Are There Increasing Returns to Local Concentration of Skills? Evidence on Wages and Returns to Education in Transition

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Abstract

In this paper I use extensive spatial variation in end-of-communism local skill endowment to test for the presence of human capital spillovers and to understand the regional variation in returns to education in a transition country – the Czech Republic. The evidence is consistent with a tendency of skill-intensive production to locate in areas relatively abundant in skills, but I find no evidence for "increasing returns" from local concentration of human capital.

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1 Introduction

The "new economic geography" literature makes the case that in presence of strong increasing returns or local externalities, economic integration is likely to result in the most productive factors flowing to the advanced regions where increasing returns can be realized. In particular, the literature argues that spatial concentration of production factors leads to self-reinforcing spatial divergence (e.g., Fujita, Krugman, and Venables, 1999). Persistent and by some measures growing within-country disparities have therefore become a key concern in the process of European integration, both for the academic and policy audiences.[1]

An important potential source of regional divergence featured in this literature is local human capital concentration. In theory, both skill-capital complementarities and positive human capital externalities can provide an advantage to areas with high skill endowment.[2] There is now evidence that the skill level of U.S. cities has fundamental effects on their population growth (Glaeser et al., 1995) and wage levels (Moretti, 2004). It is difficult to separate the effect of human capital concentration on economic outcomes from the reverse causality. An important source of exogenous variation in local skill level used in this literature is the historical presence of colleges.[3]

In this paper I argue that the recent experience of post-communist economies, and of the Czech Republic in particular, provides a useful case for asking about the importance of local concentration of human capital for regional divergence. First, these countries underwent massive reallocation of production. According to Jurajda and Terrell (2003) more jobs were provided by newly started private firms than by companies surviving from communism only five years after the 1991 start of the

[1] See, e.g., Puga (1999) and Giannetti (2002) for recent theoretical advances, and Canova (2001) and Puga (2002) for a discussion of the European Community's views and regional policies.

[2] Based on these theoretical arguments, initial differences in the spatial distribution of human capital may be further exacerbated by skill-biased labor migration (Giannetti, 2003, and Devillanova, 2004).

[3] While Glaeser and Saiz (2003) rely on the exogeneity of the local number of colleges in 1940, Moretti (2004) utilizes the spatial distribution of colleges as of 1862.

Czech pro-market reforms. The transition process involved dramatic skill upgrading (Commander and Köllő, 2004) as well as increasing international integration manifested in large inflows of foreign direct investment (FDI)[4] and culminating in the accession into the European Union (EU) of 8 post-communist countries. Second, as I document using the case of the Czech Republic, these economies inherited from communism an extensive spatial variation in skill endowments, which was further magnified during the transition period. To a large extent, this variation can be traced to the establishment of a college before and during the communist era.[5]

I therefore use this variation to ask if areas facing the market forces and international integration with more human capital feature higher wages as of the end of the first transition decade – in 2001. I also estimate Czech local returns to education and relate them to relative skill supply in order to ask whether the adoption of skill-biased technologies (and the local skill-biased demand shock) has been stronger in areas that inherited more skilled labor.

In both cases I find no evidence for any role of the local human capital concentration beyond standard imperfect-substitution and relative-supply effects. In particular, wages of college-educated workers are not higher in areas endowed with more college education, but wages of less educated workers positively co-vary with the concentration of college degree holders, consistent with imperfect substitution among different types of labor (Moretti, 2004). Relative local supply of skills negatively covaries with relative wages by skill. Focusing on the exogenous part of the relative skill supply variation allows me to estimate the slope of the demand function: the implied relative demand elasticity is fully consistent with that estimated by Bound et al. (2004) across U.S. states. Taken at face value, this would suggest a substantial tendency of skill-intensive firms to locate in areas relatively abundant in skilled labor, but the effect falls short of equalizing skill premia across

[4] The Czech Republic attracted more FDI (as a percentage of GDP) than any other Central European country.

[5] In the empirical analysis, I control for the local industrial structure as of the end of central planning, which could plausibly be correlated with both local skill level and transition skill-biased demand and productivity shocks.

locations with different labor supply.

The evidence provided here on the variation in local returns to education complements two strands of transition economics. First, a large body of empirical research documents the rise in returns to education following the collapse of central planning, but the relative importance of various underlying causes of the rise in returns, including, e.g., institutional factors or skill-biased technological change, remains unclear.[6] I estimate local-area returns to education within one institutional environment and show that they vary on a scale similar to that present in the before/after transition studies. To shed light on the underlying forces of the variation in returns I evaluate the role of local labor FDI, population density, and price level.

Second, the present analysis complements the regional-equilibration empirical research from transition countries. The transition from planning to market led to a dramatic increase in regional variation of economic outcomes. While the 2002 unemployment rate in Italy ranged from 3% in the North-eastern regions to 18% in the Mezzogiorno, in the Czech Republic a similar disparity between unemployment rates occurs across districts mere 80 kilometers away[7] and such differences are typical of other transition economies as well (Bornhorst and Commander, 2004). There is now a growing literature suggesting that the persistence of these regional inequalities in transition countries is supported by weak equilibration mechanisms, including an insufficient wage and labor mobility adjustment (see, e.g., Bornhorst and Commander, 2004, Fidrmuc, 2004, or Huber, 2004). By documenting the spatial variation in skill concentration, I am able to assign half of the local-area variation in unemployment rates to the local skill endowments and to provide an explanation for the observed lack of mobility based on skills and relative wages.

The paper is organized as follows. In the next Section, I illustrate the Czech districts' imbalances

[6] Two recent studies consider the variation in country-level returns to education in post-communist countries: Fleisher, Sabirianova, and Wang (2004) and Denny, Harmon, and Lydon (2002).

[7] While Prague-West had a registered unemployment rate of 2.3%, the district of Most, about 80 kilometers away, faced a 21% unemployment rate as of 2001. See Section 2 for the definition of Czech districts.

using data from the 1991 and 2001 census. Section 3 then discusses the economic theory of regional labor market disparities and presents the estimated local private returns to education and wage spillover effects based on a large matched employer-employee data set covering salaried employment in the Czech enterprise sector in 2001. Concluding remarks are offered in Section 4.

2 Czech Local Labor Markets

There are 74 districts in my data corresponding to the European Comission's NUTS-4 regional level ("Nomenclature of Statistical Territorial Units").[8] Excluding the capital city of Prague, these districts are very small territorial units with average population over 15 years of age of 100 thousand and average labor force of 60 thousand as of 2001. The Prague metropolitan area then has the population and labor force of ten times the respective district average and corresponds to a NUTS-3 level. As of 2001, the district unemployment rate ranged from 3 to 20 percent with a national average rate of 8 percent, resulting in a coefficient of variation of 0.44.[9]

2.1 Educational Disparities

This section documents district disparities in educational attainment and asks about their change over time: between 2001 and 1991.[10] Figure 1 plots the 1991 college-education shares of district population over 15 and shows that imbalances in educational endowment of districts are significant even outside of the two main cities, Praha (Prague) and Brno. (Brno, the capital of Moravia, is

[8] The Czech Republic's districts were originally established in 1960. I pool all Prague's city districts as well as the two suburban districts of Prague East and West into one 'super' district because the city forms one large labor market. Further, one district (Jeseník) is dropped because of time inconsistencies.

[9] This statement applies to both the registered unemployment rate calculated off the unemployment registry of the District Labor Offices and to the unemployment rates based on the International Labor Organization's (ILO) definition, which come from the 2001 census.

[10] Educational structure of the district labor force or employment can be estimated for 2001, but is not available for 1991; hence, the time change of local education is investigated using population shares.

the second largest city after Prague.) Furthermore, during the 1990s, there were large changes in district shares of college-educated population: The absolute increase in the share of college-educated population has been fastest in districts which already had a high share of inhabitants with a college diploma.[11] Not surprisingly, there is also a strong positive association (not shown) between the district population shares of college degree holders and the district average years of education imputed from the district educational-degree composition using the typical number of years of education required to attain each type of degree.[12]

The variation in district populations' educational composition stems from two main sources: local education production, and skill-biased migration. Czech public colleges were the sole providers of tertiary education until the end of communism; today, they continue to provide the vast majority of college degrees in the Czech Republic and they remain highly over-subscribed. Their expansion is limited by the low government spending on education and their tuition-free status (OECD, WB???). The presence of a public college in 12 out of 74 districts alone explains 52% of the 2001 district variation in the share of college-educated population and it explains 33% of the variation in the change of college-educated population between 2001 and 1991.[13] Students residing near a college may be more likely to graduate from college than those growing up far from a college town. Further, those from rural districts graduating from city colleges may be more likely to stay in the college town.

The present distribution of public colleges, which drives much of the variation in district college concentration, was established under communism and may therefore be thought of as being

[11] District inequality in college shares actually declined during the first transnition decade: As the district average of the share of college educated population grew from 7 to 13% between 1991 and 2001, the coefficient of district variation in this share declined from 39 to 28 percent. However, a more economically meaningful question may be how the dispersion changed relative to the new higher average demand for skilled labor.

[12] This association is weaker in terms of 2001-1991 changes. See Section 2.2 for details on specific education degrees.

[13] Bound et al. (2004) find only a modest link between the production and stock of baccalaureate degree recipients in the more mobile US population and across much larger territorial units – the US states.

exogenous to the skill demand and productivity shocks of the new post-communist economy. Most of Czech colleges were established by the end of the 1960s and only a small subset was originally related to a local large firm.[14] Nevertheless, in districts where the original impetus for establishing a university was tied to strong manufacturing and to the extent that this manufacturing was important as of 1991, it is likely that overall labor demand dropped during transition, but the effect on relative demand for skilled labor is unclear. When relying on the exogeneity of the spatial distribution of tertiary education production, it is therefore important to control for end-of-communism industrial structure.[15]

Overall, I document extensive end-of-communism variation in local high-skill concentration as well as large changes in educational composition of local populations leading to more concentration of highly educated workers.[16] Migration studies of cross-district residence change (e.g., Fidrmuc, 2004) find small year-to-year migration flows on the order of 1%, but these small flows mask large medium-to-long-term effective change in district high-skill endowment driven in large part by local education production. The observed pattern is consistent with higher mobility of more educated workers (after or during education) attracted by locations with a higher share of highly educated and may correspond to the regional divergence scenarios modeled in recent economic theory of migration and local returns to skill (Giannetti, 2003; Devillanova, 2004).

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[14] Except for Prague and Olomouc, where universities were founded by 1348 and 1573, respectively, the other Czech colleges were typically established during the 1950s and 1960s. They often started as a pedagogical faculty (in, e.g., Ústí nad Labem, Hradec Kralové, or České Budějovice) or as engineering faculties tied to local manufacturing or chemical production (in, e.g., Plzeň, Zlín, Pardubice) and they all branched out into other fields by adding faculties over time.

[15] While industrial structure surely predicts the extent of reallocation, more reallocation in transition occurs within industries than across industries (Jurajda and Terrell, 2003; Commander and Faggio, 2003).

[16] The Czech variation in local education endowment is not exceptional in the EU-8 context. In both Prague and Budapest, about a fifth of the population has a college degree, that is about twice the national average. Across the 13 remaining Czech NUTS3 regions, the share of population over 15 with a college diploma varies from 5 to 10 percent, while the corresponding range is 6 to 10 percent across the 19 Hungarian similarly-sized regions.

2.2 Education and Unemployment Disparities

In this section, I ask about the importance of the variation in local skill endowments for the extensive regional disparity in unemployment, which is the focus of the growing transition regional-equilibration literature. For example, Bornhorst and Commander (2004) study the behavior of labor mobility, employment creation, out-of-labor-force movements and wage adjustment in response to persistent unemployment regional disparities in six transition economies. Their evidence is "rather sobering" as none of the equilibrating mechanisms appears to play a significant role in reducing regional disparities. Similarly, Fidrmuc (2004) who analyzes labor mobility in four transition countries finds that "the efficacy of migration in reducing interregional unemployment and wage differentials is low."[17]

However, none of the existing studies pays close attention to the regional variation in educational endowment. In this section, I combine information on the education structure of district labor force with registered unemployment counts by education to present the first available evidence on district-education-specific unemployment rates in a transition country.[18] To provide descriptive evidence on district-education-specific wages used in the rest of the paper, I also present the corresponding wage variation.

Although the structure of the Czech educational systems parallels those of other European countries, there is a significant difference in the educational structure of the labor force: While the secondary school completion rate is very high, only a small proportion of Czech workers have completed university. This fact is not surprising given that a major group of secondary-level students

[17] There is now also a set of wage-curve studies, which typically find statistically significant, but economically weak wage adjustment to changing unemployment (see, e.g., Münich and Galuščák, 2003, for a study of the Czech Republic).

[18] The district-education-specific unemployment rates are estimated using 2001 region-education-specific labor force participation rates combined with 2001 district-education-specific counts of population and registered unemployment. The Czech Republic consists of 14 regions (NUTS-3 level) and 77 districts (NUTS-4 level).

attends apprenticeship programs which offer only dismal prospects of continuing on to higher education degrees.[19] Most of the apprenticeship programs do not lead to a school-leaving examinations ("maturita" in Czech), which is a pre-requisite for tertiary education. (These exams approximately correspond to the U.K. General Certificate of Education (GCE) or the German "Abitur" exam.) My preferred categorization of the different education degrees used in the subsequent analysis is therefore into four groups: (i) elementary education, (ii) apprenticeship without GCE, (iii) all types of secondary education with GCE combined, (iv) and college degrees and higher.[20]

Figure 2 illustrates the dramatically higher regional variability of unemployment rates for lower educated workers. The graph plots the unemployment rates for the lower 3 education groups and the 45 degree line against the unemployment rates of college graduates. While unemployment rates for the college-educated range from 1 to 3 percent, unemployment rates for high-school graduates range from 3 to 14 percent, and unemployment of workers with only the compulsory (elementary) 8 to 9 years of education goes from 5 to 60 percent.[21]

On the other hand, nominal wages vary more for highly educated workers: Figure 3 presents the variation in education-district-specific residuals from a national log-hourly-wage regression controlling for workers' gender, experience and its square and their employer's size (total employment), its square and two-digit industry.[22]

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[19] While total enrollment in Czech colleges doubled during transition, college completion rates decreased. Given the large size of cohorts graduating from secondary schools during the 1990s, tertiary attainment in the Czech population aged 25-34 remains starkly low at about 12% (OECD, 2003).

[20] This grouping roughly corresponds to the OECD classification of education levels—the ISCED groups. Category (i) essentially consists of compulsory education and spans ISCED levels 1 and 2. Category (ii) corresponds to ISCED 2 and a small group of workers with ISCED 3C. Category (iii) is identical with ISCED 3A. Finally, the highest category (iv) covers ISCED levels 5 and 6.

[21] These figures are consistent with the national-level unemployment rates by education based on the labor-force survey data. In particular, the ILO unemployment rate of those with only elementary education (ISCED 1 and 2) was 22% in 2001 and Prague, the largest district, had the lowest overall unemployment rate.

[22] See the Appendix for a description of the wage data.

How can these two patterns be reconciled? As many other EU economies, the Czech Republic has a generous nation-wide level of social support that likely constitutes a welfare trap for low-educated workers (OECD, 2002).[23] Social support provides an effective wage floor such that if there are large differences in worker productivity across districts (or large differences in relative demand for skilled workers), a larger fraction of low-educated low-productivity workers will end up jobless in the less-productive areas.[24]

The evidence given above suggests that local education endowments are a major determinant of regional disparities. Indeed, educational structure of districts' population explains nearly 50% of the cross-sectional variation in district unemployment rates.[25] If low-educated workers face similar wage levels across districts because of an effective wage floor set up by a national social support scheme, then local wage adjustment to high unemployment rates of these workers is unlikely. Further, low-educated workers face high unemployment rates in all areas, likely lowering the incentive to migrate. Educational structure therefore provides a prime explanation of the persistence of spatial unemployment variation attacked in the transition regional-equilibration literature.

[23] To illustrate the work disincentive effect of these support schemes, consider the Czech social assistance benefits in early 2002, when the average gross monthly wage was over 15 thousand CZK and the pre-tax (net) minimum wage was 5,700 (4,715) CZK. During that time, the minimum living standard for a single individual was 4,100 CZK and a family of two adults and two children aged 11-15 was guaranteed the income of 12 thousand CZK, which is above the after-tax average monthly salary. In some cases, other forms of social support (child and parental allowances) are available on top of the guaranteed minimum subsistence level.

[24] In contrast, in the US, wages of lower educated workers are downward flexible and indeed vary more across locations than wages of highly educated highly mobile workers (Topel, 1986).

[25] The R-squared in an OLS regression of district 2001 ILO unemployment rate on the shares of each education group in the district population is 0.49.

3 Local Wage Analysis

3.1 Testing for Human Capital Spillovers

In this section I rely on the variation in the location of Czech public colleges established under communism to ask whether wages of otherwise identical workers are higher in districts with a higher concentration of human capital.[26]

A productivity spillover from the local concentration of highly skilled workers would be consistent with market failure and would motivate optimal subsidy to human capital (e.g., Heckman, 2000). Human capital externalities are also invoked in economic development theory (e.g., Lucas, 1988). However, only mixed evidence exists to-date on the presence of such externalities (Moretti, 2004; Acemoglu and Angrist, 2000).[27]

A fundamental problem with identifying the spillover effect is the potential presence of locality-specific unobservable characteristics affecting both wages and the share of highly educated workers.[28] The Silicon Valley technology boom is a prime example of such local-demand-shock bias as it raises both local productivity and the share of highly educated labor. However, given the communist miss-allocation of resources, one can plausibly think of the 1991 presence of a public college as being historically predetermined and orthogonal to current district-specific productivity shocks (see Section 2.1). Alternatively, one could consider the 1991 concentration of college education as being exogenous.

Another difficulty with identifying the causal impact of local human capital concentration on wage levels is that wages of less educated workers may increase in regions experiencing a rise in

[26] In this approach I follow Moretti (2004); see also Glaeser and Saiz (2003) for a similar identification strategy.

[27] For the underlying theories of human capital externalities, see, e.g., Kremer (1993) and the extensive set of references offered in Moretti (2004).

[28] There is also a potential bias from individual unobservables, which, I am not able to address. Both Moretti (2004) and Glaeser and Maré (2001) suggest that this bias is small.

their share of highly educated workers because of imperfect substitution across skill types.[29] Moretti (2004) therefore seeks qualitative evidence on the existence of spillovers by relating the wages of highly educated workers to the share of these workers in local labor force. I follow this approach and present the results in Table 1. The details of the estimation procedure and the data description are given in the Appendix.

The upper left panel of Table 1 reports the estimated coefficients from a regression of adjusted log wages of college degree holders in a district on the district's 1991 population share of college labor. The bottom left panel then performs the same exercise using the 2001 districts' employment share of college labor.[30] A major weakness of this analysis is the inability to fully control for permanent district-specific characteristics such as physical and cultural amenities. It is therefore important to test for the sensitivity of the results with respect to excluding the main cultural centers – Prague and Brno.

While there is some insignificant positive association between college-educated workers' adjusted wages and the districts' college concentration in column (1), this association disappears after excluding Prague and Brno, the two major cities which are perhaps most suspicious of experiencing a positive productivity shock. This conclusion is confirmed in column (3) where the current college concentration is instrumented with the local presence of a public college as of the end of communism.[31]

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[29] See, e.g., Katz and Murphy (1992) for evidence on imperfect substitution and Moretti (2004) for an underlying model of local labor markets with human capital externalities, no scale effects, and constant elasticity of substitution.

[30] The district-education-specific employment shares rates are estimated using 2001 region-education-specific employment rates combined with 2001 district-education-specific population counts. The Czech Republic consists of 14 regions (NUTS-3 level) and 77 districts (NUTS-4 level). The results are not sensitive to alternatively using 2001 population shares.

[31] The first-stage positive coefficient on the college dummy has a t ratio of 15. The results are not sensitive to controling for district cummulated FDI per capita. District population or employment density were not statistically significant in any of the specifications.

The right two panels of Table 1 then replicate this analysis with wages of high-school graduates. There is support for a positive relationship between the concentration of college education in a district and the average wages of high-school graduates after controlling for the individual own-education effect, and this support is not sensitive to excluding Prague and Brno or to focusing on the likely exogenous variation in local college concentration.[32] This positive relationship is consistent with imperfect substitution among high-school and college workers.[33]

Overall, these results suggest no role of local college-education concentration for worker productivity in a country, which experienced major skill upgrading of production, where college concentration varies dramatically across local economies, and where tertiary attainment remains among the lowest in the OECD.

3.2 Local Returns to Education

In this section, I estimate local returns to education and relate them to local supply of human capital. This evidence is novel in the transition context. It is now well documented that wage differentiation and returns to education rose quickly during transition from central planning to market economy.[34] As of the collapse of communism, the Mincerian returns to a year of schooling in transition economies was typically about 0.04 while 10 years later it rose to about 0.08 (Fleisher et al., 2004). However, the relative importance of various underlying causes of the rise in returns, including, e.g., institutional factors or skill-biased technological change, remains unclear. Further,

[32] Similar positive coefficients are obtained (but not shown) for less educated workers.

[33] A potential criticism of the strategy used in this section of estimating educational spillovers is that it is not clear why spillovers should occur at a local labor market level as opposed to the firm level or the national level. Having matched employer-employee data (see the Appendix) allows me to control for firm average educational attainment, but I cannot fully control for worker heterogeneity as I cannot match workers over time. I do find a positive coefficient on the firm level of human capital in a regression controlling for individual education.

[34] For evidence on mid- to late-transition returns to education in the Czech Republic, see Filer et al. (1999), Münich et al. (in press), and Jurajda (in press).

there are no studies estimating local returns to education in a transition economy.

This type of evidence is also relatively new in the context of developed economies. Beeson (1991) and Black et al. (2004) are the only studies that focus solely on estimating local returns to education.[35] Black et al. (2004) estimate city-specific college/high-school wage gaps for the US and find these to be large and persistent. In 1990, their estimated log wage gap varies from 0.33 in Seattle to 0.54 in Houston.[36]

I estimate two types of district-specific education wage premia: the log-wage return to an additional year of education[37] and the log-wage gap between workers with college degrees and those with all types of high-school education (i.e. both with and without the 'maturita' exam, see Section 2). The details of the estimation procedure are given in the Appendix.

I find extensive variation in 2001 Czech local returns to education and in local college/high-school wage gaps. District-specific returns to a year of additional education range from 0.03 to 0.11, while the average standard error of these district coefficients is only 0.008. The variance in returns to an additional year of schooling present within one transition country, and therefore unaffected by macroeconomic or institutional variability, is therefore comparable in magnitude to the variation in country-level returns before and after transition (for surveys of this literature see, Svejnar, 1999,

[35] Although see Bound and Holzer (2000), Bound et al. (2004) or Wheeler (2001) who also consider relative wages by skill at the local level in the U.S.

[36] They also show that U.S. skill premia are lower in cities with higher housing prices and support this finding with a model of worker migration where local price and wage variation arises from differences in local amenities. Specifically, Black et al. (2004), who do not consider the effects of relative skill supply, analyze migration decisions of two types of workers (skilled and unskilled) and assume that wages are equalized for one of the two types of workers across locations. This implies that the price of housing is higher in higher-amenity locations. As long as amenities are "luxury" goods relative to housing, low-educated workers have a lower willingness to pay for the amenity compared to high-educated workers. For less skilled workers to live in a city with higher amenities and higher housing prices, they must be offered a higher wage.

[37] As in many transition data sets, education is coded as highest degree attained and years of schooling are therefore imputed based on this information. See Münich et al. (in press??) for a comparison of Czech returns to education based on such imputed years of schooling to those based on reported years of schooling. MORE

and Fleisher et al., 2004). Comparing college-educated employees with high school graduates leads to district log-hourly-wage gaps ranging from 0.29 to 0.81, which is a range somewhat wider than that found for the US by Black et al. (2004). Figure 4 sorts and presents the district estimates of the college/high-school gap together with the 95% confidence interval of each estimate. Clearly, the variation in returns is not an artifact of sampling variance.[38]

What can explain the extensive variation in Czech local relative wages by skill? A first-hand explanation is that it corresponds to the uneven distribution of colleges possibly combined with limited territorial mobility of the labor force. In this case of an exogenous variation in the relative supply of educated workers, a simple demand and supply framework[39] (with possible national-level changes in demand by skill due to transition) would predict that relative wages of highly skilled workers should be lower in districts where skilled labor is relatively abundant, at least in the short run. Over the long run, firms adjust labor demand by focusing on technologies intensive in skilled labor in regions relatively abundant in skills – this is the prediction of Heckscher-Ohlin models. Indeed, with full adjustment in labor demand, exogenous differences in skill supply would lead to no differences in relative wages.

Alternatively, the change in the concentration of highly educated workers across districts could be a response of mobile labor force to exogenous changes in local demand. Higher relative demand for skilled labor would lead to increases in the relative skill supply and higher relative wages.[40] However, over the 2001-1991 period in the Czech Republic, college-degree concentration increases more in districts which had more college-educated labor as of 1991. In order to rationalize a potential

[38] The pattern of returns is not systematically affected when using only male or only young (25-35) workers. For example, the correlation between the college/high-school wage gaps estimated at the local level for all workers and for men only is 0.97. The corresponding correlations across the other comparisons never fall below 0.8.

[39] See Bound et al. (2004) for a recent exposition of such model.

[40] Ultimately, in a labor market with full mobility adjustment, i.e. no migration costs and no local amenities, there would be no relationship between the relative supply and relative wages of skilled workers.

positive association between relative wages and the observed increases in relative supply within a simple demand and supply framework, one would have to answer the question of why relative demand for skilled labor increased more in areas initially relatively abundant in skilled labor. It is possible that transition led to an increase in the productivity and employment in industries that use skilled workers more intensively and that these industries were initially located primarily in the highly-educated areas. In the empirical analysis, I therefore control for this possibility by conditioning on the end-of-communism local industrial composition. Alternatively, the higher skill demand and higher skill premia could be endogenous to the initial concentration of skilled labor – a scenario consistent with Acemoglu (2003)[41] or with some of the "increasing returns" theories (e.g., Giannetti, 2003).

In Table 2, I present an empirical exploration of these hypotheses. In columns (1) and (2) I show simple correlations between relative skill supply and local relative wages by skill, before and after excluding the two major city districts. More specifically, the entry in column (1) is the coefficient from a regression of the 74 college/high-school log wage gaps presented graphically in Figure 4 on the corresponding measure of relative supply of these two types of labor. In general, skill premia co-vary negatively with relative skill supply.

In column (3) I instrument for the local relative skill supply using the presence of a public

[41] Acemoglu's 2003 international trade analysis endogenizes skill-biased technological change to relative skill supplies. While the focus of his model is on the induced technological change in the developed economies (technology leaders), the theory also has predictions for the evolution of skill premia in less-developed countries. In the basic version of his model, the Czech Republic, given its large inflow of FDI, would be classified as a technology follower and would be predicted to experience a downward pressure on its skill premium from opening to international trade. However, a possible extension of his basic model (outlined in Section 5.3 of Acemoglu, 2003), involves endogenizing technology adoption in the technology followers to the relative amount of available skill. A tantalizing but informal strategy would be to take this logic to the regional level, where more skill-biased technologies would then be adopted in more skilled regions (beyond the standard Heckscher-Ohlin effect), such that these districts would then exhibit greater skill premia.

college as of the end of communism.[42] To the extent that historical college location is exogenous to the market-economy skill-biased demand shocks, this allows me to identify the slope of the relative demand curve.[43] The coefficients in columns (1) to (3) are remarkably similar to those estimated by Bond et al. (2004) in a similar exercises studying much larger geographical areas – the U.S. states. Taking the estimate from column (3) at face value would imply a within-district relative demand elasticity close to 6. Such elasticity level is much higher than those obtained from U.S. time series data (Katz and Murphy, 1992) and is consistent with a significant tendency of skilled-intensive firms to locate in areas relatively abundant in skills. However, this tendency falls short of equalizing relative wages and is much weaker compared to the endogenous-technology-adoption scenario implied by Acemoglu (2003, Section 5.3). The estimate in column (3) as well as the comparison of columns (2) and (3) are also consistent with non-zero, but limited territorial mobility of Czech workers motivated by relative demand shocks.

Several remarks are in order to frame the analysis of Table 2:

(i) I am focusing on the two main types of labor which cover over 90 percent of Czech employment and leaving out the least educated group of workers with only elementary schooling (i.e. 8-9 years).

(ii) According to the 2001 Census, 20% of Czech employed workers commute outside of their district of residence. Ideally, one would empirically model this spatial spillover of skill supply, but such estimation is beyond the scope of this paper.

(iii) A standard demand/supply approach would relate the change in supply to the change in relative wages. I do not have available a measure of district-specific relative wages in 1991. Given that under the communist regime, returns to education as well as regional differences in relative wages were small and strictly regimented by the use of a wage grid (Münich et al., in press), the

[42] The positive first-stage coefficient on the college dummy has a t ratio of 12.

[43] Since the presence of a college is closely tied to local human capital concentration, however, this instrumenting strategy will not remove local demand changes driven by initial skill concentration, i.e. the potential source of local "increasing returns".

2001 skill wage structure could be thought of as approximating the bulk of the change in relative wages between 1991 and 2001. However, this approach would rely on the untenable assumption that relative wages under communism were in an equilibrium with respect to relative supply of skills. The only equilibrium one can observe is that of the 2001 labor market.

(iv) It is tempting to also regress the local returns to a year of schooling on the local average years of education. This average area education measure differs from the relative within-district college/high-school supply measure used above in that it reflects the total local human capital of a district. However, given that the return to a year of college education in the Czech Republic is much higher than the return to a year of secondary schooling, such regression would be misleading. Much of the variation in average years of schooling is driven by college education (Section 2.1). When the share of college educated increases, this lowers the return to a year of college, but at the same time, because the share of the district workforce with high returns to a year of education increases, there is a positive effect on the district linear returns to a year of schooling; in the present analysis the latter effect dominates.

(v) The coefficients are not sensitive to the weighting scheme employed or to controlling for 1991 industry employment structure and are replicated when using an outlier-robust least-absolute-deviation estimator as opposed to least squares.

To further understand the variation in Czech district returns to education I regress the relative wage measure on three related variables in columns (4) and (5) of Table 2. The regression does not correspond to any structural interpretation and simply presents conditional correlations. Specifically, I introduce 2001 district stock of FDI per capita as an additional co-variate related to skill-biased demand shocks and skill-capital complementarity.[44] Foreign capital investment is attracted to areas relatively abundant in skills.[45] Further, Sabirianova et al. (2004) show that

[44] This investment measure is in millions of USD and is compiled by the Czech National Bank.

[45] Regressing cumulated 2001 district FDI per capita on the 1991 district share of college-educated population over 15 results in a positive and statistically significant coefficient (using robust standard errors) of 0.05 (0.018) with

foreign-owned firms are substantially more productive compared to both locally-owned private and state-owned firms. It is therefore possible that high-quality technology (capital) is complementary to local human capital concentration, although the theoretical prediction of the relationship may be ambiguous (Devillanova, 2004).[46]

Next, I also control for agglomeration economies by local area population density and for the local price level by a housing price index. Densely populated areas may feature higher skill premia because they allow for a more selective matching of workers and capital based on their complementary quality (Wheeler, 2001). Higher local price level may motivate a lower skill premium through the outmigration of less skilled workers who value local amenities less than high-educated workers (Black et al., 2004, see note n. 36).

The estimates of the FDI parameter are positive and therefore consistent with the demand shocks of international integration being positively associated with higher skill premia, but they do not reach conventional levels of statistical significance.[47] Similarly, neither population density nor local housing prices appear to be systematically associated with local skill premia, conditional on local skill supply.

(without) Prague. Excluding the capital Prague and going from the minimum to the maximum 1991 share of college-educated population (i.e. going from 0.04 to 0.15) then corresponds to additional 2 thousand USD FDI per capita – that is about one district standard deviation in FDI per capita.

[46] One can approximate across-industry demand shocks of transition reallocation by a Katz-Murphy-type man-power demand index based on the locality-specific reflection of country-wide industry-employment changes. Controling for initial industry structure of employment, as I do in Table 2, is similar in spirit. Yet, most reallocation in transition occurs within industries (Jurajda and Terrell, 2003; Commander and Faggio, 2003).

[47] I exclude from the estimation the district of Mladá Boleslav, which features a below-average college/high-school wage gap and which is by far the largest recipient of FDI outside of the capital city of Prague. The exclusion does not affect the other parameters but changes the sign of the insignificant FDI coefficient.

4 Conclusions

The contribution of this paper is to investigate the importance of the local concentration of human capital in an economy which inherited a dramatic variation in local skill endowments from a non-market regime and which was subject to major skill-upgrading and international integration – the Czech Republic. The estimated local wages by education and local returns to education are linked to several strands of applied theory.

Following the identification strategy of Moretti (2004), i.e. relying on the exogeneity of the historical location of colleges, suggests little role of the local human capital concentration for local productivity beyond the individuals' own education effect. Next, the first available evidence on local returns to education in a post-communist economy (and possibly also outside of the US) points to extensive within-country dispersion of private benefits to education and implies relative demand elasticities consistent with those estimates in the U.S.

The finding of little role of local human capital concentration is not supportive of the implicit motivation of the EU regional programs implemented within the structural and cohesion funds, which take the view of the "increasing returns" literature, namely that economic integration results in a concentration of the most productive factors in the most advanced regions and increases regional inequalities (Canova, 2001). Nevertheless, it appears that local education production is a key factor driving persistent regional inequality.

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Appendix: Wage Data Description

I use a 2001 Czech national employer survey, the Information System on Average Earnings (ISAE), in which firms report hourly wages of their employees. The firm sample is based on a 2000 stratified random sampling conducted by the Czech Statistical Office within the Eurostat's Structure of Earnings Survey program. Only firms employing more than 10 workers are sampled and the sampling rate is close to 100% for firms employing over 1000 workers. The data include over one third of the entire Czech enterprise employment and cover all firm size categories, and industries, except the public budgetary sector of health, education, and public administration.

The worker part of the data consists of hourly wages, gender, education (the highest degree obtained), and age for all employees of the surveyed enterprises. These wage records are drawn directly from companies' personnel databases and correspond to social security quarterly wage records. (Each quarter, employers calculate for each worker an average hourly wage, defined as total cash compensation including bonuses and other special payments divided by total hours worked for that quarter. This wage is then used in setting workers' sickness and unemployment benefits.) The uniformity of the wage definition and the use of personnel records minimizes the extent of reporting errors likely present in household survey data. Unfortunately, education is missing for 8% of workers and this part of data is excluded from the analysis. The 2001 analysis-ready sample covers 805,767 workers in 2,240 firms.

The average number of firms (workers) observed per district is 41 (10,863) and there is obviously strong sampling variance at the local level, especially in terms of firm size and industrial structure. Therefore, the wage data used in this paper consist of individual log-wage residuals from a national regression with firm size and two-digit industry controls as well as with worker-specific controls (gender, experience and its square). The residuals in these national regressions are clustered at firm level to correct inference for the inter-dependence of worker unobservables within firms.

These adjusted wage data are then used to estimate district (i) average wages by education (district-education fixed effects), and (ii) returns to education. The latter consists of district-specific regressions controlling for individual education. The implicit assumption embodied in the estimation of district relative wages is that within the Czech districts, which average 100 thousand inhabitants and a few dozen kilometers in diameter, labor markets are integrated, labor is fully mobile, and the within-district wage structure can therefore be captured using a small sample of firms. The interpretation of the estimates of district average wages is, however, affected by the necessity to 'filter out' the industrial composition of the sampled firms, which itself is a reflection of the local industrial structure, albeit a noisy one.

Finally, when district-level second-stage regressions are performed, regressing district wages or returns on other controls, these are weighted by either the number of district observations (for average wages) or by the inverse of the variance of district-specific estimated slope coefficients (for returns to education). For a similar two-step procedure see Moretti (2004).

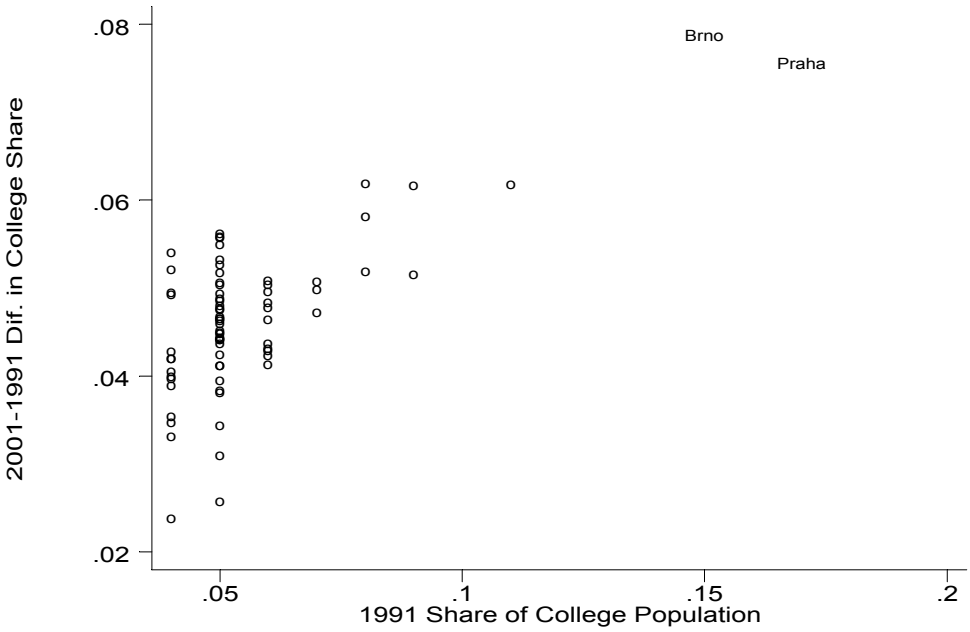

Figure 1: 2001-1991 Change vs. 1991 Level of Share of College-Educated Population

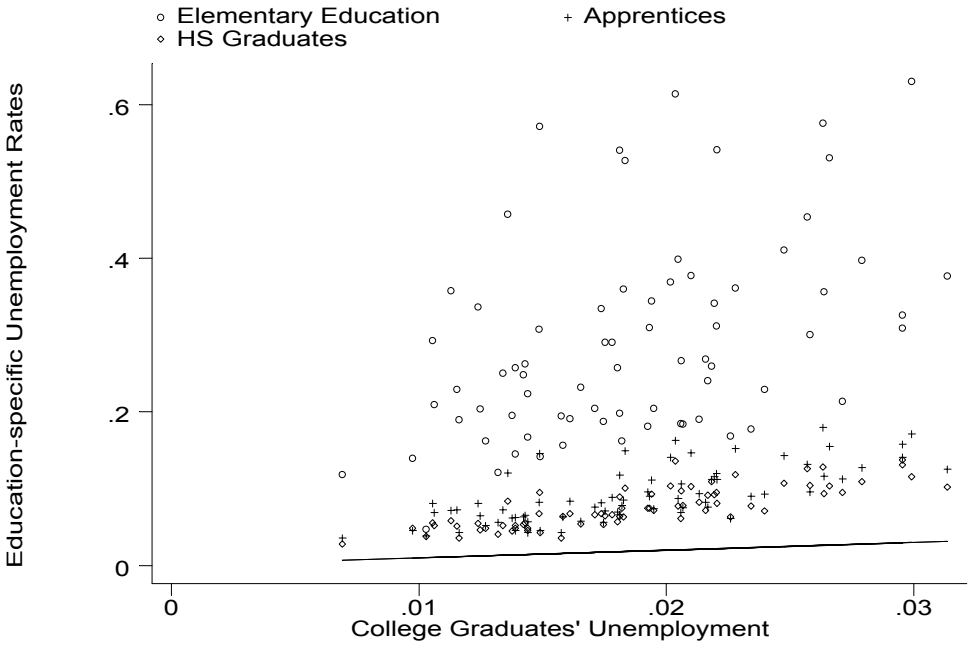

Figure 2: District Unemployment Rates by Education, 2001

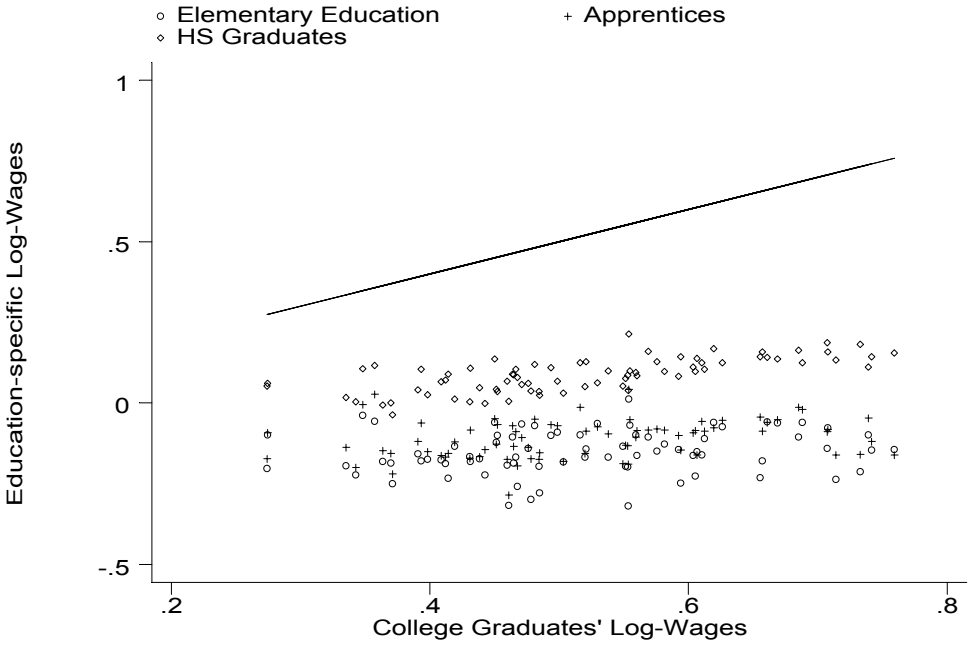

Figure 3: District Relative Wages by Education, 2001

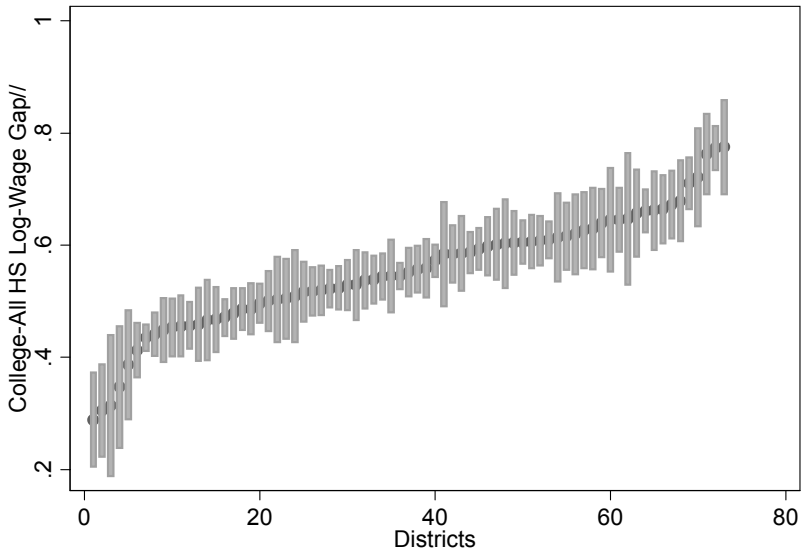

Figure 4: District College/High-School Wage Gaps w/ 95% Confidence Intervals

Table 1: District Wages and the Share of College Education

	(1)	(2)	(3)	(4)	(5)	(6)
	College Wage			High-School Wage		
1991 % College	0.359	-0.208	–	0.480	0.913	–
	(0.301)	(0.435)		(0.195)	(0.251)	
2001 % College	0.262	0.011	-0.137	0.322	0.609	0.739
	(0.170)	(0.249)	(0.362)	(0.122)	(0.139)	(0.228)
Prague and Brno	Yes	No	No	Yes	No	No
IV	No	No	Yes	No	No	Yes

Notes: Each estimate is based on a separate regression controlling for 1991 shares of employment in 8 industrial categories. The dependent variable is the district-education intercept for either college or high-school graduates from a regression of log wages on firm and individual controls including education. The independent variable is either the 1991 share of district population or the 2001 share of district employment with college degree. The instrument is the presence of a public college in district as of 1990. Robust standard errors in parentheses. The regression is weighted using the number of observations in each district group.

Table 2: Determinants of District Skill Premia

	(1)	(2)	(3)	(4)	(5)
Relative Skill Supply	-0.083	-0.115	-0.169	-0.213	-0.152
	(0.036)	(0.038)	(0.058)	(0.076)	(0.055)
FDI per capita				8.23	12.0
				(10.0)	(9.3)
Population Density				0.511	-0.055
				(2.49)	(0.307)
Housing Price				0.239	0.117
				(0.201)	(0.176)
Prague and Brno	Yes	No	No	Yes*	No*
IV	No	No	Yes	No	No

Notes: The dependent variable is the regression-adjusted district-specific measure of the difference in the log of college and high school hourly wage rates. See the appendix for details on the regression adjustment. The independent variable "relative skill supply" is the log of the ratio of college degree holders to high-school graduates in district employment. The density rate is the number of inhabitants per square kilometer / 10,000. The house price index is the avg. price of family houses sold during 2000-2002, relative to Prague level. The FDI measure is a district stock of USD million. Each regression also controls for 1991 shares of employment in 8 industrial categories. Robust standard errors in parentheses. The regressions are weighted using the inverse of the variance of the district estimates of skill premia. The instrument is the presence of a public college in district in 1990.

* In columns (4)-(5), the district of Mladá Boleslav, an outlier in terms of FDI is excluded.