich, Svenjar and Terrell (1999) estimate that the rate of return to an additional year of education has increased from 2.7% in 1989 to 5.8% in 1996. Orazem and Vodopivec (1997) and Stanovnik (1997) find similar estimates for Slovenia. While Campos and Jolliffe (2003) and Kertesi and Kollo (2001), in their analysis of Hungary, also uncover similar increases in the returns to education. In particular, Campos and Jolliffe find that returns to a years schooling increased from 6.4% in 1986 to 11.2% in 1998.

While human capital studies typically measure the returns to years of schooling, such an approach may be inappropriate in a transition context where years of education reveal little about the type of education attained, e.g., it fails to distinguish between vocational training, such as apprenticeship, and vocational education. While the returns to a technical education were higher than the returns to an academic education under communism, in the post-communist period one finds the opposite. Indeed, in regards the Czech Republic, Filer, Jurajda and Planovsky (1999) find that the largest increase occurred for general secondary education. Flanagan (1998), conversely, finds that the returns to education increased for university graduates, while there was little change for those with vocational training. More specifically, Munich, Svenjar and Terrell (1999) find that in 1989, Czech men with a university degree earned 28.3% more than those with a junior high school degree; while by 1996 this figure had increased to 72%. Campos and Jolliffe (2003) also find that the returns were greatest in Hungary for those with a secondary general education, while Kertesi and Kollo (2001) augment these results. Overall, these studies suggest that a general education provides skills that are adaptable and flexible during times of turbulence and change.

The majority of post-communist studies estimate the returns for male and female sub-samples, and indeed all reach similar conclusions. Chase (1997) finds that, while women generally have higher returns to education, that the returns for men have increased more in the post-communist period. In addition, Stanovnik (1997) analyses the returns to education in Slovenia in 1978, 1988 and 1993 using Household Expenditure surveys, finds that the returns to more than 12 years of schooling in 1993 have been less for women (3.9%) compared to men (5.4%). Conversely, Orazem and Vodopivec (1997), Newell and

O'Reilly (1997) and Campos and Jolliffe (2003) all find that while the returns for women were greater during the communist period, this effect was eliminated in the post-communist period.

A review of the literature also reveals that majority of post-communist studies are single-country analyses, with only two studies to date adopting a comparative approach. Fleisher, Sabiranova and Wang (2004), in their meta-analysis of 33 returns to education studies in 10 transitional economies, provides the most comprehensive overview of the literature. They find that typically post-communist specific studies tend to deviate from the classic Mincerian model, such that they include several additional regressors, such as industry of employment, firm characteristics and occupational dummies in their models. Most importantly, they do not find any transition study that controls for measures of ability. They discover that the majority of studies rely on years of schooling and that only 5.3% use levels of education, and that in regards the gender divide, approximately half of all studies estimate split sample models. Finally, they find that the returns to schooling had the highest rate of growth during the early transition period. In addition, nearly all studies find that the returns to experience decreased in the post-communist period.

III. Model Estimation

This paper first uses standard linear methods to estimate the returns to basic skills (and other variables) in three countries. It then extends this model and uses a two step estimator of the partially linear model due to Yatchew (1997, 1998, 2003) building on earlier work by Robinson (1998). The underlying model between the dependent variable, log hourly earnings, and its determinants is given by:

$$w = \beta X + f(Z) + \varepsilon \tag{1}$$

X is a set of control variables including years of schooling and a small number of demographic variables. Z is a scalar measure of basic skills and $f(Z)$ is some arbitrary continuous function that we wish to estimate. Z is assumed to have compact support and the first derivative of $f(Z)$ is bounded by some constant. Estimation proceeds in two steps. Firstly one sorts the data by Z and takes first differences. For two adjacent observations, i and j , this generates:

$$\begin{aligned}
w_i - w_j &= \beta(X_i - X_j) + f(Z_i) - f(Z_j) + \varepsilon_i - \varepsilon_j \\
&\approx \beta(X_i - X_j) + \varepsilon_i - \varepsilon_j
\end{aligned} \tag{2}$$

The latter approximation relies on smoothness and continuity of $f(Z)$. Estimation of the second equation by OLS is \sqrt{n} consistent, asymptotically normal but inefficient (Robinson 1988). The inefficiency arises because one can think of the model as an MA(1) process in the residuals: specifically OLS has 66.7% efficiency of the efficient estimator. It is possible to reduce the inefficiency by taking higher order differencing or alternatively one could use the bootstrap. In general for d 'th order differencing the efficiency of OLS is $2d/(2d+1)$ relative to Robinson's (1988) efficient estimator. Differencing in general requires putting a series of weights on each term so, for example, the optimal second order differencing operator is $\Delta_2 X = .809X_t - .5X_{t-1} - .309X_{t-2}$. This paper uses 10th order differencing which is 95% efficient. The weights are given at the end of the paper. The second step uses the estimated parameters from the first stage regression to generate the term:

$$\hat{w} = w - \hat{\beta} X \tag{3}$$

A kernel regression of this variable on the basic skills variable estimates the $f(Z)$ function. One could also use some other method such as fitting a spline function or non-parametric least squares. We present this with pointwise bootstrapped standard errors.

A test of a parametric specification of $f(Z)$ against the null of the partially linear form in (1) is possible by comparing the variances of the restricted and unrestricted model. Say one assumes that basic skills enters linearly so that $f = \gamma Z$. Estimate this restricted model by OLS and define the estimated variance

$$s_{res}^2 = \frac{1}{N} \sum (w - \hat{\beta} X - \hat{\gamma} Z)^2.$$

Using the optimal differencing weights, estimate the differenced model (2) and define the estimated variance

$$s_{diff}^2 = \frac{1}{N} \sum (\Delta w - \hat{\beta}_{diff} \Delta X)^2$$

where $\hat{\beta}_{diff}$ is the OLS estimate of β from the differenced model. Yatchew (1997) shows that for d 'th order differencing

$$\sqrt{d \cdot N} (s_{res}^2 - s_{diff}^2) / s_{diff}^2 \sim N(0,1) \quad (4)$$

So large values of this test statistic will reject the restricted hypothesis against the null of the semi-parametric alternative (1).

IV. Data

The analysis is carried out using the International Adult Literacy Survey (IALS) which was administered by twelve countries in association with the EU, the OECD and UNESCO in a series of waves between 1994, 1996, and 1998 (eight additional countries were included in 1998). While the initial wave of surveys were administered in 1994, the Czech, Slovenian and Hungarian surveys were performed as part of the second wave which was conducted in 1998. Overall, 3,132 respondents from the adult civilian population aged between 16 and 65 were included in the Czech survey, 2,593 in the Hungarian and 2,972 in the Slovenian. The surveys were initially performed to provide a common mechanism that would enable comparison of literacy proficiency across countries, however by design, the survey measure encompasses a much broader range of cognitive skills⁷.

The IALS is structured around three stages. Stage one required the respondent to complete a background questionnaire, which included information on age, sex, education, labour market experiences and literacy related activities. Stage 2 involved the completion of 6 simple assignments; if the respondent answered incorrectly on more than two of these tasks the interview was terminated. This was to avoid re-interviewing those respondents of whom it is known that their literacy levels are already very low. Finally, the respondent was required to complete a booklet of tasks, from which their literacy level was determined. This literacy level is measured on three scales: prose, document and quantitative. Prose literacy is the knowledge required to understand and use information from texts, such as newspapers, pamphlets and magazines. Document literacy is the knowledge and skill needed to use information from specific formats, for example, maps, timetables and payroll forms. Quantitative literacy is defined as the ability to use mathematical operations, such as calculating a tip or compound interest. In order to provide an actual measure of literacy each individual was given a score for each task, which varied depending on the difficulty of the assignment. Scores for each scale range from 0-500. The measure of basic skills used is simply the average over the three literacy types: prose,

⁷ A number of papers have used the IALS to examine the returns to basic skills in specific countries e.g. McIntosh and Vignoles (2001), Denny and Harmon (2001), Green and Riddell (2003).

document and quantitative. The score in each domain is calculated using Item Response Theory whereby the difficulty of each question is taken into account.

While in principle one could have attempted to distinguish between the effects of these different skills, in general the correlations between them are very high so it not practical. Whether this is because these abilities are genuinely highly correlated or because this an artefact of the survey instrument we cannot tell⁸. So in general we simply take the average over the three measures of literacy. We then rescale this average to have a mean of zero and a standard deviation of one for the entire sample i.e. within the three countries.

V. Results

Descriptive statistics are provided in Table 1. The OLS estimates of the basic earnings equations, both including and excluding the basic skills measure, are in Table 2. The dependent variable is the natural log of hourly earnings⁹. Human capital is measured by years of education. An alternative measure, often used in many of the papers on transition economies, is educational levels. However as the educational systems differ it is not possible to provide a simple classification of education levels which is consistent across the three countries. The OLS estimates of the returns to skills using the data on education levels yield very similar results.

The specification also includes a small number of additional controls; age and dummies for gender and living in a rural area. Males and females are pooled given the sample size. The square of age is omitted, as rather unusually, it is never statistically significant. Controlling for family background, using father's level of education, also makes no difference.

As seen in Table 2, the returns to education across all three countries is, in general, both statistically and economically significant. The marginal return to a years education is the lowest in the Czech Republic at just below 6%, closely followed by Hungary with 6.5%, while the marginal return is the highest in Slovenia at 7.1%. These returns are of similar magnitude but somewhat smaller to those found in the existing literature and discussed in Section II. The penalty associated with being female varies considerably, from a high of 25% in the Czech Republic to around 10% in Slovenia.

⁸ Reder (1998), in an analysis of the US' National Adult Literacy Survey, the precursor to the IALS, casts doubt on whether the three measures identified distinct types of functional literacy. This, and other potential difficulties with the IALS measures, are discussed by Goldstein (2000).

⁹ For most IALS countries the earnings data is only given in 5 bands. However a continuous earnings variable is available for a subset of countries including the three used here.

For each country, the basic Mincer is augmented by a measure of basic skills. The coefficient is the return to a one standard deviation increase in basic skills. In Hungary the return to basic skills are not statistically significant whereas in the other two countries the return to a one standard deviation increase in skills is well determined and around 6-7%.

Since in general skills are positively correlated with education, the return to years of education falls by between 0.5 and 1.5 percentage points. This is somewhat smaller but not out of line with estimates of “ability bias” summarized in Bowles *et al* (2001). In an analysis of all the IALS countries but using a different specification, Denny, Harmon & O’Sullivan (2003) find that the “ability bias” is quite similar across different countries. The latter paper also shows that amongst the IALS countries, returns to basic skills in the transition economies are either low (Slovenia, Hungary) or about average (Czech Republic). As the other coefficients in the model are essentially unchanged this suggests that basic skills are largely orthogonal to those variables. The finding that returns to skills in Hungary are not significant is quite surprising and out of line with international evidence in general, including other research with the IALS data for other countries.

To explore this further we use the semi-parametric methods outlines in Section II to estimate the earnings/basic skills function. Figures 1 to 3 show the functions for the three countries. 95% confidence intervals are based on point-wise bootstrapping (400 replications) and each function is normalized to start at zero.

The graphs reveal that none of the functions look close to being linear over the whole support. In addition the three countries show quite different patterns. Figure 2 (Hungary) clarifies why the estimated linear return to skills in Table 2 is not statistically significant since the curve is quite flat except for increasing returns at the end of the distribution, suggesting, somewhat surprisingly, that it is only very high levels of basic skills that generate positive returns. In the Czech Republic (Figure 1) there are initially high returns which, after apparently some negative returns, yield a lower return over the rest of the support. In Slovenia, zero or negative initial returns give way to positive returns.

A disadvantage of these non-parametric estimates is that a straightforward value for the marginal return is not immediately available. To overcome this we experiment with a linear spline specification using Figures 1 to 3 to choose the appropriate knots since it appears that each function may be closely approximated by a small number of linear segments. The estimates of the spline function models are reported in Table 3 with the values of knots given below the table. These knots can be seen to correspond approximately to the main turning points in Figures 1 to 3. Table 3 shows a high initial

return in the Czech republic of .554 followed by a brief interval over which the return is negative and thereafter a return of .08. In Hungary for most of the distribution the returns are indeed close to zero, except for very high values of ability where there are exceptionally high returns.

To compare the returns to skills relative to returns to education one can divide the respective coefficients in Table 2. For the Czech Republic this is 1.638 (.077/.047), for Hungary it is .59 and Slovenia 1.16. This shows that there is considerable variation in these relative returns and suggests, for example, that policy makers in Hungary should focus on boosting formal education to increase peoples earnings.

The spline functions impose a restriction on the earnings/skills function and one can use the statistic in (4) to test the validity of this against the non-parametric alternative. The test statistics in Table 4 show that one *cannot* reject the spline specification against the partially linear model for all three countries. Of course one had to estimate the non-parametric model in the first place to be able to choose the spline knots suitably. A t test for equality of the slopes of the splines is given at the bottom of Table 3: equality can clearly be rejected for the Czech Republic and Slovenia and is borderline for Hungary. However, since relatively few observations are found in the tails of the distribution, these non-linearities may not be empirically important.

Table 5 gives the returns to schooling from the differenced model underlying the non-parametric estimates in figures 1 to 3. One can note that they are quite close to those in Table 3 and to the second column for each country in Table 2. In short, it does not seem to matter for the Mincer return how one specifies the skills part of the model.

VI. Conclusions

According to Schultz (1975) the demand for entrepreneurial skills increases in economic systems characterised with dis-equilibrium and uncertainty, as such skills enable individuals to adjust more effectively to dramatic changes. Bowles *et al* (2001) make essentially the same argument in a Schumpeterian framework. The post-communist period typifies such a volatile state; therefore individuals possessing entrepreneurial skills should be rewarded accordingly. In general, years of education are unlikely to be a good measure of entrepreneurial skills and this should be even more pronounced when education was obtained in the communist era. It seems plausible that indicators that, at least to some extent, capture cognitive abilities will be a better measure of entrepreneurial skills. Individuals possessing a high level of basic skills may be more equipped to adapt to the

new competitive economy. Andrén *et al* (2005) argue that the return to entrepreneurial skills in the presence of rapid institutional and organizational change has been central to the recent increase in the returns to education in Romania.

This paper provides the first estimates of the return to basic skills in three transition countries. Augmenting a basic Mincer type equation with a measure of skills based on tests of literacy and numeracy we show that returns are significant in Slovenia and the Czech Republic but not in Hungary. However, using a more flexible specification of the earnings-skills relationship shows that the linear specification is not appropriate as the returns vary considerably over the range of skills and in a different way for each of the countries. For Czechs, the highest returns are for those with lowest skills whereas the opposite is true for Hungary. Indeed for much of the distribution of basic skills in Hungary, the returns are negligible.

Why the returns to skills differ across these countries is unclear. A simple supply side explanation does not help since the relative returns to education and basic skills are not correlated with the relative endowment of these factors, based on the mean levels of education and skills given in Table 1. It may be that entrepreneurial skills and the ability to profit from the dramatic changes in the structure of the economy, as measured by basic skills, were not as important in Hungary. By the time this data was collected in the late 1990s, the reform process was quite well developed in Hungary, as unlike the other two countries market reforms were introduced in the 1980s¹⁰. That said, there are well-determined returns to basic skills in mature Western economies.

For policy makers developing education and training policies, it is important to not make unnecessary assumptions about the returns to skills. Knowing how the affect of skills varies across the population is useful since this allows one to target the appropriate policies to foster human capital. Using flexible econometric methods, along the lines shown here, therefore provides useful information for the design of such skills policies.

¹⁰ See Flemming and Micklewright (2000).

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Table 1: Descriptive Statistics

	Czech	Hungary	Slovenia
Income (hourly wage)	51.70 (27.18)	261.19 (164.55)	506.53 (254.44)
Basic Skills	2.92 (0.43)	2.62 (0.42)	2.44 (0.56)
Years of Education	13.15 (2.68)	12.39 (3.04)	11.48 (2.80)
Women	0.52	0.51	0.48
Age/10	4.06 (1.03)	3.80 (1.06)	3.67 (0.92)
Rural	0.26 (0.44)	0.37 (0.48)	0.28 (0.45)
N	1308	885	991

Notes: Means and standard errors (in parenthesis) are reported. Wages are in Czech koruna, Hungarian florints and Slovenian tolar. In 1998 US\$ these are \$1.50, \$1.18 and \$3.20 respectively, using the mean exchange rate over the period in which the data was collected.

Table 2: OLS Estimates of Czech, Slovenian and Hungarian Earnings Function

	Czech Republic		Hungary		Slovenia	
	(1)	(2)	(1)	(2)	(1)	(2)
Basic Skills	~	0.077*** (0.015)	~	0.036 (0.024)	~	0.065*** (0.016)
Years of Education	0.057*** (0.005)	0.047*** (0.006)	0.065*** (0.006)	0.061*** (0.006)	0.071*** (0.005)	0.056*** (0.006)
Woman	-0.255*** (0.024)	-0.252*** (0.024)	-0.161*** (0.034)	-0.161*** (0.034)	-0.094*** (0.028)	-0.106*** (0.028)
Age	0.044*** (0.012)	0.054*** (0.012)	0.037** (0.016)	0.043*** (0.016)	0.078*** (0.017)	0.090*** (0.017)
Rural	-0.085*** (0.025)	-0.082*** (0.025)	-0.038 (0.035)	-0.039 (0.035)	-0.086*** (0.032)	-0.071** (0.032)
Constant	3.051*** (0.084)	3.116*** (0.085)	4.561*** (0.092)	4.597*** (0.095)	5.078*** (0.087)	5.240*** (0.095)
N	1308	1308	885	885	991	991

Notes: Heteroscedastic robust standard errors in parenthesis. Significance levels: *** 1%, ** 5%, * 10%

Figure 1 Log hourly wage/basic skills function: Czech

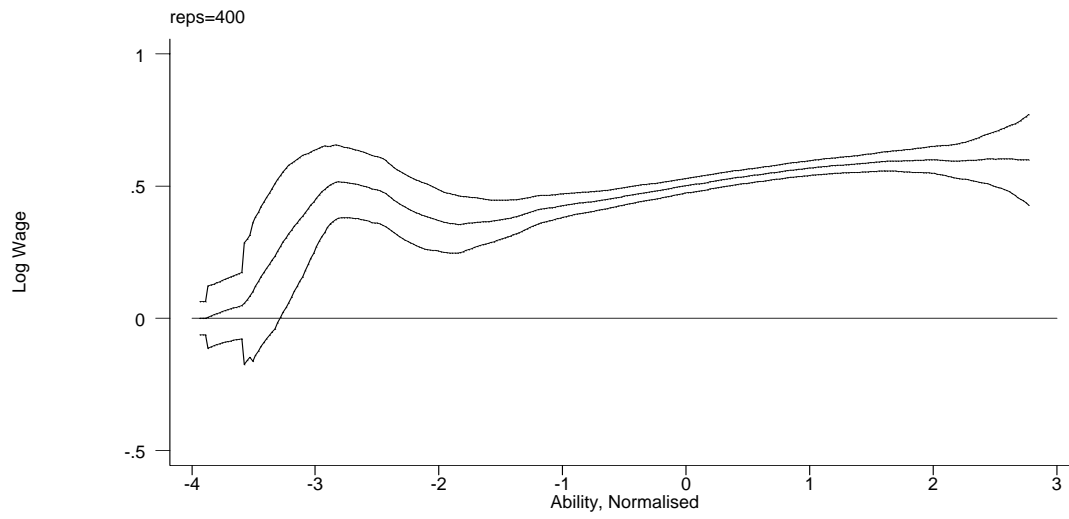


Figure 2 Log hourly wage/basic skills function: Hungary

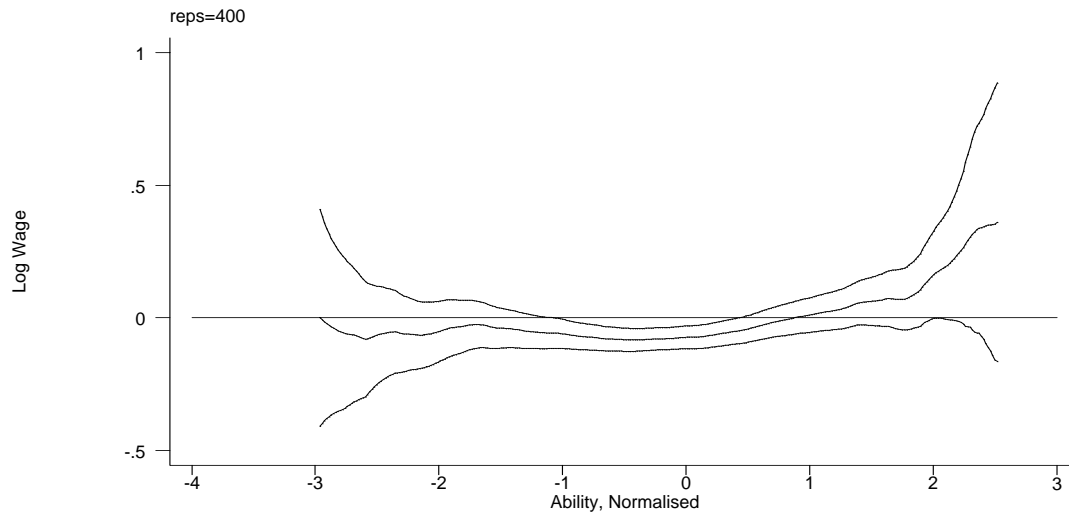


Figure 3 Log hourly wage/basic skills function: Slovenia

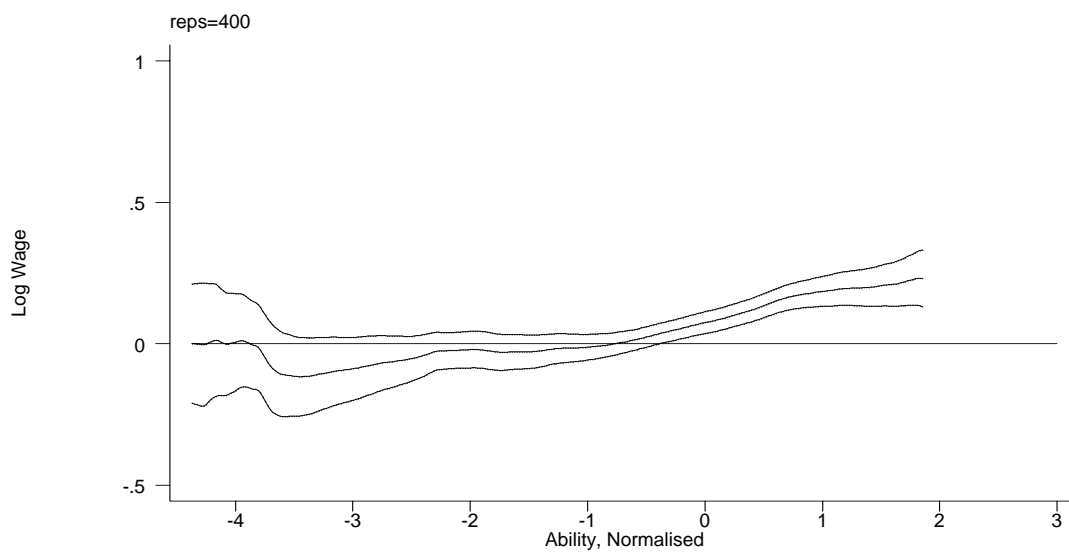


Table 3: OLS Estimates of Czech, Slovenian and Hungarian Earnings Function with Splines

	Czech Republic ¹	Hungary ²	Slovenia ³
Basic Skills: Spline 1	0.554*** (0.085)	0.029 (0.024)	0.072 (0.536)
Basic Skills: Spline 2	-0.330** (0.136)	1.154** (0.586)	-0.771 (0.710)
Basic Skills: Spline 3	0.080*** (0.016)	~	0.069*** (0.017)
Years of Education	0.047*** (0.006)	0.060*** (0.006)	0.056*** (0.006)
Woman	-0.251*** (0.023)	-0.160*** (0.034)	-0.106*** (0.028)
Age	0.053*** (0.012)	0.044*** (0.016)	0.089*** (0.017)
Rural	-0.082*** (0.025)	-0.040 (0.035)	-0.070** (0.032)
Constant	4.765*** (0.352)	4.595*** (0.095)	5.505** (2.297)
N	1308	885	991
t test for equality of slopes of splines	21.21***	3.64*	7.09***

Notes: Heteroscedastic robust standard errors in parentheses. Significance levels: *** 1%, ** 5%, * 10%

¹ The cut-off points for the Czech splines are -2.7 and -1.8.

² The cut-off point for the Hungary spline is 1.9.

³ The cut-off points for the Slovenian splines are -3.9 and -3.6.

Table 4 Testing non-parametric estimates against spline functions in Table 3

	Czech Republic	Hungary	Slovenia
Test statistic N(0,1)	1.036	0.354	1.62

Note: Tests based on equation (4).

Table 5 Return to years of education in differenced model

	Czech Republic	Hungary	Slovenia
Years of Education	0.046 (0.005)	0.062 (0.007)	0.051 (0.006)

Note: These are the returns to years of education from the estimation of (2) but using optimal 10-th order differencing.

Optimal 10'th order differencing weights: (from Yatchew (2003) Table 4.1)

For m=10, the weights $d_0 \dots d_{10}$ are

0.9494, -0.1437, -0.1314, -0.1197, -0.1085, -0.0978, -0.0877, -0.0782, -0.0691, -0.0527