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Legacy of the Czar: Complementarity between education and work in Russia

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ABSTRACT

Vocational school graduates enjoy a higher employment probability than other types of graduates across industrial economies. This may result from either the signaling effects of vocational school degrees or skill complementarity between vocational schooling and work experience. Regarding wage regressions, signaling effects should make the coefficient of the interaction term between years of schooling and work experience negative, whereas complementarity between education and work experience should increase this coefficient because the cross-derivative of output with respect to schooling and work experience is positive. Thus, the negativity of the interaction term between years of schooling and work experience decreases as schooling becomes more complementary to work. We find that the negativity of the interaction term is smaller for vocational track graduates than for general track graduates in Russia. This result is arguably because the Russian vocational track emphasizes complementarity between education and work to a greater degree than its general track.

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1. Introduction

Among major advanced economies, the United States (US) and Japan have unstratified elementary and secondary education systems that offer general education to most youth through the upper-secondary level. In contrast, continental European nations have stratified systems that track pupils in general and vocational secondary students after their elementary or junior secondary levels (Allmendinger, 1989; DiPrete et al., 2017; Glaeser & Cooper, 2011; Han, 2016; Kerckhoff, 2001; Pfeffer, 2008).

Research has shown that European stratified systems may reproduce and enhance existing social stratification (Han, 2016; Kupfer, 2010; Mijs, 2016; von Below et al., 2013). Furthermore, van de Werfhorst (2011) used a cross-national dataset from continental European nations to demonstrate that the skills acquired on the vocational track do not offset the disadvantages faced by students on this track and that the reproduction of social stratification between generations is embedded even in informal networks. Using

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a German dataset, Roth (2018) found that an informal social network that connects parents helps children join company-sponsored training programs to enter occupations that correspond to the social status of their parents.

Although Biewen and Thiele (2020) showed that parents with a higher social status are better able to correct for mismatches in their children's early careers, this result does not contradict the hereditary feature of stratification demonstrated by Roth (2018).

However, this result does not exclude the possibility that vocational education equips students with skills that are more complementary to those acquired in the workplace than the skills gained by those on the general track. When controlling for other factors, the acquisition of vocational education has contributed to a higher occupational status (Bol & van de Werfhorst, 2011). Moreover, Heisig and Solga (2015) showed that an emphasis on vocational skills in upper-secondary education tended to improve the numeracy skills of students on lower tracks.

Using a Spanish dataset, Murillo et al. (2012) reported declining but positive returns on vocational education and attributed the decline to mismatches between education and the skills actually required in workplaces. Additionally, using a Spanish dataset, Blázquez et al. (2019) found that participation in training programs during unemployment improved the probability of employment. Although this result does not directly support the formal vocational tracking of children, it does indicate the possible benefits of vocational education prior to entry into the workforce. Using a Romanian dataset, Popescu and Roman (2018) concluded that participation in vocational training modestly increased the probability of employment. Additionally, reforms to extend the general education content of the vocational track do not necessarily improve labor market outcomes in either Sweden (Hall, 2016) or Croatia (Zilic, 2018).

Regarding the nature of stratification due to tracking, the heterogeneity across nations is substantial. Forster and Bol (2018), for instance, showed that vocational track students in the Netherlands demonstrated higher levels of performance. Additionally, Prokic-Breuer and Dronkers (2012) reported that the Dutch vocational track seems to increase the overall academic performance of Dutch pupils compared with the vocational tracks of students in Germany and Switzerland.

Choi et al. (2019) illustrated two possible, countervailing effects of stratified vocational education systems. Using data from the Organisation for Economic Co-operation and Development (OECD) countries, Choi et al. (2019) found that graduates of the vocational track lagged in terms of labor market outcomes in the long term – an effect that is likely to capture the reproduction of social stratification – but experienced better employment opportunities immediately after graduation – an effect that likely captures successful skill acquisition in the vocational track and its signaling effects. However, this employment premium for vocational school graduates attenuates over time.

As European vocational schools are often linked with training programs sponsored by the corporate sector, such as the apprenticeship schemes in Germany (Solga & Konietzka, 1999; Witte & Kalleberg, 1995) and the partnerships between vocational schools and the corporate sector in Russia (Marques et al., 2020), the European vocational track appears to offer a particularly salient or immediate form of complementarity between schooling and work experience that may improve productivity.

We test this conjecture by using data from Russia, where the education system is deeply stratified (T. P. Gerber, 2003). Our identification strategy involves evaluating the

relative strength of skill complementarity effects compared with signaling effects. As the innate abilities of workers are private information when they join the market after graduation, employers use observable information such as educational background as a signal of abilities, which is also referred to as the “sheepskin” effects of a degree (Hansen et al., 1970; Heywood, 1994; Olfindo, 2018; Spence, 1973; Temple, 2002; van der Meer, 2011; Waldman, 1984; Waldman et al., 2013). As workers acquire work experience, employers gradually learn about their innate abilities from information related to their outputs, career paths, and promotions (Waldman, 1984). Therefore, the signaling impact of schooling is high in the early stages of one’s career and then gradually attenuates (Habermalz, 2006).

This attenuation process, which is called employer learning, is typically observed as a negative coefficient for the interaction term between years of schooling and years of work experience in a Mincerian wage equation for which the dependent variable, wages, is represented by a logarithmic term (Farber & Gibbons, 1996). Empirical results, especially those based on US datasets, support this theoretical prediction (Altonji & Pierret, 2001; Lange, 2007; Pinkston, 2006; Schönberg, 2007). Data from China, which has a stratified education system, similarly support the employer learning hypothesis (Wang & Li, 2020).

While employer learning effects are observed to be unambiguous in the US, they are not necessarily observed to be so in Germany. Bauer and Haiken DeNew (2001) and Lluís (2005), using a German dataset, found that employer learning effects, if they existed, were very weak in Germany. We suggest that one possible explanation of the results of weakly observed employer learning in the European context by Bauer and Haiken DeNew (2001) and Lluís (2005) is the complementarity between European vocational schooling and work experience. To identify the complementarity between vocational education and work, we examine whether the coefficient of this interaction term is greater than the coefficient of the interaction term for general schooling and work experience. Neither Bauer and Haiken DeNew (2001) nor Lluís (2005) differentiated years of schooling between the general and vocational tracks, so this possibility has not been tested in Germany. In this paper, we test this possibility for Russia.

Notably, our aim is to identify the relative effects of the complementarity between schooling and (future) work experience, which are priced in the labor market, against the signaling effects. To identify the signaling effects in isolation, datasets such as the National Longitudinal Surveys of Youth in the US, which include information on IQ that is unknown to employers but is known to researchers, are useful because researchers can assume that IQ is a proxy for one’s innate ability. Such information is unknown to employers when workers join the market after graduation. By using such data, researchers can identify the signaling effects that are conditional on IQ, as presented by Farber and Gibbons (1996); Altonji and Pierret (2001); Pinkston (2006); Schönberg (2007); Lange (2007). However, as we want to estimate the complementarity effects that are conditional on the signaling effects, it suffices to estimate the coefficient of the interaction term between years of schooling and years of work experience. Thus, our identification strategy does not require proxies for innate abilities that are unknown to employers but known to researchers, such as IQ.

Essentially, a Mincerian wage regression estimates the relative price of schooling in a hedonic setting rather than the returns on education investment (Heckman et al., 2006,

2008). However, our interest is in whether the market values the signaling or complementarity effects of schooling. Thus, despite the concerns suggested by Heckman et al. (2006), we believe that an estimation of the complementarity between schooling and work experience in a Mincerian setting is conceivable.

Our focus and identification strategy also diverge from previous works that either explicitly or implicitly address the complementarity of vocational schooling with work, such as Bol and van de Werfhorst (2011); Murillo et al. (2012); Popescu and Roman (2018); Choi et al. (2019). Bol and van de Werfhorst (2011) recognized vocational schools' signaling of their possible complementarity with work when workers enter the market. Murillo et al. (2012); Popescu and Roman (2018); Choi et al. (2019) also found positive impacts of vocational schooling on labor market outcomes in workers' early stages after graduation, thereby also indicating signaling effects. Our interest is, instead, in the complementarity between vocational schooling and work experience that materializes over time through work experience and hence in the increasing rather than declining positive impacts on labor market outcomes.

The remainder of this paper is organized as follows. Section 2 reviews the Russian education system and places it in a historical and comparative context alongside other continental European countries. Section 3 presents our identification strategies and predictions. Section 4 introduces the dataset used in this study, Section 5 presents the empirical results, and Section 6 concludes the paper.

2. Historical and comparative context

2.1. A stratified system and its origin

The nine mandatory years of schooling in Russia consist of primary education from the first to the fourth year and general education from the fifth to the ninth year. Students then choose between two tracks, general and vocational. Students who choose the general track proceed to general upper-secondary education for two years followed by university-level education for four or five years. Students who choose the vocational track proceed to vocational upper-secondary school for three years followed by technical tertiary education. Although this sequence is the basic structure, some students move between these two tracks. For instance, students who have graduated from vocational school may enter related university programs or departments (Nikolaev & Chugunov, 2012, p. 1, 19–33, 39–45, 48–57).

The creation of the Russian stratified education system dates back to the reign of Peter the Great in the early 18th century. Peter's move to extend education was part of his Westernization reforms that predominantly focused on vocational training. The vocational track of secondary education in Russia originated with his reforms (Bannatyne & Hall, 1998; Okenfuss, 1973). Based on this legacy, apprenticeships in industries were transformed into systematic training programs and linked to modernized vocational schooling in industrialization from the late 19th century (Magsumov, 2018, 2019; Meyser, 2004).

The Russian Revolution of 1917 did not displace the legacy of Czarist Russia but rather strengthened it. Secondary vocational schools were expanded to prepare the workforce for industrialization in the former USSR (Holmes, 1973), and the vocational upper-

secondary and tertiary tracks were further extended in the 1950s and 1960s, as was the general tertiary education track. This development resulted in Russian education becoming highly stratified and its vocational education being even more extensive than Germany's vocational education program (T. P. Gerber & Hout, 1995; Heyneman, 1997, 1998).

Even after the collapse of the USSR, the government continued to treat the technical and vocational track as the core of public education (Heyneman, 1997; Wallenborn, 2010). Despite the dissolution of the ideological cohesion that dominated the Soviet education system (Heyneman, 2000; Zajda, 2003), the stratified education system continued to dominate (Heyneman, 1997). In fact, empirical studies have indicated that the strong links between stratified educational tracks and the first occupations for which the tracks were designed did not essentially change (T. P. Gerber, 2003).

Although the vocational programs that were sponsored by state-owned enterprises under the Soviet regime have contracted (Kotásek, 1996), partnerships between private companies and local governments have been reorganized along with the privatization of enterprises and the decentralization of educational policy making (Marques et al., 2020; Walker, 2006).

2.2. European context

Vocational education systems are inevitably linked to labor market institutions. If workers were free to move without institutional constraints designed to prevent poaching, then employer investment in worker skills would be significantly discouraged. Thus, a certain level of restriction or coordination in labor markets is likely to increase the investment in training programs, such as apprenticeships, that are sponsored by companies or industrial bodies.

Western Europe and Russia share a history of imposing various restrictions on the mobility of workers such as apprentices since early modern times (Stanziani, 2009a, 2009b). Furthermore, Austria-Hungary and Germany referenced the Russian system when modernizing their vocational education systems, typically in metalworking and electrical engineering enterprises such as Schuckert, MAN, Krupp, Siemens, and Bosch, from the 1890s to the 1910s (Wiemann, 2004). The interdependence of vocational education and market coordination is not only historical, as even now, vocational education systems appear to perform more effectively in the more coordinated labor markets of Western Europe and Russia (Bol & van de Werfhorst, 2011).

In facing the challenge of globalization, the European consensus is to not concede in implementing the unstratified education system shared by the US and Japan. Instead, European nations are struggling to update their historical legacy of vocational education to keep pace with technological changes (The European Centre for the Development of Vocational Training, ed, 2004a, 2004b; Powell et al., 2012). As Western Europe and Russia share a history of vocational education, a study on Russia has European-wide relevance.

2.3. Current educational and labor market outcomes

The stratified education system implies that educational achievement when completing the lower-secondary level strongly affects one's educational trajectory and occupational choices (Cherednichenko, 2012, 2013; The European Centre for the Development of Vocational Training, ed, 2004b). Because of the stratified education system, students in vocational upper-secondary schools exhibit significantly lower academic performance than students in general upper-secondary schools (Amini & Nivorozhkin, 2015).

Moreover, research indicates that differences in educational achievement significantly predict mortality rates (Perlman & Bobak, 2008) as the stratified education tracks match occupational choices and perceived social class, and it is this difference that leads to different life expectancies (Bessudnov et al., 2012). Additionally, graduates of the vocational track are more likely to drink alcohol and use drugs than graduates of the general track (Stothard et al., 2007; Wall et al., 2011). Therefore, as in other countries, the Russian stratified education system is likely to enhance social stratification.

However, vocational education on its own appears to benefit workers. For example, Marques et al. (2020) found growth in the partnerships between local governments and the private sector for vocational training and concluded that vocational education not only coincides with lower youth unemployment but is also considered an opportunity for young workers to learn skills from the private sector.

3. Identification strategy

3.1. Employer learning

Consider a production technology

$$\log y_{i,t}(S_i, X_{i,t}, \mu_i) = \alpha_1 S_i + \alpha_2 X_{i,t} + \alpha_3 X_{i,t}^2 + \alpha_4 S_i X_{i,t} + \alpha_5 \mu_i + \xi_{i,t} \quad (1)$$

where $y_{i,t}(S_i, X_{i,t}, \mu_i)$ denotes the output of worker i in period t , which is a function of worker i 's years of schooling, S_i , years of labor market experience in period t , $X_{i,t}$, and innate ability that is hidden to employers, μ_i , and the variance of $\log y_{i,t}$ is $\text{Var}[\log y_{i,t}] = \sigma_\xi^2$. Since μ_i is not observable to employers at the time of graduation, employers predict output $y_{i,t+1}$ as a function of the perceived ability of worker i ,

$$\log w_{i,t} = \mathbb{E}[\log y_{i,t} | I_{i,t}] + \epsilon_{i,t} \quad (2)$$

where the information set $I_{i,t} = \{S_i, X_{i,t}, \hat{\mu}_{i,t-1}\}$. In practice, given the technology presented as in Equation (1), employers set wages given S_i , $X_{i,t}$, and $\hat{\mu}_{i,t}$ such that

$$\log w_{i,t} = \mathbb{C} + \alpha_1 S_i + \alpha_2 X_{i,t} + \alpha_3 X_{i,t}^2 + \alpha_4 S_i X_{i,t} + \alpha_5 \hat{\mu}_{i,t} + i_{i,t} \quad (3)$$

Since employers do not have any information about past output $y_{i,t-1}$ in period 1, they use available information about S_i as a signal of the ability of worker i such that

$$I_{i,0} = S_i. \quad (4)$$

Moreover, employers know from experience that S_i is a noisy signal such that

$$\mu_i = \mathbb{C} + S_i + \omega_i, \quad (5)$$

where $E[\omega] = 0$ and the variance of ω is $\text{Var}[\omega] = \sigma_\omega^2$, which leads to

$$\hat{\mu}_{i,0} = \mathbb{C} + S_i. \quad (6)$$

After the first period, employers observe residual $r_{i,t}$ between the true production technology (1) and wage function (3) based on their prediction such that

$$r_{i,t} \equiv \log y_{i,t}(S_i, X_{i,t}, \mu_i) - \left(\alpha_1 S_i + \alpha_2 X_{i,t} + \alpha_3 X_{i,t}^2 + \alpha_4 S_i X_{i,t} \right) = \alpha_5 \mu_i + \xi_{i,t}. \quad (7)$$

At the end of each period t , firms use the information provided by $r_{i,t}$ to update the prior estimate of ability $\hat{\mu}_{i,t-1}$. The information set used to estimate ability from period $t = 1$ onward is thus $I_{i,t} = \{S_i, X_{i,t}, y_{t-1}, \hat{\mu}_{i,t-1}\}$. For simplicity, let us assume that noises of educational backgrounds and past outputs as signals of abilities follow the normal distribution and have identical variances, $\sigma_\xi^2 = \sigma_\omega^2$. Then, by a Bayesian model of learning about an unknown parameter when the errors are normal (Bartels, 2002; A. Gerber & Green, 1999), $\hat{\mu}_{i,t}$ is expanded as (see section A.1 in the appendix for the derivation)

$$\begin{aligned} \hat{\mu}_{i,t} &= \frac{t}{t+1} \hat{\mu}_{i,t-1} + \frac{1}{t+1} r_{i,t} = \frac{1}{t+1} \hat{\mu}_{i,0} + \frac{1}{t+1} \sum_1^t r_{i,t} \\ &= \frac{1}{t+1} (\mathbb{C} + S_i) + \frac{1}{t+1} \sum_1^t (\mu_i + \xi_{i,t}) \\ &= \frac{1}{t+1} (\mathbb{C} + S_i) + \frac{t}{t+1} \mu_i + \sum_1^t \frac{\xi_{i,t}}{t+1}. \end{aligned} \quad (8)$$

Equation (8) means that the weight of the initial estimate of ability $\hat{\mu}_{i,0} = \mathbb{C} + S_i$ on wage $w_{i,t}$ decreases by updating information even if it was as informative as output in early periods. This decrease in the weight of $\hat{\mu}_{i,0} = \mathbb{C} + S_i$ is the process of employer learning. Then, subtracting Equation (6) from wage Equation (3), we obtain

$$\log w_{i,t} = \mathbb{C}' + (\alpha_1 + \alpha_5) S_i + \alpha_2 X_{i,t} + \alpha_3 X_{i,t}^2 + \alpha_4 S_i X_{i,t} + v_{i,t}, \quad (9)$$

where $\mathbb{C}' = \alpha_5 \mathbb{C}$ and $v_{i,t} = \alpha_5 (\hat{\mu}_{i,t-1} - \hat{\mu}_{i,0}) + \epsilon_{i,t}$. This is a standard Mincerian wage equation. Another expansion of Equation (3) is

$$\log w_{i,t} = \mathbb{C}_i' + (\alpha_1 + \alpha_5)S_i + \alpha_2 X_{i,t} + \alpha_3 X_{i,t}^2 + \alpha_4 S_i X_i + \epsilon_{i,t}, \quad (10)$$

where $\mathbb{C}_i' = \alpha_5 \mathbb{C} + \alpha_5 (\hat{\mu}_{i,t-1} - \hat{\mu}_{i,0})$. Equation (10) can be estimated as a fixed effects model.

In Equations (9) and (10), α_4 captures at least two factors. One is employer learning. If employers learn about workers' abilities from their work and reduce the weight of S_i through updates of $\hat{\mu}_{i,0} = \mathbb{C} + S_i$ over $X_{i,t}$, then from Equations (9) and (10),

$$\frac{\frac{\partial \log w_{i,t}(S_i, X_{i,t})}{\partial S_i}}{\partial X_{i,t}} = \frac{\partial^2 \log w_{i,t}(S_i, X_{i,t})}{\partial S_i \partial X_{i,t}} = \alpha_4 < 0, \quad (11)$$

must hold. That is, if the valuation of S_i as a signal of ability decreases with $X_{i,t}$ through employer learning, it drives α_4 into the negatives. Mincer (1974) found that the coefficient between schooling and experience, α_4 , can be negative and posited that this coefficient describes “the apparent convergence of experience profiles” (Mincer, 1974, 92–93). However, he did not provide any analytical reasoning for this observation. Since the study by Hansen et al. (1970), the signaling effect has attracted both theoretical and empirical attention. Among the related studies, Farber and Gibbons (1996) established an explicit link between the theoretical and empirical research strands. If employers learn about the innate ability of a specific worker as the worker gains work experience, then the signaling effect of schooling also declines, which results in a negative coefficient of the interaction term between schooling and experience in the Mincerian wage equation.

The other factor that affects α_4 is skill complementarity between skills earned by schooling S_i and those earned through work experience $X_{i,t}$. Complementarity between S_i and $X_{i,t}$ in Equation (1) implies

$$\frac{\partial^2 \log y_{i,t}(S_i, X_{i,t}, \mu_i)}{\partial S_i \partial X_{i,t}} = \alpha_4 > 0. \quad (12)$$

That is, α_4 increases with the degree of complementarity between S_i and $X_{i,t}$ as employers observe true production technology (1) as long as process (2) implies $\partial w_{i,t} / \partial y_{i,t} > 0$.

In summary, α_4 captures the relative impact of the signaling and complementarity effects and increases with the complementarity effect on $y_{i,t}$ relative to the signaling effect on $w_{i,t}$. For instance, if a schooling track is better tailored toward complementarity with skills acquired through work experience than other tracks, the α_4 for graduates of the track would be greater than that for graduates of the other tracks.

3.2. Specifications for the two tracks

Our interest is in whether the degree of skill complementarity between schooling and work experience differs between the general and vocational tracks. To focus on this issue, we consider a wage equation expanded from Equation (9) as follows,

$$\log w_{i,t} = \mathbb{C} + \beta_1 S_{ps_i} + \beta_2 S_{gt_i} + \beta_3 S_{vt_i} + \beta_4 X_{i,t} + \beta_5 X_{i,t}^2 + \beta_6 S_{gt_i} \times X_{i,t} + \beta_7 S_{vt_i} \times X_{i,t} + v_{i,t}, \quad (13)$$

where S_{ps} denotes years of general primary and lower-secondary education, S_{gt} denotes years of general upper-secondary and tertiary education, hereafter the “general track,” and S_{vt} denotes years of vocational upper-secondary and tertiary education, hereafter the “vocational track”. We also consider a fixed effects model specification expanded from Equation (10),

$$\log w_{i,t} = \mathbb{C}_i + \beta_1 S_{ps_i} + \beta_2 S_{gt_i} + \beta_3 S_{vt_i} + \beta_4 X_{i,t} + \beta_5 X_{i,t}^2 + \beta_6 S_{gt_i} \times X_{i,t} + \beta_7 S_{vt_i} \times X_{i,t} + \epsilon_{i,t}, \quad (14)$$

4. Data

For our analysis, we use the Russia Longitudinal Monitoring Survey, which has been administered since 1992 across the Russian Federation.¹ As attrition in each wave is replaced, the survey is an unbalanced panel dataset. Heeringa (1997) reports the survey design and sample attrition. Although the primary goal of the survey is to monitor the process of structural reforms in Russia after the collapse of the USSR, the rich information that the panel data contain has yielded a wide range of research on topics including education, public health, medicine, sociology, and economics in studies such as those by Walker (2006); Stothard et al. (2007); Perlman and Bobak (2008); Wall et al. (2011); Bessudnov et al. (2012); Cherednichenko (2012, 2013).² Within these concurrent survey data, we use the twelve waves from 1998 to 2009 to ensure data consistency.

Specifically, we used

- $w_{i,t}$: Nominal hourly wage in Russian rubles of respondent i in period t .
- $a_{i,t}$: Age of respondent i in period t .
- S_i : Total years of schooling of respondent i , such that $S_i = S_{ps_i} + S_{gt_i} + S_{vt_i}$.
- S_{ps_i} : Years of general primary and lower-secondary education of respondent i .
- S_{gt_i} : Years of general upper-secondary and tertiary education of respondent i , referred to as the general track.
- S_{vt_i} : Years of vocational upper-secondary and tertiary education of respondent i , referred to as the vocational track.

¹The Russia Longitudinal Monitoring Survey is conducted by the National Research University – Higher School of Economics and ZAO Demoscope together with the Carolina Population Center of the University of North Carolina at Chapel Hill and the Institute of Sociology of the Russian Academy of Sciences. The dataset is open for research use. The instructions for the use of the data and the related data usage policy are available at <http://www.cpc.unc.edu/projects/rllms-hse>, last accessed on September 16, 2020. For estimations below, we used the plm package for R (<https://cran.r-project.org/web/packages/plm/index.html>).

²Information about the publications that have used the dataset is available at <https://www.cpc.unc.edu/projects/rllms-hse/publications>, last accessed on September 17, 2020.

Table 1. Descriptive statistics across tertiary educational backgrounds.

Tertiary education	Overall <i>N</i> = 144,053	None <i>N</i> = 51,208	Tertiary: General <i>N</i> = 32,409	Tertiary: Vocational <i>N</i> = 60,436
<i>w</i>	582.6 (3,222.9)	876.9 (2,573.7)	551.7 (3,179.2)	472.1 (3,488.2)
no response	87,050	39,011	15,288	32,751
<i>a</i>	43.3 (18.7)	45.6 (22.2)	41.0 (16.4)	42.5 (16.2)
<i>S</i>	11.4 (3.5)	8.1 (2.6)	15.7 (2.0)	11.8 (1.7)
<i>S_{ps}</i>	9.0 (2.0)	8.1 (2.6)	10.1 (0.9)	9.3 (1.3)
<i>S_{gt}</i>	1.0 (2.1)	0.0 (0.0)	4.6 (1.8)	0.0 (0.0)
<i>S_{vt}</i>	1.3 (1.6)	0.0 (0.0)	1.0 (1.6)	2.6 (1.2)
<i>LMX</i>	31.7 (19.9)	38.1 (24.5)	25.3 (16.2)	30.7 (16.6)
no response	8,909	8,893	6	10
<i>EMPX</i>	21.1 (15.6)	22.9 (17.2)	18.8 (14.7)	20.7 (14.4)
no response	74,774	26,069	17,689	31,016
<i>UEMPX</i>	12.3 (9.9)	17.6 (12.8)	7.8 (5.8)	10.5 (6.9)
no response	78,799	29,275	18,359	31,165
<i>D_g</i>	61,776 (43%)	21,512 (42%)	13,114 (40%)	27,150 (45%)
<i>D_{SE}</i>	42,680 (63%)	9,899 (66%)	13,023 (64%)	19,758 (61%)
no response	76,136	36,147	11,925	28,064
<i>D_{FE}</i>	2,699 (4.0%)	500 (3.3%)	892 (4.4%)	1,307 (4.0%)
no response	75,935	36,024	12,048	27,863
<i>D_{PostUSSR}</i>	14,740 (21%)	6,267 (25%)	3,482 (24%)	4,991 (17%)
no response	74,774	26,069	17,689	31,016

Note: For continuous variables, we present the mean and standard deviation (in parentheses), and for dummy variables, we present the number of observations that take 1 and its percentage (in parentheses).

- $LMX_{i,t}$: Years of labor market experience of respondent i in period t , which is $a_{i,t} - (S_{ps_i} + S_{gt_i} + S_{vt_i})$.
- $EMPX_{i,t}$: Cumulative number of years that respondent i has spent in employment as of period t .
- $UEMPX_{i,t}$: Cumulative number of years that respondent i has spent in unemployment as of period t such that $LMX_{i,t} = EMPX_{i,t} + UEMPX_{i,t}$.
- D_{g_i} : 1 if respondent i is female and = 0 if male.
- $D_{PostUSSR_i}$: 1 if respondent i graduated from the highest education program after in or after 1991 and = 0 otherwise.

Table 2. Employer learning.

	Dependent variable:	
	log <i>w</i>	
	(1) OLS (Mincerian)	(2) Fixed effects
<i>S</i>	0.145*** (0.132, 0.159)	0.353*** (0.328, 0.378)
<i>LMX</i>	0.086*** (0.076, 0.096)	0.371*** (0.350, 0.391)
LMX^2	-0.001*** (-0.001, -0.001)	-0.001*** (-0.001, -0.001)
<i>D_{SE}</i>	-0.380*** (-0.412, -0.348)	-0.022 (-0.061, 0.016)
<i>D_{FE}</i>	0.343*** (0.272, 0.415)	0.123*** (0.046, 0.199)
<i>D_g</i>	0.294*** (0.263, 0.324)	-0.892 (-2.010, 0.227)
<i>D_{PostUSSR}</i>	0.655*** (0.596, 0.714)	0.059 (-0.039, 0.157)
$S \times LMX$	-0.002*** (-0.002, -0.001)	-0.002*** (-0.003, -0.001)
Ⓒ	-0.136 (-0.371, 0.099)	
Observations	19,727	19,727
R ²	0.118	0.564
Adjusted R ²	0.117	0.201
F Statistic	329.190*** (df = 8; 19,718)	1,740.029*** (df = 8; 10,759)

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ The 95% confidence intervals are in parentheses.

- $D_{SEi,t}$: 1 if respondent i is employed in a state-owned enterprise in period t and $= 0$ otherwise.
- $D_{FEi,t}$: 1 if respondent i is employed in a foreign-owned enterprise in period t and $= 0$ otherwise.

We control for $D_{PostUSSR}$ because we consider the possible peculiarities inherited from the Soviet period and the persistent impact of the reforms implemented after the collapse of the USSR (Brainerd, 1998; Flabbi et al., 2008; Pastore & Verashchagina, 2006). For the same reason, we also control for employment in a state-owned enterprise with the dummy D_{SE} and for employment in a foreign-owned enterprise with the dummy D_{FE} . The descriptive statistics overall and across general and vocational tracks are presented in Table 1.

5. Empirical results

5.1. Overview of employer learning

First, we provide an overview of the relationship among wages, education, and labor market experience using total years of schooling S_i as the educational background. Table 2 shows specification (1) based on the standard pooling Mincerian wage regression, which corresponds to Equation (9), and specification (2) according to the Mincerian wage regression of the fixed effects model, which corresponds to Equation (10). The Hausman test indicates that the fixed effects model is preferred to the random effects model to estimate (10).³ The interaction term between the total years of schooling

Table 3. Skill complementarity of different tracks.

	Dependent variable:	
	log w	
	(1) OLS (Mincerian)	(2) Fixed effects
S_{ps}	0.054*** (0.039, 0.069)	0.295*** (0.272, 0.319)
S_{gt}	0.167*** (0.152, 0.182)	0.358*** (0.326, 0.391)
S_{vt}	0.094*** (0.070, 0.118)	0.338*** (0.299, 0.377)
LMX	0.067*** (0.060, 0.074)	0.347*** (0.331, 0.362)
LMX^2	-0.001*** (-0.001, -0.001)	-0.001*** (-0.001, -0.001)
D_{SE}	-0.381*** (-0.413, -0.348)	-0.022 (-0.061, 0.017)
D_{FE}	0.346*** (0.275, 0.418)	0.122*** (0.045, 0.199)
D_g	0.287*** (0.256, 0.317)	-0.874 (-1.994, 0.245)
$D_{PostUSSR}$	0.667*** (0.608, 0.726)	0.063 (-0.035, 0.161)
$S_{gt} \times LMX$	-0.002*** (-0.002, -0.001)	-0.002*** (-0.003, -0.001)
$S_{vt} \times LMX$	-0.001* (-0.002, 0.00002)	-0.001** (-0.003, -0.00005)
C	0.845*** (0.643, 1.047)	
Observations	19,727	19,727
R^2	0.122	0.564
Adjusted R^2	0.121	0.200
F Statistic	248.496*** (df = 11; 19,715)	1,264.231*** (df = 11; 10,756)

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ The 95% confidence intervals are in parentheses.

³Report of the Hausman test: $\chi^2 = 12, 586$, $df = 8$, p value < 0.01 .

and labor market experience, $S_i \times LMX_{i,t}$, has a significantly negative coefficient in both specifications. These results are consistent with the employer learning hypothesis and the results in the Czech Republic before and after the transition from the communist regime (Münich et al., 2005).

5.2. Skill complementarity of the general and vocational tracks

Next, Table 3 shows the results of applying Equations (13) and (14) as specifications (1) and (2). The Hausman test indicates that the fixed effects model is preferred to the random effects model.⁴ The interaction between the general track and labor market experience ($S_{gt} \times LMX$) has a significantly negative coefficient in both specifications, as does the interaction between the vocational track and labor market experience ($S_{vt} \times LMX$). However, the negativity of the coefficient of the interaction term between the vocational track and labor market experience ($S_{vt} \times LMX$) is smaller in both specifications, though the confidence intervals overlap. The results do not contradict the inference that the skills that graduates acquire through the vocational track are more complementary to the skills acquired in the workplace relative to the signaling effects than are the skills that graduates acquire through the general track. We further elaborate on the issue below.

Another finding from Table 3 is that once fixed effects are controlled for in specification (2), the impact of years of the vocational track (S_{vt}) on wages increases more substantially than that of years of the general track (S_{gt}). This finding indicates that after controlling for innate ability, skill acquisition through the vocational track may improve productivity more than that through the general track.

Finally, in Table 4, labor market experience in Equations (13) and (14) is decomposed into the cumulative number of employed years ($EMPX$) and the cumulative number of unemployed years ($UNEMPX$) such that $LMX_{i,t} = EMPX_{i,t} + UNEMPX_{i,t}$ for respondent i in period t . The Hausman test indicates that the fixed effects model is preferred to the random effects model.⁵

In specification (1) corresponding to Equation (13), the interaction between years of the general track and employment experience ($S_{gt} \times EMPX$) has a significantly negative coefficient, while the interaction between years of the vocational track and employment experience ($S_{vt} \times EMPX$) has a significantly positive coefficient. In specification (2) corresponding to Equation (14), $S_{vt} \times EMPX$ has an insignificant coefficient, which does not contradict our aforementioned inference that employer learning and skill complementarity work in the opposite directions on α_4 in Equation (10).

The signaling effects of the general track mainly appear to act against graduates of the vocational track. Once subsampled into both tracks, the interaction term between the years of general track and employment experience ($S_{gt} \times EMPX$) does not have a significant coefficient because years of the general track is less informative for comparison within graduates of the general track (Table A1 in the appendix). In contrast, within the vocational track, the interaction term between the years of vocational track and employment experience ($S_{vt} \times EMPX$) has a significantly positive coefficient in OLS

⁴Report of the Hausman test: $\chi^2 = 12,464$, $df = 11$, p value < 0.01 .

⁵Report of the Hausman test indicates that $\chi^2 = 12,177$, $df = 15$, p value < 0.01 .

Table 4. Skill complementarity and unemployment depreciation.

	Dependent variable:	
	log w	
	(1) OLS (Mincerian)	(2) Fixed effects
S_{ps}	0.053*** (0.037, 0.069)	0.297*** (0.272, 0.322)
S_{gt}	0.129*** (0.109, 0.149)	0.357*** (0.319, 0.395)
S_{vt}	0.053*** (0.024, 0.082)	0.310*** (0.267, 0.354)
$EMPX$	0.057*** (0.051, 0.063)	0.316*** (0.305, 0.326)
$EMPX^2$	-0.001*** (-0.001, -0.001)	-0.0005*** (-0.001, -0.0003)
$UEMPX$	0.025*** (0.010, 0.040)	0.306*** (0.284, 0.328)
$UEMPX^2$	-0.001*** (-0.001, -0.0003)	-0.0005 (-0.001, 0.0004)
D_{SE}	-0.385*** (-0.417, -0.352)	-0.020 (-0.059, 0.019)
D_{FE}	0.354*** (0.281, 0.426)	0.115*** (0.037, 0.193)
D_g	0.304*** (0.272, 0.335)	-0.905 (-2.025, 0.215)
$D_{PostUSSR}$	0.732*** (0.667, 0.797)	0.126** (0.022, 0.230)
$S_{gt} \times EMPX$	-0.001** (-0.001, -0.0002)	-0.002** (-0.003, -0.0003)
$S_{vt} \times EMPX$	0.001* (-0.0001, 0.002)	-0.0002 (-0.002, 0.001)
$S_{gt} \times UEMPX$	0.001 (-0.001, 0.003)	-0.003* (-0.006, 0.0001)
$S_{vt} \times UEMPX$	0.002 (-0.0005, 0.005)	-0.001 (-0.005, 0.002)
\bar{C}	1.168*** (0.938, 1.398)	
Observations	19,270	19,270
R^2	0.127	0.563
Adjusted R^2	0.126	0.192
F Statistic	186.327*** (df = 15; 19,254)	895.302*** (df = 15; 10,407)

*p < 0.1; **p < 0.05; ***p < 0.01 The 95% confidence intervals are in parentheses.

Table 5. Skill complementarity and unemployment depreciation (standardized).

	Dependent variable:	
	log w	
	(1) OLS (Mincerian)	(2) Fixed effects
S_{ps}^z	0.104*** (0.073, 0.135)	0.584*** (0.535, 0.632)
S_{gt}^z	0.272*** (0.244, 0.301)	0.604*** (0.540, 0.668)
S_{vt}^z	0.151*** (0.123, 0.179)	0.461*** (0.418, 0.505)
$EMPX^z$	0.222*** (0.195, 0.249)	4.587*** (4.505, 4.669)
$EMPX^{z2}$	-0.246*** (-0.274, -0.218)	-0.115*** (-0.166, -0.063)
$UEMX^z$	0.071*** (0.019, 0.124)	2.883*** (2.797, 2.969)
$UEMX^{z2}$	-0.087*** (-0.140, -0.033)	-0.046 (-0.129, 0.038)
D_{SE}	-0.385*** (-0.417, -0.352)	-0.020 (-0.059, 0.019)
D_{FE}	0.354*** (0.281, 0.426)	0.115*** (0.037, 0.193)
D_g	0.304*** (0.272, 0.335)	-0.905 (-2.025, 0.215)
$D_{PostUSSR}$	0.732*** (0.667, 0.797)	0.126** (0.022, 0.230)
$S_{gt}^z \times EMPX^z$	-0.023** (-0.040, -0.005)	-0.054** (-0.098, -0.009)
$S_{vt}^z \times EMPX^z$	0.019* (-0.001, 0.038)	-0.005 (-0.039, 0.030)
$S_{gt}^z \times UEMPX^z$	0.026 (-0.015, 0.067)	-0.058* (-0.118, 0.001)
$S_{vt}^z \times UEMPX^z$	0.034 (-0.007, 0.076)	-0.018 (-0.072, 0.035)
\bar{C}	2.821*** (2.781, 2.860)	
Observations	19,270	19,270
R^2	0.127	0.563
Adjusted R^2	0.126	0.192
F Statistic	186.327*** (df = 15; 19,254)	895.302*** (df = 15; 10,407)

*p < 0.1; **p < 0.05; ***p < 0.01 The 95% confidence intervals are in parentheses.

(specification (1) in Table A2 in the appendix). However, the coefficient becomes insignificant in the fixed effects model (specification (2) of Table in A2), which indicates that the skill complementarity depends on workers' innate abilities.

Additionally, once fixed effects are controlled for in specification (2) in Table 4, the gap between the returns on general education (S_{gt}) and vocational education (S_{vt}) shrinks drastically. This finding suggests that skills added by the vocational track to innate abilities, which are controlled for as fixed effects, are substantial.

Table 5 presents the estimated results of the same specifications in Table 4 but uses the standardized variables, whose means are 0 and variances are 1, where superscript z denotes the standardized value, except for dummy variables. The Hausman test indicates that the fixed effects model is preferred to the random effects model.⁶ We obtain the same qualitative results as those in Table 4. Thus, our argument based on Table 4 is not dependent on scaling the variables.

6. Discussion

Our results indicate that employer learning effects captured by the interaction terms between years of schooling and years of experience are more weakly observed among graduates of the vocational track than among graduates of the general track. As discussed in section 3, one possible reason for this finding is that skills acquired at school and those acquired in the workplace complement each other to improve productivity such that $\partial^2 y_{i,t} / \partial S_i \partial X_{i,t} > 0$.

Amini and Nivorozhkin (2015) concluded that in the stratified Russian education system, as in Western European systems (Kupfer, 2010; von Below et al., 2013), students on the vocational track display lower academic achievement than students on the general track. Furthermore, Nikolaev and Chugunov (2012) expressed concerns regarding the state of Russian vocational education, particularly because the once narrowly defined skill building in the Soviet era failed to keep pace with technological changes after the collapse of the USSR (Nikolaev & Chugunov, 2012, 45–46). However, our results do not exclude the possibility that Russian vocational education still equips graduates with skills relevant to some industries. One possibility is that vocational education provides graduates with skills that continue to be complementary to the skills to be acquired in the workplace, if less narrowly defined. To explicitly demonstrate the skill complementarity between vocational education and work, we need rich data regarding achievement in vocational education and productivity after graduation, which is beyond the scope of this article. Nonetheless, our results do not rule out this possibility, and thus, this subject is suggested as a topic for future research.

Additionally, education systems are inevitably interdependent with other institutions, notably with labor market institutions, and institutional complementarity leads to historical path dependency (Heyneman, 2000). Given this path dependency of interdependent education systems and labor market institutions (Bol & van de Werfhorst, 2011), the replacement of the European stratified system with an unstratified system such as that of the US or Japan is unrealistic. The first step in

⁶Report of the Hausman test: $\chi^2 = 12, 177$, $df = 15$, p value < 0.01 .

addressing European youth unemployment is to determine whether the vocational education system improves labor market outcomes. Bol and van de Werfhorst (2011) determined that European vocational education provides better employment opportunities through signaling effects. Supporting this viewpoint, we suggest possible complementarity between vocational education and labor market/employment experience.

Recent studies that focus on the positive side of vocational education have emphasized the possibility of improving the academic achievement of students on the vocational track (Heisig & Solga, 2015; Prokic-Breuer & Dronkers, 2012). However, the specific virtue of the vocational track is that, ideally, it would enable students not only to perform better academically but also to learn skills that are complementary to their work. Our results hint at the possibility that Russian upper-secondary and tertiary vocational schools still equip students with skills that are complementary to work.

As discussed in section 2, the Russian system is unlikely to be the same in specifics but shares essential features with continental Western European systems. Accordingly, our results motivate future research on skill complementarity between vocational education and work experience in other European countries. Finally, Bauer and Haisken DeNew (2001) and Lluís (2005) did not differentiate years of general education and those of vocational education when using the German dataset according to general and vocational tracks. Hence, a comparable analysis of another European giant, e.g., Germany, would deepen our understanding of the interdependence of the European education systems and labor markets institutions.

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Appendix

A.1 Belief updates by employers

Motivated by Bartels (2002), we consider a Bayesian update model

$$\hat{\mu}_{i,t} = \frac{\frac{1}{\sigma_{\hat{\mu}_{i,t-1}}^2}}{\frac{1}{\sigma_{\hat{\mu}_{i,t-1}}^2} + \frac{1}{\sigma_{\xi}^2}} \hat{\mu}_{i,t-1} + \frac{\frac{1}{\sigma_{\xi}^2}}{\frac{1}{\sigma_{\hat{\mu}_{i,t-1}}^2} + \frac{1}{\sigma_{\xi}^2}} r_{i,t}, \quad (\text{A1})$$

where the prior belief in period $t - 1$ and the new information in period t are weighted by their precision evaluated by the reciprocal of their variances. Following Bartels (2002), the posterior precision in period t , $1/\sigma_{\hat{\mu}_{i,t}}^2$, given by the prior precision and the precision of the new information is presented as

$$\frac{1}{\sigma_{\hat{\mu}_{i,t}}^2} = \frac{1}{\sigma_{\hat{\mu}_{i,t-1}}^2} + \frac{1}{\sigma_{\xi}^2}, \quad (\text{A2})$$

which leads to the update of the estimated ability in period $t = 1$

$$\hat{\mu}_{t,1} = \frac{\frac{1}{\sigma_{\omega}^2}}{\frac{1}{\sigma_{\omega}^2} + \frac{1}{\sigma_{\xi}^2}} \hat{\mu}_{t,0} + \frac{\frac{1}{\sigma_{\xi}^2}}{\frac{1}{\sigma_{\omega}^2} + \frac{1}{\sigma_{\xi}^2}} r_{i,1}, \quad (\text{A3})$$

since

$$\frac{1}{\sigma_{\hat{\mu}_{i,1}}^2} = \frac{1}{\sigma_{\omega}^2} + \frac{1}{\sigma_{\xi}^2}. \quad (\text{A4})$$

From period $t = 2$ onward, the new evidence follows the same process. Then, the assumption that $\sigma_{\xi}^2 = \sigma_{\omega}^2$ yields Equation (8).

A.2 Supplementary result

Tables A1 and A2 present the results of the same specifications as in Table 4 for each subsample of the general and vocational tracks. Unsurprisingly, the interaction term between general upper-secondary and tertiary education and employment experience ($S_{gt} \times EMPX$) does not have a significant coefficient in either the OLS (1) or fixed effects model (2) in Table A1. This is because the general track served as a signal of ability primarily against graduates of the vocational track. Once subsampled as graduates of the general track, the signal has little impact.

Additionally, the interaction term between years of the vocational track and employment experience ($S_{vt} \times EMPX$) has a significantly positive coefficient in the OLS specification. This result indicates that years of vocational track education are valued as complements of employment experience and further indicates that Russian vocational education provides graduates with skills that are complementary to work experience rather than just providing signals against graduates of the general track.

Tables A3 and A4 split the sample into the first half of the period, 1994–2001, and the second half of the period, 2002–2009. The interaction term between the general track and employment experience ($S_{gt} \times EMPX$) does not have a significant coefficient in either subsample, which indicates that employer learning effects are hardly observed in the short term. For the second half period, the interaction term between the vocational track and employment experience ($S_{vt} \times EMPX$) has a significantly positive coefficient, which indicates skill complementarity, for the second half period (Table A4), but it does not for the first half period (Table A3). Thus, the skill complementarity effects of the vocational track are not warranted in the short term.

Table A1. Skill complementarity and unemployment depreciation: General upper-secondary and tertiary education.

	Dependent variable:	
	log w	
	(1) OLS (Mincerian)	(2) Fixed effects
S_{ps}	-0.043**(-0.076, -0.010)	0.193*** (0.126, 0.261)
S_{gt}	0.040** (0.001, 0.079)	0.283*** (0.218, 0.348)
$EMPX$	0.063*** (0.053, 0.074)	0.308*** (0.287, 0.328)
$EMPX^2$	-0.001***(-0.001, -0.001)	-0.001***(-0.001, -0.0002)
$UEMPX$	-0.009(-0.036, 0.019)	0.224*** (0.176, 0.272)
$UEMPX^2$	0.0001(-0.001, 0.001)	0.001(-0.001, 0.003)
D_{SE}	-0.477***(-0.534, -0.419)	-0.035(-0.118, 0.049)
D_{FE}	0.368*** (0.238, 0.497)	0.132*(-0.025, 0.288)
D_g	0.189*** (0.136, 0.242)	
$D_{PostUSSR}$	0.780*** (0.675, 0.886)	0.171*(-0.010, 0.352)
$S_{gt} \times EMPX$	0.0002(-0.001, 0.001)	-0.001(-0.003, 0.001)
$S_{gt} \times UEMPX$	0.002(-0.003, 0.006)	0.004(-0.003, 0.010)
\bar{C}	2.810*** (2.407, 3.214)	
Observations	6,113	6,113
R^2	0.106	0.548
Adjusted R^2	0.104	0.105
F Statistic	60.174*** (df = 12; 6,100)	339.976*** (df = 11; 3,089)

*p < 0.1; **p < 0.05; ***p < 0.01 The 95% confidence intervals are in parentheses.

Table A2. Skill complementarity and unemployment depreciation: Vocational upper-secondary and tertiary education.

	Dependent variable:	
	log w	
	(1) OLS (Mincerian)	(2) Fixed effects
S_{ps}	0.005(-0.015, 0.024)	0.261*** (0.227, 0.294)
S_{vt}	-0.017(-0.066, 0.032)	0.253*** (0.184, 0.322)
$EMPX$	0.059*** (0.051, 0.068)	0.335*** (0.320, 0.351)
$EMPX^2$	-0.001***(-0.001, -0.001)	-0.001***(-0.001, -0.001)
$UEMPX$	-0.064***(-0.084, -0.044)	0.219*** (0.190, 0.249)
$UEMPX^2$	0.001*** (0.001, 0.002)	0.002*** (0.001, 0.003)
D_{SE}	-0.340***(-0.382, -0.298)	-0.032(-0.084, 0.019)
D_{FE}	0.314*** (0.224, 0.404)	0.113** (0.011, 0.215)
D_g	0.258*** (0.218, 0.298)	-0.248(-2.023, 1.526)
$D_{PostUSSR}$	0.806*** (0.723, 0.890)	0.271*** (0.135, 0.408)
$S_{vt} \times EMPX$	0.002** (0.0004, 0.003)	-0.001(-0.004, 0.001)
$S_{vt} \times UEMPX$	0.010*** (0.005, 0.015)	0.004(-0.002, 0.010)
\bar{C}	2.203*** (1.911, 2.494)	
Observations	12,063	12,063
R^2	0.086	0.537
Adjusted R^2	0.085	0.106
F Statistic	94.139*** (df = 12; 12050)	603.479*** (df = 12; 6244)

*p < 0.1; **p < 0.05; ***p < 0.01 The 95% confidence intervals are in parentheses.

Table A3. Skill complementarity of different tracks: 1994–2001.

	Dependent variable:	
	log w	
	(1) OLS (Mincerian)	(2) Fixed effects
S_{ps}	0.025** (0.001, 0.049)	0.398*** (0.348, 0.448)
S_{gt}	0.084*** (0.049, 0.118)	0.462*** (0.364, 0.561)
S_{vt}	0.020 (−0.028, 0.069)	0.381*** (0.281, 0.481)
$EMPX$	0.028*** (0.020, 0.037)	0.388*** (0.358, 0.418)
$EMXP^2$	−0.001*** (−0.001, −0.0004)	0.0003 (−0.0002, 0.001)
$UEMPX$	0.014 (−0.017, 0.044)	0.415*** (0.362, 0.467)
$UEMPX^2$	−0.001** (−0.002, −0.0001)	−0.001 (−0.003, 0.001)
D_{SE}	−0.221*** (−0.273, −0.169)	−0.082** (−0.164, −0.001)
D_{FE}	0.460*** (0.351, 0.569)	0.079 (−0.082, 0.240)
D_g	0.318*** (0.271, 0.365)	−1.851** (−3.630, −0.073)
$D_{PostUSSR}$	0.187*** (0.072, 0.303)	0.153 (−0.100, 0.406)
$S_{gt} \times EMPX$	−0.0004 (−0.001, 0.0005)	−0.003 (−0.006, 0.001)
$S_{vt} \times EMPX$	0.001 (−0.001, 0.002)	0.001 (−0.002, 0.004)
$S_{gt} \times UEMPX$	0.004** (0.0003, 0.008)	−0.007* (−0.014, 0.0004)
$S_{vt} \times UEMPX$	0.003 (−0.002, 0.007)	0.001 (−0.007, 0.009)
\bar{C}	1.258*** (0.895, 1.621)	
Observations	7,825	7,825
R^2	0.086	0.429
Adjusted R^2	0.085	−0.513
F Statistic	49.257*** (df = 15; 7,809)	147.724*** (df = 15; 2,955)

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ The 95% confidence intervals are in parentheses.

Table A4. Skill complementarity of different tracks: 2002–2009.

	Dependent variable:	
	log w	
	(1) OLS (Mincerian)	(2) Fixed effects
S_{ps}	0.023*** (0.006, 0.040)	0.202*** (0.168, 0.236)
S_{gt}	0.078*** (0.059, 0.098)	0.291*** (0.237, 0.344)
S_{vt}	0.013 (−0.017, 0.043)	0.237*** (0.176, 0.299)
$EMPX$	0.033*** (0.027, 0.040)	0.257*** (0.241, 0.273)
$EMPX^2$	−0.001*** (−0.001, −0.001)	−0.001*** (−0.001, −0.0004)
$UEMPX$	−0.024*** (−0.038, −0.010)	0.215*** (0.182, 0.248)
$UEMPX^2$	0.0002 (−0.0003, 0.001)	0.0004 (−0.001, 0.002)
D_{SE}	−0.307*** (−0.341, −0.274)	−0.070** (−0.126, −0.014)
D_{FE}	0.308*** (0.233, 0.384)	0.136** (0.030, 0.242)
D_g	0.262*** (0.230, 0.294)	
$D_{PostUSSR}$	0.279*** (0.209, 0.349)	0.138** (0.007, 0.268)
$S_{gt} \times EMPX$	−0.0001 (−0.001, 0.0004)	−0.002* (−0.004, 0.0002)
$S_{vt} \times EMPX$	0.001** (0.0002, 0.002)	−0.001 (−0.002, 0.001)
$S_{gt} \times UEMPX$	0.004*** (0.002, 0.006)	−0.002 (−0.006, 0.002)
$S_{vt} \times UEMPX$	0.002 (−0.001, 0.005)	0.002 (−0.003, 0.006)
\bar{C}	2.614*** (2.370, 2.857)	
Observations	11,445	11,445
R^2	0.136	0.424
Adjusted R^2	0.135	−0.564
F Statistic	120.442*** (df = 15; 11,429)	221.808*** (df = 14; 4,210)

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ The 95% confidence intervals are in parentheses.