# The Structure of Wages in Russia: 1985–2015*

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**Abstract**

This paper identifies a demand shock on the Russian labor market in the early 1990s. The shock changed the specialization structure of the employed professionals in the labor market; influenced income inequality; and parsimoniously explains two known puzzles of the Russian wage structure: the relatively low college returns in 1994–1996 (aka Market Adjustment Puzzle) and the drop in the college returns in 1998–2008.

The nature of the identified demand shock indicates that firms were deploying organizational technologies in response to a rapid desertion of central planning (aka Price Shock Therapy). The deployment suggests that there is an unexplored similarity between the economic transition and skill-biased technical change, as examined in this paper.

The similarity implies that the economic transition had an aspect of being a period of learning the new organizational technologies, and, therefore, the transformational recession that followed partially resulted from the lack of personnel capable of implementing the new technologies. Cross-country evidence confirms this implication.

**Keywords:** Skill-biased technical change; transformation recession; transition; college wage premium; organizational capital.
**JEL codes:** J31; J24; O33; P30.

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# 1 Introduction

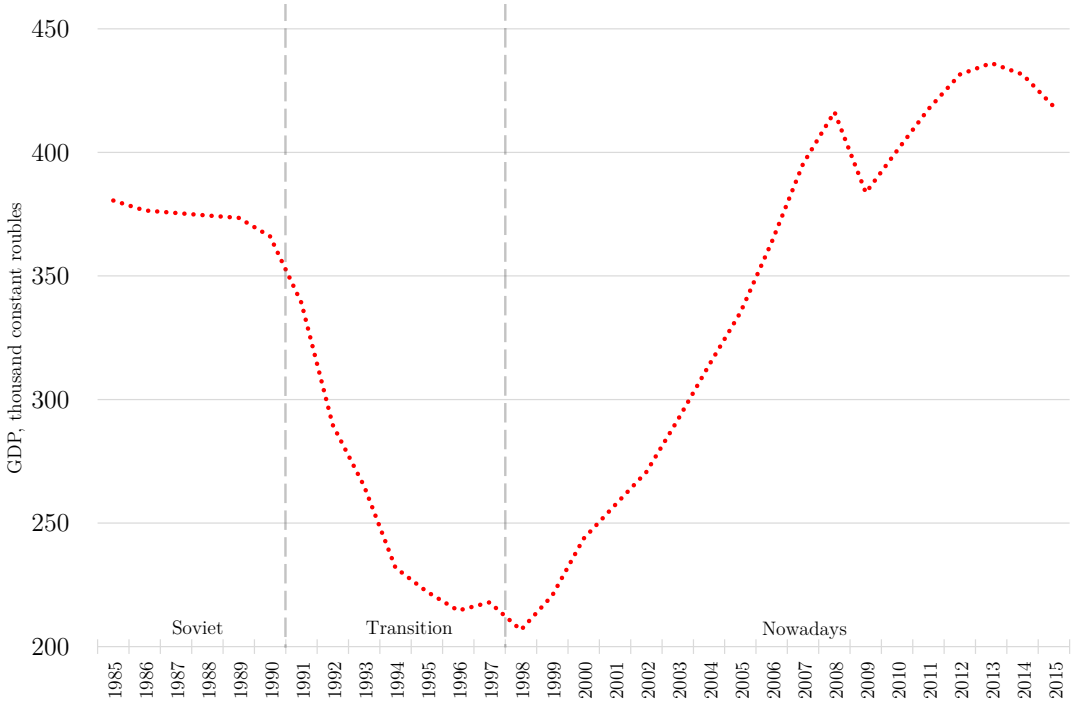
It is widely accepted that the information technology (IT) revolution drove changes in wage structures and earnings inequality in the United States and other Organization for Economic Co-operation and Development countries in the 1970s. The empirical observation that the deployment of a new technology is accompanied by the creation of better paid jobs that require higher qualifications is known as skill-biased technical change (SBTC) (Acemoglu and Autor 2011; L. F. Katz and Autor 1999; Violante 2016). To generalize SBTC beyond IT, economists use the term "general purpose technology" to describe technological advances that pervade many sectors, improve rapidly, spawn further innovations and induce wage inequalities (Rousseau 2016). Jovanovic and Rousseau (2005) identify similarities in the ways in which the United States economy reacted to adaptations of electricity and IT from 1894 to 1930 and 1971 to 2005, respectively. Chin et al. (2006) show that the introduction of the steam engine from 1891 to 1912 created a new demand for engineers and deskilled able-bodied seamen. More recently, it has been argued that, in a modern economy, SBTC mechanisms reduce the demand for unskilled workers as a result of organizational changes (i.e., the decentralization of authority, the delayering of managerial functions and increased multitasking) (Bresnahan et al. 2002; Caroli and Van Reenen 2001; Dessein and Santos 2006; Garicano and Rossi-Hansberg 2006; Milgrom and Roberts 1990).

Although SBTC processes have become the leading explanation for changes in the wage structures of developed countries, in Russia, little consideration regarding the effects of technological changes on the wage structure has been given to date. This paper shows that the SBTC framework provides a powerful explanation of the Russian wage structure for the period 1985 to 2015 and consolidates the somewhat disorganized literature on wages in Russia.

Academic discussions of wages in Russia generally consider three periods (see Figure 1): (1) wages in the Soviet period (i.e., before 1991); (2) wages during the transition period (i.e., from 1991 to 1998); and (3) wages in Russia nowadays (i.e., from 1998 to date).

During the Soviet period, both college wage premiums (Gregory and Kohlhase 1988; K. Katz 1999) and general monetary inequalities (Novokmet et al. 2018) were very low. Inequalities existed in the form of access to better shops, products or vacation facilities, and jobs that required HE often provided that access. Unlike other Eastern European countries that were signatories to the Warsaw

Figure 1: Russian economic output




*Notes:* GDP per capita is gross domestic product divided by midyear population. Data are in constant 2010 Russian roubles. Dashed vertical lines separate the periods.
*Source:* World Bank.

Pact,[1] returns to education during the transition period in Russia remained among the lowest in the world and were only slightly above returns during the Soviet period (aka the Market Adjustment Puzzle). Returns peaked in 1998, but have been gradually decreasing ever since. This is attributed to the larger involvement of applicants with lower levels of ability during the expansion of the HE system (Belskaya and Sabirianova Peter 2014; Belskaya, Sabirianova Peter, and Posso 2014; Kyui 2016). Similarly, Gorodnichenko, Peter, and Stolyarov (2010) detect a peaking of income inequality in 1998 and a gradual decrease ever

[1] In Poland, returns to education increased while the experience premium fell (Rutkowski 1996). Similar patterns took place in the Czech Republic and Slovakia (Chase 1998). In contrast, returns to both education and experience fell during the transition in Slovenia (Stanovnik and Verbič 2005) and in Romania (Andrén et al. 2005). Other influential comparative studies for the period of transition are as follows. Fleisher et al. (2005) concluded that returns to schooling increased proportionally with the speed of economic reforms and favored the young. Brainerd (2000) found that women lost more in Russia and the Ukraine, but gained more in the rest of Eastern Europe. Krueger and Pischke (1992) showed that returns to both education and experience fell slightly in eastern Germany after unification. Sabirianova Peter (2003) used linked employer-employee data and showed that in Russia the transition to a market economy was skills-biased because market liberalization adjusted wages to the true marginal productivity. Gorodnichenko and Peter (2005) compared wage premiums for schooling between Russia and its closest institutional analog, the Ukraine, for the period 1985–2002 and noted that, once both economies were decentralized, the Russian wage premium went up quicker than that of the Ukraine's and attained a significantly higher value.

since. They attribute this to an absence of significant macroeconomic turmoil.

The explanation of the Russian wage structure in this paper hinges on the most characteristic feature of the transition period – the transformational recession (an unexpected and universal[2] decline in output during the transition from a centralized to a market economy). To date, the transformational recession has largely been ignored in discussions on Russian wage structures.

Atkeson and Kehoe (1995, 2005) put forward the first theoretical explanation for the recession, developing a model in which the transition is interpreted as an investment in new organizational capital. The economic output decline during the first year of the transition may have reflected the adoption of new organizational technologies. If national accounts were to include firms' investments in information capital and reorganization, the decline would not have been so drastic.

In this research, it is noted that, if indeed firms' investments were biased towards organizational technologies, then the detectable creation of better paid jobs should accompany those technologies (due to technology-skill complementarity and SBTC). To this end, this paper reestimates the return on HE from 1985 to 2015 and acknowledges that the skills of law and business ($\ell b$) graduates are complementary to organizational technologies. For almost two decades after the collapse of the Soviet Union, Russian students declared their choices of specialization when they made their applications and studied specialization-specific curricula from the first semester onward, without comingling with students of other specializations. Students' declarations of their areas of specialization provide a unique proxy for the type of skills supplied on the labor market.

Using the Russia Longitudinal Monitoring Survey (RLMS), it is shown that, during the transition period, the skills provided by $\ell b$ graduates experienced a substantial increase in returns. Conversely, the return on the skills provided by the remaining ($\overline{\ell b}$) graduates remained stagnant until 1997 (the returns of $\ell b$ were 136% higher than that of $\overline{\ell b}$ in 1995/1996). A scaled-up version of this differential persisted for another 10 years after a return of economic growth in 1998 (the returns were 120% higher in 2000 and 40% higher in 2002/2003); however, it ceased to exist in 2007/2008 due to the increase in the supply of $\ell b$ graduates in the market. This pattern suggests that firms did deploy organizational technologies after the economic reforms that created an unusually large labor market demand-side shock on the skills of $\ell b$ graduates after economic decentralization.

[2]In ten out of the fifteen ex-Soviet republics, GDP for 1996 was estimated to stand at less than half its 1989 estimate (Boycko et al. 1997).

These findings provide a parsimonious explanation for the relatively low returns of HE from 1994 to 1996 and the decrease in returns from 1998 to 2015. Low returns during the transition period are not the result of an oversupply of educated workers; rather, it is the undersupply of $\ell b$ graduates that spikes the returns on specialization (up to 53%), and the oversupply of $\overline{\ell b}$ graduates, whose returns are the same as those of the Soviet Union (no more than 19%). The decrease in returns in present day Russia is not (at least exclusively) the result of a larger enrollment of applicants with lower abilities during the expansion of the HE system; rather, it is the effect of the transitory wage differential, which initially elevates the average returns and then causes them to plunge.

An analysis of occupations shows that the transitory differences in returns of various specializations led to massive changes in the structure of employed professionals and technicians from 1985 to 2015. The economic transformation made most skills supplied by science, technology, engineering and math (STEM) graduates redundant (41% decrease) and replaced them with skills supplied by $\ell b$ graduates (240% increase).

These empirical findings add to an existing body of evidence that points to the similarity between the processes of economic transitions and SBTC. Economic theories that explicitly formulate an economic mechanism to explain SBTC also emphasize the effect of learning during periods of radical technical change. For example, this explains the productivity decline which occurred in most developed economies in the 1980s (Caselli 1999; Galor and Moav 2000; Greenwood and Yorukoglu 1997). When a new technology is first being deployed, output can decrease temporarily, as workers and firms learn how to use it (Aghion 2002; Hornstein and Krusell 1996).

Interpreting economic transition as a form of SBTC implies that the transformational recession may have been a period of learning/adaptation of the new technology. As such, it can be argued using theoretical modeling that the transformational recession could have been reduced if policy makers had acknowledged the dependency of the implementation of technologies on the supply of workers with complementary skills. Conversely, the HE system, unlike most of the economy, remained the property of the state, which led to a decade of underfunding, as the government struggled to balance its finances. In 1994, the parliament passed a series of laws that formally allowed private firms to invest in HE (Belskaya and Sabirianova Peter 2014); however, a fully functional regulatory framework that allowed HE to be privately financed by firms and applicants was not institutionalized until the 2000s. Thus, while the popularity of $\ell b$ specializations due to the high returns was unprecedented (Public Opinion

Foundation 1998, 2006), the HE system was insensitive to labor market price signals for almost a decade after the beginning of the reforms.

Given the well-documented structural similarities between Russian and Soviet economies (Ananyev and Guriev 2018; Mikhailova 2012), and that the differential leveled out in 2007/2008 (exactly when the Russian economy regained its size to that of late Soviet Russia), it can be guesstimated that 6–7% of the labor force should have been supplying their $\ell b$ skills to foster the adoption of new organizational technologies in the market economy, which would have cushioned the transformational recession. However, at the beginning of the transitional reform, only 2–3% of the labor force had such skills, complicating the adoption of technologies and exacerbating the recession.

The remainder of this paper proceeds as follows: Section 2 stylistically compares centralized and market economies; Section 3 summarizes the institutional environment using the compact theoretical model; Section 4 introduces the dataset and the solutions to certain data complications, provides definitions of specializations and outlines the empirical strategy; Section 5 provides estimates of the wage premium, the transitory wage differential and occupational shifts; Section 6 and Section 7 show the significance of the discovered differential in relation to output decline; and Section 8 provides a reiteration of the main findings.

## 2 Institutional Background

Walras's general equilibrium is a widely accepted stylistical representation of a market economy. A pool of consumers defines an aggregate consumption profile and, through the price system, firms follow demand. The environment requires firms to engage with consumers and each other; however, the contractual and informational imperfections that arise from these interactions require a judicial system and a body of contracts. This accounts for the amount of $\ell b$ graduates in the market economy. By analogy, a stylistical centralized economy does not use price signals to broadcast values and an aggregated consumption profile is defined by politicians. Demand and supply are connected by the Central Planner, while the execution of the plan is carried out by several hundreds of ministries that, through directives, harmonize enterprises into industries and industries into an economy. Firms have no need to engage with each other or consumers, which suggests a significantly lesser need for personnel trained in $\ell b$.

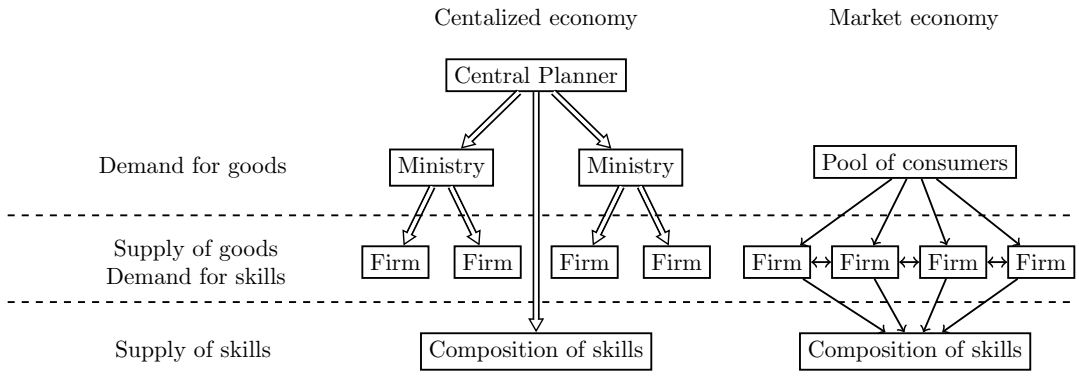
Figure 2 compares both types of economies in relation to the criteria. The

thick arrows on the centralized type of economy signify the coordination of economic activities undertaken through administrative means (e.g., commands, directives, targets and regulations) rather than by a market mechanism, which is signified by the thin arrows.[3]

Central planning was applied to the United States economy from 1942 to 1946, the Mormon economic system in mid-19th century Utah, and the Inca production system in the 16th-century Andes; however, the Soviet Union was the first country to implement central planning to its fullest development in the 1920s (Ericson 2017). Initially, central planning proved effective at fostering growth. However, whereas market economies experienced an improvement in efficiency and delivered modern products through inter-branch relationships and flexible cross-industrial coordination from the 1970s, the existing system of branch ministerial organization in the Soviet Union resisted such arrangements. As the Russian economy grew in size and sophistication (e.g., in 1980, approximately 25 million commodities had entered the Central Plan in the Soviet Union; by comparison, no more than 1,200 had entered China's (Qian and Xu 1993)), centralized planning and control became more difficult and errors began to have a greater effect. In the late 1980s, disequilibria and imbalance, which had always existed, reached intolerable levels. The absence of the price system prevented a Walrasian re-equilibration and planning mistakes accumulated over decades, driving demand and supply further and further apart. By the last year of the Soviet Union, non-market considerations for resource allocation resulted in a situation in which the economy was able to send astronauts to space, but failed to produce enough food for the people (Levine 1983; Nove 2003).

The major economic and political reforms started in 1991 and were collectively labelled "price shock therapy" due to the inclusion of a sudden release

Figure 2: Centralized and market economies




[3]The most influential works on the nature and problems of the Soviet centralized economy are by Ericson (1983, 1991, 2006) and Grossman (1962, 1963, 1966).

of price and currency controls, the withdrawal of state subsidies, trade liberalization, large-scale privatization, and the dismissal of the Central Planner and ministries. The reforms assumed that the elimination of price and trade distortions that had kept the economy far inside its production frontiers would bring the economy closer to its potential output, while the development of new activities would shift the production frontier further out, leading to further increases in output over time. Most prices and wages were freed on January 2, 1992; in 1994, 70% of industrial workers were working in private firms (Boycko et al. 1997).

These institutional features inspired work by Atkeson and Kehoe (1995). They view the transition from a centralized economy to a market economy as a sudden improvement in the quality of the available organizational technologies. As the most recent works argue that organizational shifts are behind SBTC, the economic transformation seems to be the most visible yet overlooked quasi-experimental illustration of these shifts.

# 3 Conceptual Framework and Predictions

The modeling is based on the observation that transformation is similar to SBTC and that price shock therapy did not change the fundamentals of the economy in the short- to mid-term. However, the sudden release of price and currency controls, the withdrawal of state subsidies, trade liberalization, large-scale privatization, and the dismissal of the Central Planner increased the share of work that required personnel to be trained in $\ell b$.

The modeling adopts an approach that became standard in the SBTC literature after it was first used by L. F. Katz and Murphy (1992).

There is a representative good

$$Y = F(A, K, L_s(\cdot), L_u), \tag{1}$$

generated by skilled labor $L_s(\cdot)$, unskilled labor $L_u$, capital $K$, and economy-wide technological change $A$, with $F(\cdot)$ increasing in all arguments.

The setup is similar to that used by Card and Lemieux (2001), who analyze the differential between different age groups. However, in this model, the differential relates to the same demographic group (within the same argument $L_s$ of the function $F(\cdot)$). Thus, there is no need to parametrize the relationship between the arguments.

Skilled workers are assumed to be risk-neutral labor income maximizers who

are divided into two educational groups (i.e., $\ell b$ and $\overline{\ell b}$) that coexist under two assumptions. First, for a given amount of output, the possibility of substituting $\ell b$ with $\overline{\ell b}$ is fixed. Second, relative wages paid in the equilibrium reflect the relative productivity of workers. The latter assumption is empirically plausible, as we know that after price shock therapy wages were set via informal plant-level bargaining over which unions had little influence (Brainerd 1998).

The first assumption permits the specification of $L_s$ as a Constant Elasticity of Substitution (CES) aggregate of $\ell b$ and $\overline{\ell b}$ graduates

$$L_s = \left[\alpha N_{\ell b}^{\rho} + (1-\alpha) N_{\overline{\ell b}}^{\rho}\right]^{1/\rho}, \tag{2}$$

where $\rho \stackrel{\text{def}}{=} 1 - (1/\sigma)$, with $\sigma$ being the elasticity of substitution between college graduates of types $\ell b$ and $\overline{\ell b}$. As the groups are substitutes, it implies that $\rho \in (0, 1]$.[4] Parameter $\alpha \in (0, 1)$ governs a share of work that has be to performed by $\ell b$ graduates due to a certain economic environment. It captures an increase in relative demand; thus, a demand side shock for $\ell b$ graduates can be interpreted in this framework as an increase in $\alpha$.

The second assumption (i.e., that wages reflect marginal productivity) implies that the relative wage premium is

$$\frac{\beta_{\ell b}}{\beta_{\overline{\ell b}}} \stackrel{\text{set}}{=} \frac{\frac{\partial Y}{\partial N_{\ell b}}}{\frac{\partial Y}{\partial N_{\overline{\ell b}}}} = \frac{\cancel{\frac{\partial Y}{\partial L_s}} \times \frac{\partial L_s}{\partial N_{\ell b}}}{\cancel{\frac{\partial Y}{\partial L_s}} \times \frac{\partial L_s}{\partial N_{\overline{\ell b}}}} = \frac{\alpha}{(1-\alpha)} \frac{N_{\ell b}^{\rho-1}}{N_{\overline{\ell b}}^{\rho-1}}. \tag{3}$$

Noting the definition of $\rho$ and taking a natural logarithm yields

$$\ln\left(\frac{\beta_{\ell b}}{\beta_{\overline{\ell b}}}\right) = \ln\left(\frac{\alpha}{1-\alpha}\right) - \frac{1}{\sigma} \ln\left(\frac{N_{\ell b}}{N_{\overline{\ell b}}}\right). \tag{4}$$

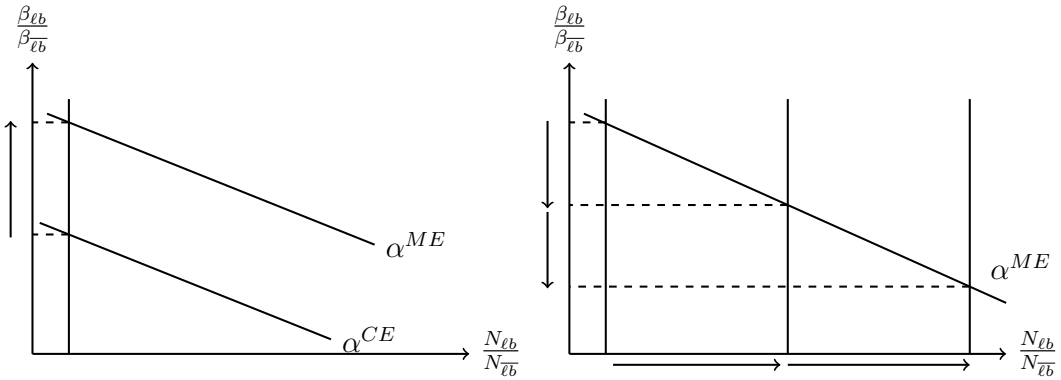
The wage premium of $\ell b$ graduates relative to $\overline{\ell b}$ depends on the share of work allocated to them, their relative supply, and the technological capacity to substitute $\ell b$ with $\overline{\ell b}$.

The following proposition summarizes the straightforward comparative statics.

**Proposition 1.** *An increase in the share of work that has to be performed by $\ell b$ increases the relative wage premium. Conversely, an increase in the relative supply pushes the premium down:*

[4] A thorough discussion of the parameters of substitution in a similar context can be found, for example, in Acemoglu (2002, p. 18). A good general discussion of a CES function can be found in Rainer et al. (2011).

Figure 3: Comparative statics graphically




*Left figure:* A share of work performed by law or business graduates in the market economy, $\alpha^{ME}$, is higher than that in the command economy, $\alpha^{CE}$. A rapid switch from one type of economy to another without a change in the composition of skills increases the relative wage premium.
*Right figure:* An increase in the relative supply decreases the relative wage premium.

$$\frac{\partial \ln(\beta_{\ell b}/\beta_{\overline{\ell b}})}{\partial \alpha} = \frac{1}{(1-\alpha)\alpha} > 0 \tag{5}$$

*and*

$$\frac{\partial \ln(\beta_{\ell b}/\beta_{\overline{\ell b}})}{\partial (N_{\ell b}/N_{\overline{\ell b}})} = -\frac{1}{\sigma} < 0. \tag{6}$$

Figure 3 visually summarizes this proposition. The key results in Section 5 are presented as an empirical counterpart of this visualization.

# 4 Data and Methods

## 4.1 Data

For empirical purposes, this paper uses RLMS, a series of nationally representative panel surveys designed to monitor the effects of Russian reforms on the health and economic welfare of households and individuals in the Russian Federation. The data has been collected annually since 1994 (with the exception of 1997 and 1999). The data for 1985, 1990 and 1991 are collected retrospectively. The RLMS project is run jointly by the Carolina Population Center at the University of North Carolina, Chapel Hill, and the Demoscope team in Russia. For a history of the survey, an outline of the sample design and the replenishment of sample designs, the loss to follow-up and other key factors, see the data resource profile in Kozyreva et al.'s (2016) paper. This paper uses information for years 1985–2015. In total, the dataset spans 109,607 observations, or an average of 5,768 observations per wave. Biases caused by sample attrition due

to the higher mortality rates of older age groups or labor mobility are reduced by restricting age to 15–59 years and using sample weights.

The following variables are constructed from the dataset. *Experience* is age minus the variable *Schooling* and minus the number 6. *Schooling* is constructed based on respondents' self-declared educational status: 4 years for grades 1–6, 8 years for grades 7–9, 10 years for secondary school grades 10–12, 9 years for a vocational non-secondary school diploma, 11.5 years for a vocational secondary school diploma, 13 years for a technical school diploma and an incomplete HE, 14 years for a bachelor's degree, 15 years for a specialist diploma, 16 years for a master's degree, and 18 years for a doctorate degree. *Tenure* refers to the number of years a respondent has worked at their current job. *Education level* has five indicators: *Less than secondary school*, *Secondary school*, *Vocational diploma*, *Higher education* and *Graduate school*. *Residency* has four indicators: living in *Regional center*, *Town*, *Urban village* or *Rural area*. *Federal city* is an indicator of if a respondent lives in Saint-Petersburg, Moscow or Moscow Oblast. *Ownership* has three indicators: *State company*, *National company* and *Foreign company*. The latter also includes mixed ownership. *Employer size* has seven indicators: *Size 0-10, 10–50, 50–100, 100–500, 500–1000, >1000* and *Size missing*. All definitions closely resemble those adopted by Gorodnichenko and Peter (2005) and Münich et al. (2005).

The dependent variable is a log of monthly contractual wages after tax at the primary workplace corrected for in-kind remuneration. This choice of dependent variable is standard for the dataset and is considered the best choice to proxy wages. This is due to wage delays during the transition period and the low quality of information on hours worked. One limitation related to choosing this dependent variable is that it is agnostic about the hours actually worked. As earnings clearly depend on working hours, this creates a version of an omitted variable bias. On average, those who are the most educated tend to work fewer hours. Thus, omitting the *Hours worked* variable, which is negatively correlated with the level of education, produces a downward bias. However, as this research is focused on the time behavior of the wage premium, this issue is somewhat less pressing.

Some earlier researchers (e.g., Gregory and Kohlhase 1988) include *Hours worked* as a covariate, although for a different dataset. More recent studies use monthly wages (e.g., Kyui 2016) or even wages averaged across several months (e.g., Carnoy et al. 2012). Exceptionally, Belskaya and Sabirianova Peter (2014) use hourly wages, ignoring the issue of missing hours or hours that

fall outside the normal range.[5]

In cases in which respondents state that, in addition to their wages, their firm makes payments in-kind and those values are known to the respondents, these values are added to their wages. This approach is similar to that of Gregory and Kohlhase (1988), who include indicators to address differences related to non-monetary job privileges. In the Soviet period, a significant portion of compensation was non-pecuniary (e.g., paid vacation at health resorts). It may be that respondents who are employed in newly created positions or who work in a new industry are compensated entirely by wages, while more traditional specializations are partially compensated by other types of non-pecuniary rewards. Not correcting for in-kind payments creates spurious differences in returns, as graduates non-randomly select themselves into different industries. This correction also addresses the issue of the low quality of the variable *Hours worked*, as it varies across specializations. One limitation of this correction is that, similar to wages, such monetary values are self-declared.

Table 1 provides the descriptive statistics for the variables considered in this study.

## 4.2 Fields of specialization and occupation

Educational levels are separated into graduate school, HE, vocational school and secondary school. This classification is typical. As a proxy for the type of skills, HE is further categorized into specializations. In Russia, students declare their choice of specializations when they make their applications and study specialization-specific curricula from the first semester onward, without comingling with students from other specializations in their class work. This is a trait of the Soviet system, as very often a specialization was designed for the needs of a single industry. This institutional peculiarity allows the specialization categories to be used as a proxy for different types of supplied skills. *STEM, Medical* and *Liberal arts* categories bear the most natural definitions. However, *ℓb* graduates are excluded and treated separately. The *Public sector* includes professions for which the state is the only employer. The specialization definitions adopted for this study are similar to those used by Denisova and Kartseva (2007). A respondent with missing specialization information falls into the *Unspecified* category (Table 3 and Table 4 in Section A have further details on definitions).

[5]The present study also tested the key results against monthly wage divided by the hours worked; however, no practical difference was found. The calculations are not included in this paper and may be requested from the author.

Table 1: Descriptive statistics

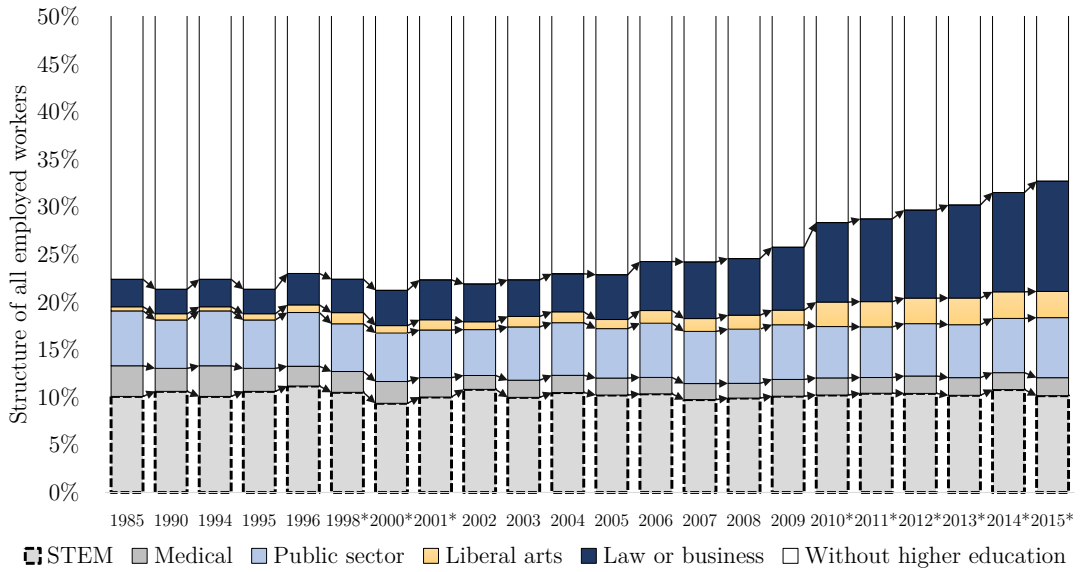
| Period | 1994-1996 | | 1998-2008 | | 2009-2015 | | 1985-2015 | |
|---|---|---|---|---|---|---|---|---|
| | Mean | St. Dev | Mean | St. Dev | Mean | St. Dev | Mean | St. Dev |
| Log of wage | 12.64 | 1.05 | 8.12 | 1.12 | 9.55 | 0.77 | 9.30 | 1.53 |
| in 1985 | · | · | 5.20 | 0.51 | · | · | 5.20 | 0.51 |
| in 1990 | · | · | 5.54 | 0.62 | · | · | 5.54 | 0.62 |
| Higher education | 0.22 | 0.42 | 0.23 | 0.42 | 0.29 | 0.45 | 0.26 | 0.44 |
| Experience | 20.44 | 10.83 | 20.04 | 10.97 | 20.49 | 11.25 | 20.33 | 11.12 |
| Female | 0.53 | 0.50 | 0.53 | 0.50 | 0.53 | 0.50 | 0.53 | 0.50 |
| Federal City | 0.18 | 0.39 | 0.18 | 0.38 | 0.16 | 0.37 | 0.17 | 0.37 |
| Tenure | 7.63 | 8.59 | 6.70 | 8.31 | 6.78 | 8.01 | 6.82 | 8.17 |
| Regional Center | 0.48 | 0.50 | 0.46 | 0.50 | 0.43 | 0.49 | 0.44 | 0.50 |
| Town | 0.30 | 0.46 | 0.29 | 0.45 | 0.29 | 0.45 | 0.29 | 0.45 |
| Urban Village | 0.06 | 0.23 | 0.05 | 0.22 | 0.06 | 0.24 | 0.06 | 0.23 |
| Rural Area | 0.16 | 0.37 | 0.20 | 0.40 | 0.22 | 0.42 | 0.21 | 0.41 |
| Foreign company | 0.04 | 0.19 | 0.04 | 0.20 | 0.03 | 0.17 | 0.03 | 0.18 |
| National company | 0.25 | 0.43 | 0.41 | 0.49 | 0.49 | 0.50 | 0.44 | 0.50 |
| State company | 0.69 | 0.46 | 0.55 | 0.50 | 0.41 | 0.49 | 0.48 | 0.50 |
| Ownership missing | 0.14 | 0.35 | 0.13 | 0.34 | 0.14 | 0.34 | 0.13 | 0.34 |
| Size 0-10 | 0.07 | 0.25 | 0.07 | 0.26 | 0.09 | 0.29 | 0.08 | 0.28 |
| Size 10-50 | 0.20 | 0.40 | 0.19 | 0.40 | 0.22 | 0.41 | 0.21 | 0.41 |
| Size 50-100 | 0.09 | 0.29 | 0.09 | 0.29 | 0.09 | 0.29 | 0.09 | 0.29 |
| Size 100-500 | 0.19 | 0.39 | 0.17 | 0.37 | 0.14 | 0.35 | 0.16 | 0.36 |
| Size 500-1000 | 0.05 | 0.22 | 0.05 | 0.22 | 0.04 | 0.19 | 0.04 | 0.20 |
| Size $\geq$ 1000 | 0.12 | 0.33 | 0.13 | 0.34 | 0.06 | 0.24 | 0.09 | 0.29 |
| Size missing | 0.28 | 0.45 | 0.30 | 0.46 | 0.35 | 0.48 | 0.33 | 0.47 |
| Sample size | 9193 | | 39308 | | 61106 | | 109607 | |

*Source:* RLMS.

A slight issue arises, as the respondents are only asked for their specialization from 1998 to 2001 and 2010 to 2015. Adopting the approach of Belskaya and Sabirianova Peter (2014) and Belskaya, Sabirianova Peter, and Posso (2014), the information for the missing years is obtained through a panel component of the data (the same respondents respond each year). The information on specializations is fully available in the data for the last six years. Thus, it is possible to pretend that information for those last six years is missing and to replicate an imputation procedure to assess its accuracy (see Section A.2 for further details). The data for 1985 and 1990 is a recall of that of 2000/2001; thus, there is an assumption that most respondents do not change their university specializations.

The category definitions are applied to the dataset to produce Figure 4. The composition of the labor force demonstrates an obvious tendency: in 1994, $\ell b$ graduates occupy approximately 3% of the labor force, whereas, in 2015, they occupy 12%. Notably, from 1994 to 1998, the share of respondents with HE is slightly higher due to a difference in the sampling formation procedures, which

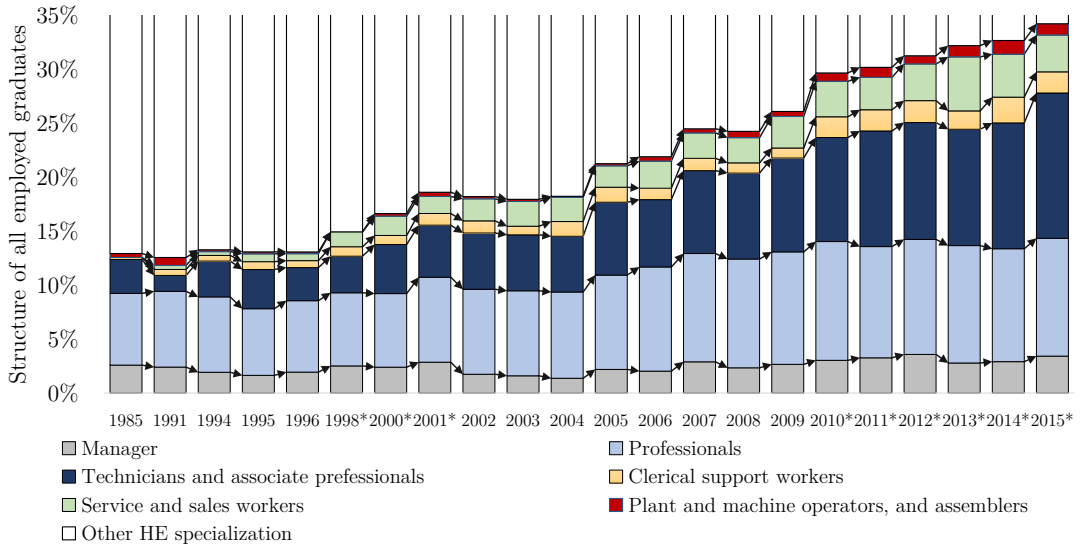
Figure 4: Share of graduates with higher education in the labor force




*Notes:* Years marked with * do not use specialization imputation. Workers with *Unspecified* specialization are excluded. Percentage of workers with higher education corresponds to the mean of variable *Higher education*.
*Source:* RLMS.

probably overstates the share of $\ell b$ graduates relative to the later period.

Figure 5: Occupation of law and business graduates




*Notes:* See comments for Figure 4.
*Source:* RLMS.

Figure 5 shows the occupations of $\ell b$ graduates. In 1985, $\ell b$ graduates account for 13.3% of all employed HE graduates; in 2015, this number increases to 35.6% (a 167% increase). The largest increase, from 3.14% in 1985 to 13.48% in 2015 (a 328.82% increase), occurs among *Technicians and associate profes-*

*sionals*.[6] The second largest increase, from 6.65% in 1985 to 10.93% in 2015 (a 64.25% increase), occurs among *Professionals*. These two occupations require skills that are typically acquired through HE programs. An increase in these two occupations is intuitive and supports the argument that the Russian economy is employing new organizational technologies.

The following two changes in occupation are interesting, as they either never exist or are never performed by HE graduates in the late Soviet Union. The third largest increase from 0.00% in 1985 to 3.42% in 2015 occurs among *Service and sales workers*. Interestingly, the share of this occupation in the general employed labor force (as distinct from the HE labor force) in 1985 is still close to nil. The fourth largest increase, from 0.18% in 1985 to 1.96% in 2015 (a 960.78% increase), occurs among *Clerical support workers*. The increase for this occupation remains continuous for the entire period. This reflects the increasing complication of organizational technologies, as professionals in this occupation are responsible for recording, organizing, storing, computing and retrieving information. The fifth largest increase, from 2.59% in 1985 to 3.42% in 2015 (a 32.2% increase), occurs among *Managers*.

There is one obvious occupational mismatch. In 2007/2008, there is an increase in *Plant and machine operators, and assemblers*. Previous research on Russian wage structures may take this as evidence of a fall in the quality of HE due to a larger enrollment of applicants with poor unobservable variables. However, while this mismatch is detectable, it is minuscule; it changes from 0.37% in 1985 to 1.04% in 2015 (a 182.12% increase). The differential that this paper discovers clarifies the reasons for this mismatch.

## 4.3 Empirical strategy

This paper uses a standard human capital equation, adjusted for residency and occupation, to break wages into workers' observables, and then break the premium for HE across various groups of university graduates to uncover $\beta_{\ell b}$ and $\beta_{\overline{\ell b}}$. At the first stage, an economically meaningful interpretation is the price of a particular observable that prevails in the labor market. At the second stage, a convenient interpretation is returns on investment into a particular specialization. At both stages, the estimates capture the interactions of the demand and the supply sides. Specifically, in the current context, the estimates capture the competition among firms to obtain the scarce supply of the skills possessed by $\ell b$ graduates.

[6] See Internatioanl Labour Organizations (2012) for the definitions of all occupations and their typical tasks.

The first stage:

$$\begin{aligned}\ln Wage_{it} =& \beta_0^t + \sum_{n=1}^{4} \beta_n^t \mathbb{1}\left\{Education\ level_{it}^n\right\} + \beta_5^t Experience_{it} + \beta_6^t Experience_{it}^2 \\ &+ \beta_7^t \mathbb{1}\left\{Female_{it}\right\} + \beta_8^t Tenure_{it} + \beta_9^t Tenure_{it}^2 \\ &+ \sum_{k=1}^{3} \gamma_k^t \mathbb{1}\left\{Residency_{it}^k\right\} + \gamma_4^t \mathbb{1}\left\{Federal\ city_{it}\right\} \\ &+ \sum_{p=1}^{3} \theta_p^t \mathbb{1}\left\{Ownership_{it}^p\right\} + \sum_{q=4}^{10} \theta_q^t \mathbb{1}\left\{Employer\ size_{it}^q\right\} + \varepsilon_{it} \\ & t \in \{1985, 1990, 1994-1996, 1998, 2000-2015\}.\end{aligned} \tag{7}$$

Subscript $i$ indexes individuals and $t$ indexes years. The explanatory variables are standard for the dataset and are grouped according to human capital measures (the $\beta$ coefficients), job characteristics (the $\theta$ coefficients) and demographic characteristics (the $\gamma$ coefficients).

The second stage:

$$\begin{aligned}\ln Wage_{it} =& \beta_0^t + \sum_{j=1}^{27} \zeta_j^t Controls_{it}^j + \varepsilon_{it} \\ &+ \beta_{\ell b}^t \mathbb{1}\left\{Higher\ education_{it} \times Law\ or\ business_{it}\right\} \\ &+ \beta_{\overline{\ell b}}^t \mathbb{1}\left\{Higher\ education_{it} \times Except\ law\ or\ business_{it}\right\} \\ & t \in \{1985, 1990, 1994-1996, 1998, 2000-2015\}.\end{aligned} \tag{8}$$

Equation (8) is different from (7), as it replaces the *Higher education* variable with *Higher education*×*Law or business*, *Higher education*×*Except law or business* and *Higher education*×*Unspecified* (neglected in the formula for expositional purposes).

The *Unspecified* variable includes workers who have obtained a HE, but for whom specialization information is missing. These workers are treated as a separate category. If these categories are not included, an omitted variable upward bias is produced, as the *Unspecified* variable correlates positively with all other levels of education and with the dependent variable. However, the corresponding coefficient does not carry meaningful information, as it includes a non-random collection of graduates. The same reasoning applies to the *Size missing* or *Ownership missing* variables, just as it does to the *Graduate school* variable and other levels of education.

To confirm the robustness of the results, a quantile regression is also employed. The information for two adjacent years is combined for three periods:

during the transition, at the peak of the differential, and at the end of the study period. It shows that the results are not driven by a potentially erroneous specialization imputation, a narrow income group (e.g., entrepreneurs) or a small sample. The quantile regression also shows that only returns on $\ell b$ produced a substantial transitory wage differential.

Quantile regression:

$$\begin{aligned}\mathbb{Q}^k\Big(\ln Wage_{it}|\mathbf{X}_{it}\Big) =& \beta_0^{k,t} + \sum_{n=1}^{27} \zeta_n^{k,t} Controls_{it}^n + \tau_{28}^{k,t} Trend_{it} \\ &+ \sum_r \beta_r^{k,t} \mathbb{1}\Big\{Higher\ education_{it} \times r_{it}\Big\} \\ t \in& \{1995/1996, 1998/2000, 2014/2015\} \\ r \in& \{STEM, Medical, Law\ or\ business, \\ & Liberal\ arts, Public\ sector, \}.\end{aligned} \tag{9}$$

In relation to the covariates, Equation (9) is similar to Equation (8) with the exception of the *Trend* variable, which refers to the numbering of years, and that HE wage premium is interacted with all groups of specializations. $\mathbb{Q}^k\left(\ln \text{Wage}_{it}|\mathbf{X}_{it}\right)$ denotes the $k^{th}$ percentile of the log wage conditional on the covariate matrix $\mathbf{X}_{it}$, and $\beta_j^k$ is the $k^{th}$ percentile estimate of the slope of variable $j$.

# 5 Results

## 5.1 Ordinary least squares results

Using data from 2008, Table 2 illustrates the effects of various controls on the returns to education. Column (1) replicates the basic specification used by Gorodnichenko and Peter (2005). Their estimates for *Schooling* for the year 2002 are $\mathbb{P}(\beta \in [0.084, 0.098]) = 0.95$, whereas this paper's estimates for the year 2008, which are of the same magnitude, but slightly lower, are $\mathbb{P}(\beta \in [0.082, 0.091]) = 0.95$. Column (2) estimates the returns on the levels of education using the original specifications of Brainerd (1998). Column (3) includes *Tenure* and uncovers its nil market value; an original discovery of Cheidvasser and Benítez-Silva (2007). Column (4) demonstrates the importance of demographic characteristics in estimating returns on levels of education. Column (5), which corresponds to the first stage Specification (7), further includes job characteristics, whose importance to a transitional economy is originally shown by Münich et al. (2005). Note that, although estimates for HE are less

affected, estimates for other levels of education and *Female* change considerably, indicating that *Schooling*, which includes all levels of education, would be changed considerably.

Figure 6 depicts the returns on HE by running Specification (7) on each wave separately. As the literature review discusses, returns during the Soviet period are low but increase during the transition period. At the end of the 1990s, the market price for HE doubles, and then drops until it reaches about the same level as that in the middle of the transition period.

Figure 7 shows the estimated returns for the $\ell b$ and $\overline{\ell b}$ specializations from Specification (8). The results show that, during the transition period, the returns on $\overline{\ell b}$ specializations are not statistically different from returns in the Soviet period (with the exception of 1994, which has the least amount of reliable information on specializations; see Section A). Conversely, the returns for $\ell b$ are about 4–5 times higher. Further, in 1998, once economic growth has returned, the returns on the skills of $\ell b$ graduates are 6–7 times higher than returns on HE in the Soviet period. In the following years, the returns slow down in response to an increase in supply. Naturally, the overall wage premium for HE, which is a weighted average across all specializations, partially mimics this massive transitory differential. This manifests as a decrease in the HE premium. The point where the returns on skills of $\ell b$ graduates gravitates to in 2015 appears to be one supported by the new post-transitional economic realities. The same level of returns is shown by $\overline{\ell b}$ specializations starting in 1998.

The economic reforms of the early 1990s introduce the market price system. Companies take advantage of the opportunities that this new system brings, and signal that they require a new mix of skills on the labor market.

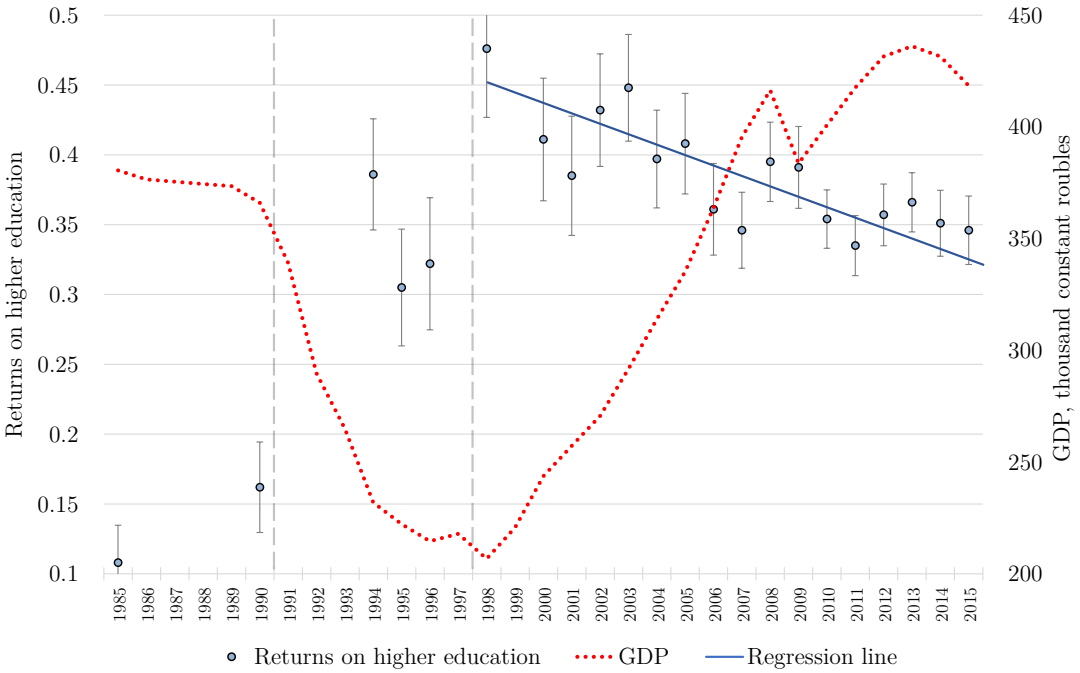
The end of the differential reflects the growing occupation mismatch that can be observed in Figure 5. Thus, there is not simply an excessive expansion of HE; rather, there is a rigidity in supply. Neither universities nor applicants could have foreseen that the differential would cease to exist when they started the educational process in 2002/2003. The HE system had to expand disproportionately to quickly fill the demand for $\ell b$ skills. However, once this gap was filled, the training capacity remained the same. Consequently, $\ell b$ graduates entered the market and began to crowd out unusual occupations. In addition, young people do not make specialization choices by observing current market returns as is generally assumed. Young people's choices reflect public beliefs rather than their direct observation of market signals. Therefore, the process is inherently inert (Alexeev 2017, p. 34).

Table 2: Covariates selection

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | **log of monthly contractual wages after taxes** | | | | | |
| Schooling (adjusted year) | 0.0864*** | | | | | |
| | (16.75) | | | | | |
| *Education levels (Secondary school is omitted)* | | | | | | |
| Graduate school | | 0.538*** | 0.540*** | 0.466*** | 0.505*** | 0.507*** |
| | | (5.60) | (5.60) | (4.91) | (5.97) | (5.98) |
| Higher education | | 0.406*** | 0.408*** | 0.364*** | 0.396*** | 0.397*** |
| | | (13.26) | (13.27) | (11.99) | (13.32) | (13.35) |
| Vocation diploma | | 0.111*** | 0.113*** | 0.0873** | 0.102*** | 0.103*** |
| | | (3.92) | (3.95) | (3.13) | (3.73) | (3.76) |
| Less than secondary school | | -0.203*** | -0.202*** | -0.168*** | -0.174*** | -0.174*** |
| | | (-4.93) | (-4.89) | (-4.26) | (-4.46) | (-4.45) |
| Experience | 0.0376*** | 0.0344*** | 0.0361*** | 0.0386*** | 0.0378*** | 0.0383*** |
| | (9.03) | (8.34) | (8.21) | (8.89) | (8.95) | (8.93) |
| Experience$^2 \div 1000$ | -0.915*** | -0.869*** | -0.918*** | -0.973*** | -0.935*** | -0.946*** |
| | (-8.81) | (-8.41) | (-8.48) | (-9.15) | (-9.02) | (-9.02) |
| Female | -0.501*** | -0.502*** | -0.504*** | -0.503*** | -0.465*** | -0.464*** |
| | (-21.78) | (-21.71) | (-21.79) | (-22.15) | (-20.74) | (-20.73) |
| Federal city | 0.665*** | 0.675*** | 0.676*** | 0.589*** | 0.564*** | 0.565*** |
| | (24.56) | (24.76) | (24.65) | (20.42) | (20.41) | (20.42) |
| Tenure | | | -0.00551 | -0.00332 | 0.00490 | 0.00491 |
| | | | (-1.22) | (-0.74) | (1.09) | (1.09) |
| Tenure$^2 \div 1000$ | | | 0.246 | 0.188 | -0.0101 | -0.0116 |
| | | | (1.62) | (1.26) | (-0.07) | (-0.08) |
| *Residency (Regional centre is omitted)* | | | | | | |
| Town | | | | -0.105*** | -0.0955*** | -0.0960*** |
| | | | | (-3.91) | (-3.65) | (-3.67) |
| Urban village | | | | -0.117* | -0.0674 | -0.0669 |
| | | | | (-2.13) | (-1.23) | (-1.22) |
| Rural area | | | | -0.393*** | -0.283*** | -0.284*** |
| | | | | (-12.35) | (-8.73) | (-8.73) |
| Employer ownership type | NO | NO | NO | NO | YES | YES |
| Employer size | NO | NO | NO | NO | YES | YES |
| Nationality | NO | NO | NO | NO | NO | YES |
| Number of observations | 3655 | 3655 | 3655 | 3655 | 3655 | 3655 |
| Adjusted $R^2$ | 0.270 | 0.269 | 0.269 | 0.301 | 0.342 | 0.342 |

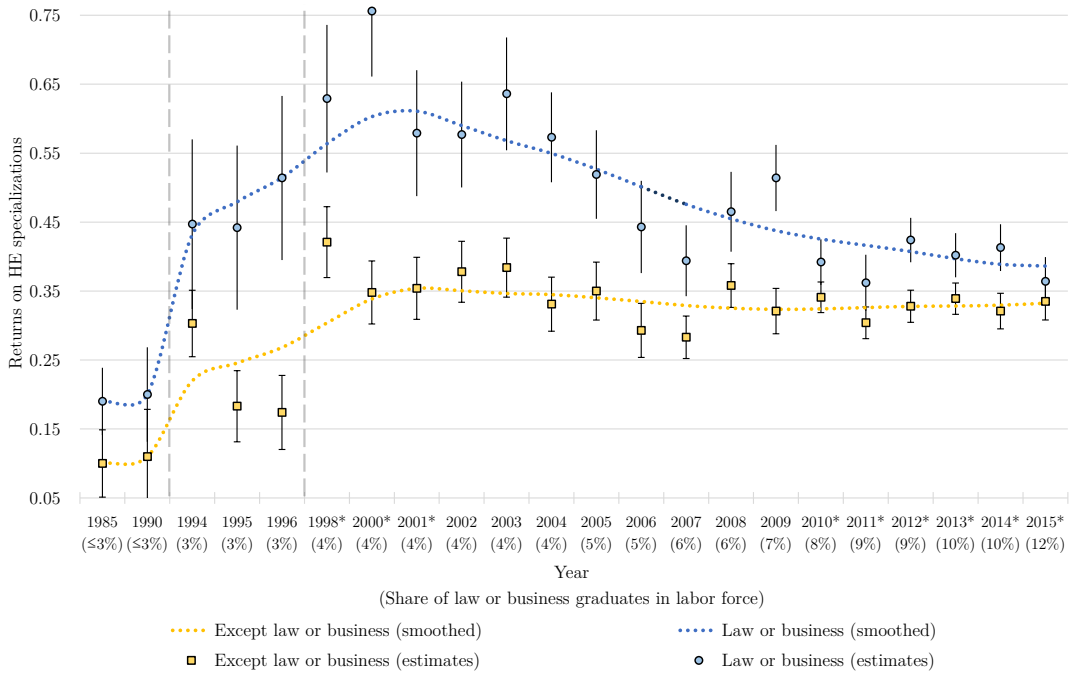
*Notes:* (Where relevant) indicator for Russian nationality, employer ownership type (with national company omitted), employer size (with size 0-10 omitted) and (for all models) constant are estimated but not shown. Sample restricted to respondents aged 15-59. Respondent clustered standard errors and sample weights are used. A model in column 5 (boxed) corresponds to equation (7). $t$ statistics in parentheses. *, **, and *** indicate significance at the 5%, 1%, and 0.1% levels.
*Source:* RLMS.

Figure 6: Premium for higher education:1985–2015




*Notes:* Returns are from Specification (7). Respondent clustered 95% confidence intervals are shown. See Figure 1 for comments on GDP. Vertical grey dashed lines separate the periods.
*Source:* RLMS and World Bank.

Figure 7: Returns for $\ell b$ and $\overline{\ell b}$: 1985–2015

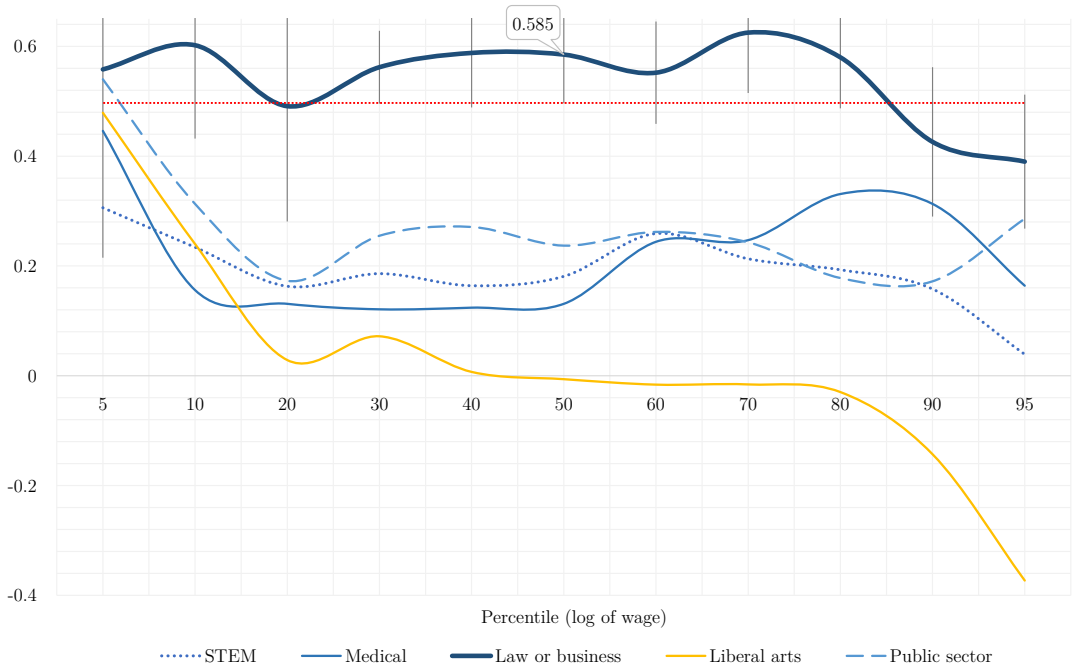



*Notes:* Returns are from Specification (8). Years marked with * do not use specialization imputation. Dotted lines are locally weighted scatterplot smoothers. Respondent clustered 95% confidence intervals are shown. Vertical grey dashed lines separate the periods.
*Source:* RLMS.

## 5.2 Quantile regression results

Now the results from Specification (9). Figure 8 depicts the estimation for 1995 and 1996 during the transformational recession and shows that companies do indeed compete for *ℓb* graduates, which drives their wages up. The results for *Liberal art* graduates are unusual; however, this is likely due to a data limitation. There were very few *Liberal arts* graduates and imputation worsened the problem.

Figure 8: Distribution of returns on higher education: 1995/1996

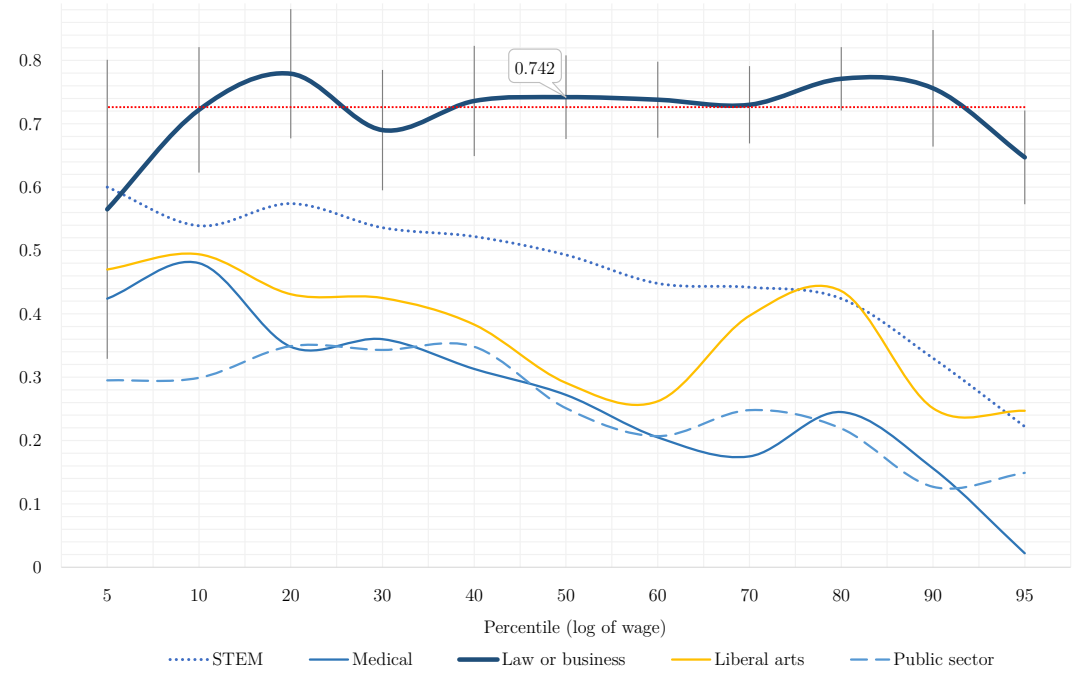



*Notes:* Returns are from Specification (9). Black vertical lines indicate a bootstrapped 95% confidence interval. Red dotted line is a corresponding OLS estimator. *ℓb* graduates occupy ≈ 2% of the labor force.
*Source:* RLMS.

Figure 9 depicts the estimations for 1998 and 2000. The shape of the line again confirms that the market treated *ℓb* graduates differently from other graduates. The coefficient for the median income group for *ℓb* graduates is slightly higher than the OLS estimate, suggesting that the outliers actually push the premium down rather than up. *Public sector* and *Medical* graduates have the lowest returns,[7] and the returns for *Liberal arts* graduates are similar to those for the *Public sector* and *Medical* graduates, with the exception of a few workers (in the 60–90th percentile) who were lucky to find higher paid jobs. Conversely, as Figure 10 shows, the labor market for 2014 and 2015 rewards *ℓb* graduates no differently than it does any other specializations.

[7]But have the lowest probability of being unemployed (Alexeev 2017) and have non-monetary job privileges.

Figure 9: Distribution of returns on higher education: 1998/2000




*Notes:* Returns are from Specification (9). Black vertical lines indicate a bootstrapped 95% confidence interval. Red dotted line is a corresponding OLS estimator. *ℓb* graduates occupy ≈ 3% of the labor force.
*Source:* RLMS.

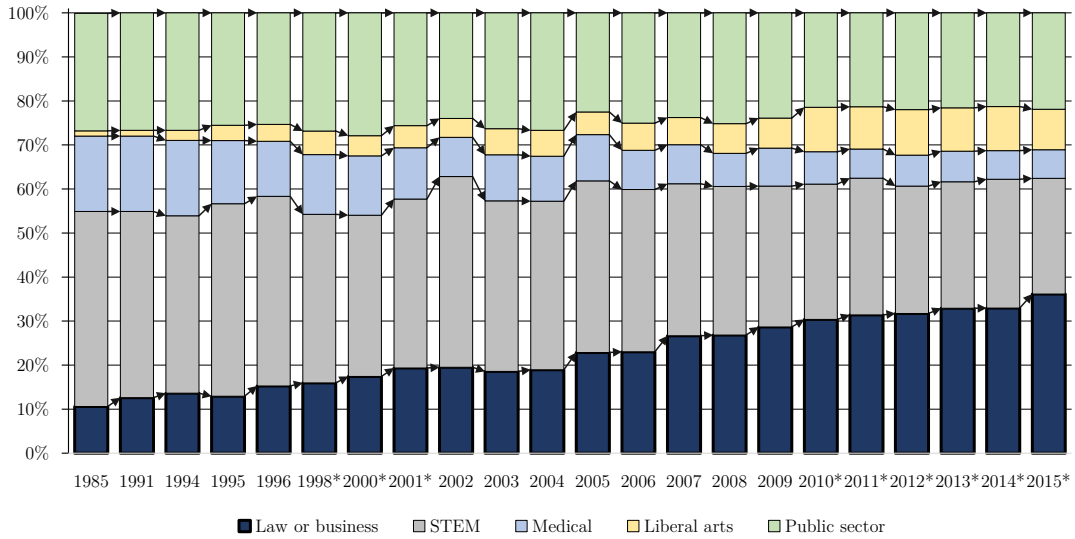
Figure 10: Distribution of returns on higher education: 2014/2015


*Notes:* Returns are from Specification (9). Black vertical lines indicate a bootstrapped 95% confidence interval. Red dotted line is a corresponding OLS estimator. *ℓb* graduates occupy ≈ 12% of the labor force.
*Source:* RLMS.

## 5.3 Shifts in occupation of graduates

Figure 11 depicts the structure of *Professionals* and *Technicians and associate professionals* by specialization. Massive differences in the returns produce noticeable changes in the occupational structure in accordance with the new economic fundamentals, fulfilling their intended purpose.

Figure 11: Specialization structure of professionals and technicians and associate professionals




*Notes:* See comments for Figure 4.
*Source:* RLMS.

In 1985, the main specialization is *STEM* (44%), followed by *Public sector* (27%), *Medical* (17%), *ℓb* (11%) and *Liberal arts* (1%). In 2015, *ℓb* is the main specialization (36%), followed by *STEM* (26%), *Public sector* (22%), *Liberal arts* (9%) and *Medical* (6%).

The largest increase of 26% (a 240% increase) occurs in *ℓb*, while the second largest increase of 8% (a 673% increase) occurs in *Liberal arts*. Conversely, numerous specializations lose their share. The largest decrease of 18% (a 41% decrease) occurs among *STEM*, while the second largest decrease of 11% (a 62% decrease) occurs among *Medical*, and the lowest decrease of 5% (a –18% decrease) occurs among *Public sector*.

By definition, the government is the main employer of *Public sector* employees. As the medical system in Russia predominantly belongs to local, state or federal governments, *Medical* graduates are also public servants. Only *STEM*, *ℓb* and *Liberal arts* specializations are subject to economic forces. Thus, it seems reasonable to conclude that the economic transformation de-skilled the *STEM* specialization and replaced it with a combination of *ℓb* and *Liberal arts* specializations.

# 6 Connection with Output Decline

The previous section identifies a transitory wage differential that indicates that firms were making investments into organizational technologies; however, there is another remarkable similarity between the transformational recession and SBTC.

During the transformational recession, Central and Eastern Europe countries and Former Soviet Union republics experienced a much stronger output drop in industries that produced more complex goods. Blanchard and Kremer (1997) hypothesize that this drop is the result of a coordination failure. During the transition period, the Central Planner was dismissed but contractual institutions (e.g., reputation, vertical integration) were still not developed. Firms that manufactured intermediary products within the same chain of production in the command economy found options for alternative uses of their products (outside of their established uses) after decentralization. Ultimately, a product – generating profit for all firms in the chain – will only be produced within a chain of production if no firm uses an alternative option, and firms continue to not supply their intermediary product outside the established production chain. The more producers in a chain of production, the higher the chance of defection; hence, the observed pattern of output decline. Later, Roland and Verdier (1999) argue that this pattern could also be the result of higher search frictions in more complex industries.

This paper complements these arguments and notes that this pattern of output decline could be a manifestation of SBTC. Most economic theories that explicitly formulate an economic mechanism to explain SBTC adopt Nelson and Phelps's (1966) view of human capital. In their view, workers' education positively affects the speed of the practical implementation of available technologies. Their theory further suggests that any increase in the wage premium is transitory. Only in the early adoption phase of a new technology can those workers who adapt more quickly reap some benefits. As time goes by, enough workers will know how to work with the new technology to offset the wage differential (Caselli 1999; Galor and Moav 2000; Greenwood and Yorukoglu 1997).

This conceptual interpretation emphasizes the effects of learning during episodes of radical technological change, which is in line with the productivity decline that occurred in most developed economies in the 1980s. At the beginning of the deployment of a new technology, output may temporarily decrease as workers and firms learn how to use the new technology (Aghion 2002; Hornstein and Krusell 1996).

If indeed an economic transition is viewed to be an economy-wide investment into new organizational technologies, then there should be a rapid creation of a class of better paid jobs complementary to the new technologies. This is the key empirical finding of this paper, as summarized in Figure 7. However, there should also be a period of learning/adaptation of new technologies. The transformational recession may have been exactly that. Industries that produced more complex goods, thus requiring more organizational technologies, would have been more affected, thus falling more in performance. Hence, a stronger drop in industries that produced more complex goods. A similar pattern was noticed in the United States, where the greatest initial productivity slowdown in the 1980s occurred in industries that adopted semiconductors to a larger extent.

The SBTC modeling approach was convenient when demonstrating the wage differential, but it is also convenient when demonstrating the output decline pattern during the transformational recession. The same result can be shown in the original model used by Card and Lemieux (2001). Output comparative statics is ambiguous and depends on the composition of skills, $N_{\ell b}^{\rho} - N_{\overline{\ell b}}^{\rho}$, and a degree of complementarity, $\rho$:

$$\frac{\partial Y}{\partial \alpha} = \frac{\partial Y}{\partial L_s}\frac{\partial L_s}{\partial \alpha} = \frac{\partial Y}{\partial L_s}\left(N_{\ell b}^{\rho} - N_{\overline{\ell b}}^{\rho}\right)\left(\alpha N_{\ell b}^{\rho} + (1-\alpha)\, N_{\overline{\ell b}}^{\rho}\right)^{\frac{\rho-1}{\rho}}\frac{1}{\rho}. \tag{10}$$

It is sufficient to study the effect of $\alpha$ on $L_s$ because the production function is assumed to be increasing in all arguments. Finding the root of $\frac{\partial L_s}{\partial \alpha}$ treated as a parametric function of $\alpha$ yields the following proposition.

**Proposition 2.** *Whenever $\rho$ approaches zero (i.e., the graduates' skills are perfect complements), a change of $\alpha$ of any magnitude decreases output. Whenever $\rho$ is different from 0 or 1, the sufficiency inequality is increasingly harder to satisfy if $N_{\ell b}$ increases:*

$$\frac{\partial Y}{\partial \alpha} < 0 \quad \text{if} \quad \alpha > \frac{N_{\overline{\ell b}}^{\rho}}{N_{\overline{\ell b}}^{\rho} - N_{\ell b}^{\rho}}. \tag{11}$$

Card and Lemieux (2001, p. 726) show that the elasticity of substitution between workers with the same education is relatively stable over time and space (i.e., $\rho$ is a constant). With this being the case, then Proposition 2 states that a larger $\alpha$ (it is larger for more complex industries) can adversely affect economic output in the manner documented the transformational recession.

Alternatively, if $\alpha$ is fixed then a lack of $\ell b$ graduates can adversely affect economic output. Therefore, a transformational recession could have been less-

ened if policy makers had acknowledged the dependency of the implementation of new technologies on the supply of workers with skills complementary to these technologies.

# 7 Cross-country Evidence

The previous section expressed the hypothesis that in Russia a lack of personnel with skills complementary to the organizational technology drove the (discovered in this study) irregularity in the labor market and the (already known) irregularities of economic output. In terms of the suggested model, this is captured with an increase in parameter $\alpha$ that induces the wage differential (as shown in Proposition 1) and the drop in economic output (as shown in Proposition 2).

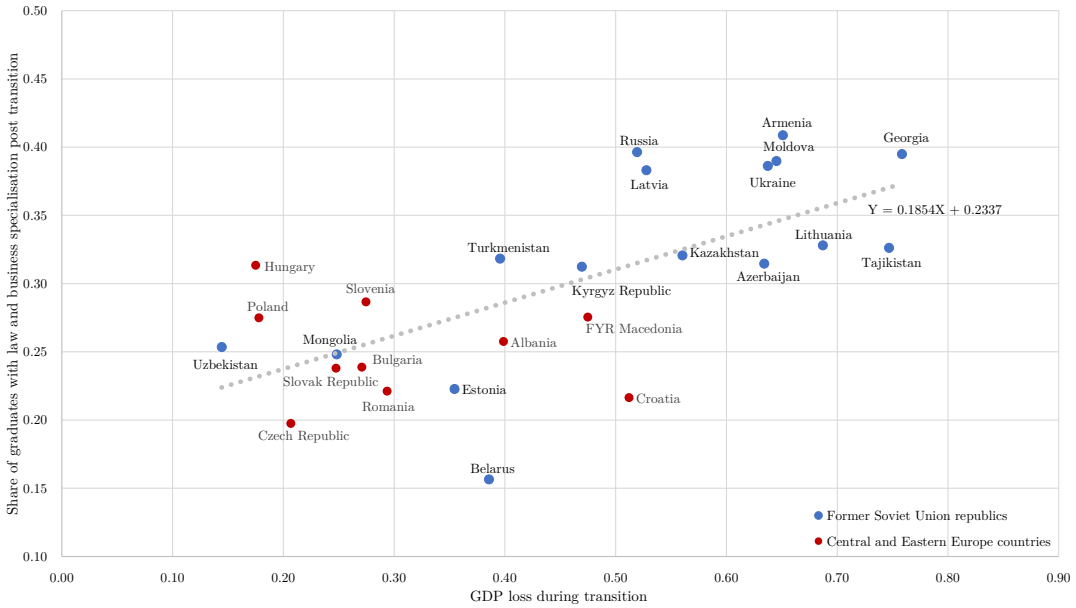
A statistical tautology to this hypothesis is that the size of differential and the drop of the output are positively correlated. That is, the transitional economies that had the largest decrease in economic output also had a largest transitory wage premium for $\ell b$ graduates.

A complication with testing the implications is that there are no available microlevel datasets for most transitional economies to detect the transitory wage premium by adopting methods similar to those used in this paper. The Russian dataset is unique in this respect. The Ukrainian Longitudinal Monitoring Survey covers only several years and, in any event, lacks information on college specialization. Fortunately, the validity and generality of the hypothesis can be tested without microlevel dataset. The Russian example shows that the wage differential changed the composition of skills available in the labor market (the very purpose of the differential). As labor market are competitive and applicants are rational, an unusually high proportion of enrollments into $\ell b$ specialization implies an existence of a persistent price signal (i.e., the desired $\ell b$ wage differential) that governs the enrollment. Therefore, the expressed hypotheses, if true, implies the following.

**Implication 1.** *The transitional economies that had a larger decrease in economic output during the transformational recession also had a larger fraction of students enrolled into $\ell b$ specializations after the transformational recession.*

Figure 12 demonstrates that data confirms the implication. Figure 12 plots the fraction of $\ell b$ students in the HE system two year after the transformational recession against the percentage loss of GDP during the transformational recession for 26 countries. For example, Uzbekistan lost 14% of GDP from 1989

Figure 12: GDP loss and recomposition of skills during transition




*Notes:* The GDP loss is a percentage decrease of real GDP during the transitional recession. Share of $\ell b$ graduates is their percentage in tertiary institutions after the transitional recession. *Source:* Fischer and Sahay (2000), UIS Data Dictionary for Education Statistics, National Statistical Agencies.

till 1995 and in 1997 had 25% of all university students with specialization $\ell b$; Georgia lost 75% of GDP from 1988 till 1994 and in 1996 had 39%. This approach is motivated by the studied above Russian case: the recession stopped in 1998 and the change in the skills became evident in about two years after.

Indeed the hypothesis seems to reconcile several existing cross-regional empirical inconsistencies. In China, output actually increased during the transition period, while in Central and East European countries the decrease was not as dramatic as in Former Soviet republics (the average decline was 28% in the former and 54% in the latter, e.g., the United States during the Great Depression declined by 34%). This can be explained by the absence of a massive demand-side shock for skills that was left unmatched with an appropriate supply, as hypothesized in this paper. The shock could have been lessened if: (1) complex industries had been decentralized gradually; (2) there had been no complex industries; or (3) the degree of penetration of the centralized planning was not extreme. All three conditions were violated by Former Soviet Union republics. Conversely, in the Chinese economy, the transitional decentralization was gradual, there was a lower level of industrialization, and the penetration of centralized control was also relatively low. Similarly, while Central and Eastern European countries were decentralized quickly and had complex capital-intensive industries, their reliance on central planning was relatively short-lived

and selective, as they only joined the socialist camp after World War II, whereas the Soviet republics were centralized in the 1920s.

## 8 Conclusion

This paper demonstrates a between-groups wage differential in the Russian labor market that suggests a demand-side shock during the major economic reforms of the early 1990s. The differential induced a substantial change among employed professionals and technicians and also had a defining effect on HE returns from 1985 to 2015. Notably, the differential provides a parsimonious explanation for the relatively low college wage premiums from 1994 to 1996 (aka the Market Adjustment Puzzle), and the decrease in college wage premiums from 1998 to 2015. The subsiding of the differential also coincides with a decrease in income inequality during 1998–2005 demonstrated by Gorodnichenko, Peter, and Stolyarov (2010).

The demand-side shock indicates a large scale adoption of new organizational technologies, which was a response during the transition period to a deliberately rapid desertion by policy makers of deeply entrenched practices of Soviet central planning (i.e., "price shock therapy"). It is further hypothesized that the transformational recession may have had an aspect of being a period of learning/adaptation of the new organizational technologies, and, therefore, an improper mix of skills is a factor that contributed to the transformational recession.

# Appendices

## A Details on the Definitions and the Imputation

### A.1 Human capital definitions and descriptive statistics

Table 3 displays the mapping of the wording used in this paper in relation to those used by the United Nations. For the full structure of degrees obtainable in Russia and their international counterparts, see HSE Data Books (2013, p. 19). It should be noted that masters' degrees are classified as HE, not as a form of graduate study. This might seem unusual; however, this approach is largely adopted for the purpose of the comparability of time series. Government official

statistics also adhere to this classification, as, before 2012, there were no master's degrees whatsoever; however, a degree called "specialist", with a duration of five years, comprised both bachelor's and master's levels of education. The Russian education system also allows individuals to acquire an initial vocational education rather than only acquiring a secondary school diploma. This explains the overlap in relation to level 3.

Table 3: Education levels definitions

| ISCED 2011 level | Current Discussion |
|---|---|
| 3 | Secondary school |
| 3-5 | Vocational diploma |
| 6-7 | Higher education |
| 8 | Graduate school |

*Notes:* The International Standard Classification of Education (ISCED) is a UNESCO classification of educational levels.

Table 4 summarizes the mapping of the defined specializations into the International Standard Classification of Occupations.

Table 4: Specialization definitions

| Current discussion | ISCO 88 | Example |
|---|---|---|
| STEM | 2111-49; 2213; 3111-43; 7241-2. | Computer programmer. |
| Medical | 2211-2; 2219-29; 3221-42; 3475. | Medical doctor, dentist. |
| Law or business | 2411; 2419-29; 2441; 3411-39. | Financial consultant, insurer. |
| Liberal arts | 2412; 2431-2; 2442-60. | Philosopher, sculptor. |
| Public sector | 110; 2230-52; 3151-2; 3441-60. | Fire inspector, police detective. |

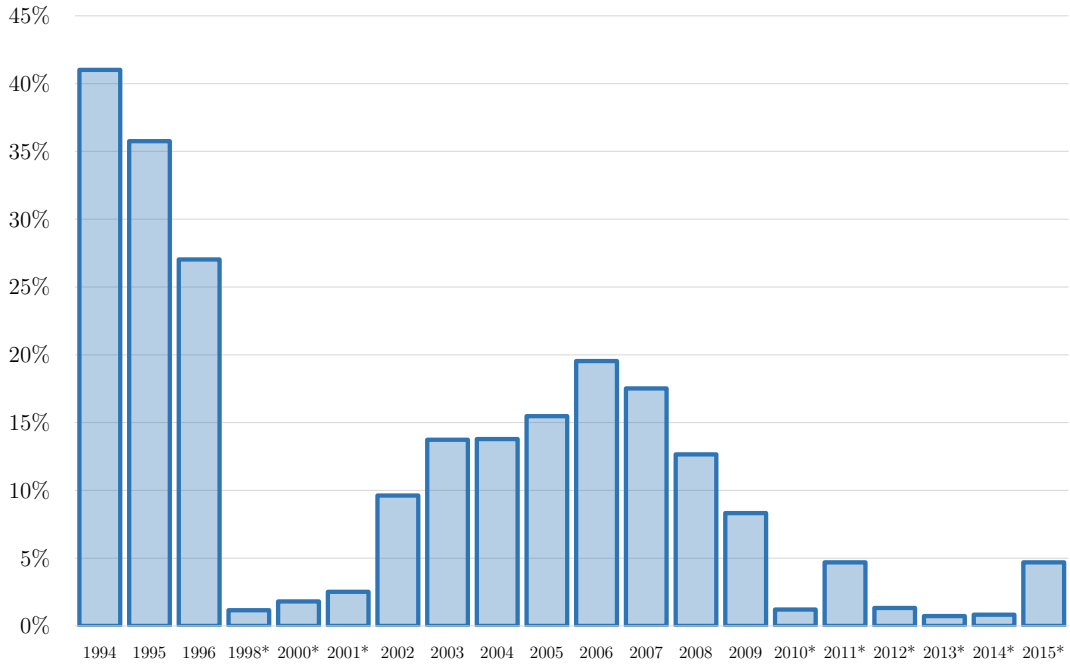
*Notes:* International Standard Classification of Occupations (ISCO) is an International Labour Organization definition of occupations. An example of the coding used in the middle column is $3113 - 5 \equiv 3113 - 3115$.

## A.2 Assessment of specialization imputation

Figure 13 depicts the portion of missing information on specializations among respondents with HE after data is imputed across the waves. The full availability of the information for the last six years allows for an assessment of the imputation.

Figure 14 depicts the returns in relation to all defined groups of specializations using the actual data and the data that is imputed from the years 2010 and 2011, pretending that information for the years 2012 to 2014 is missing. The coefficients are identical. It should be noted that the estimate for the

Figure 13: Fraction of category *Unspecified*

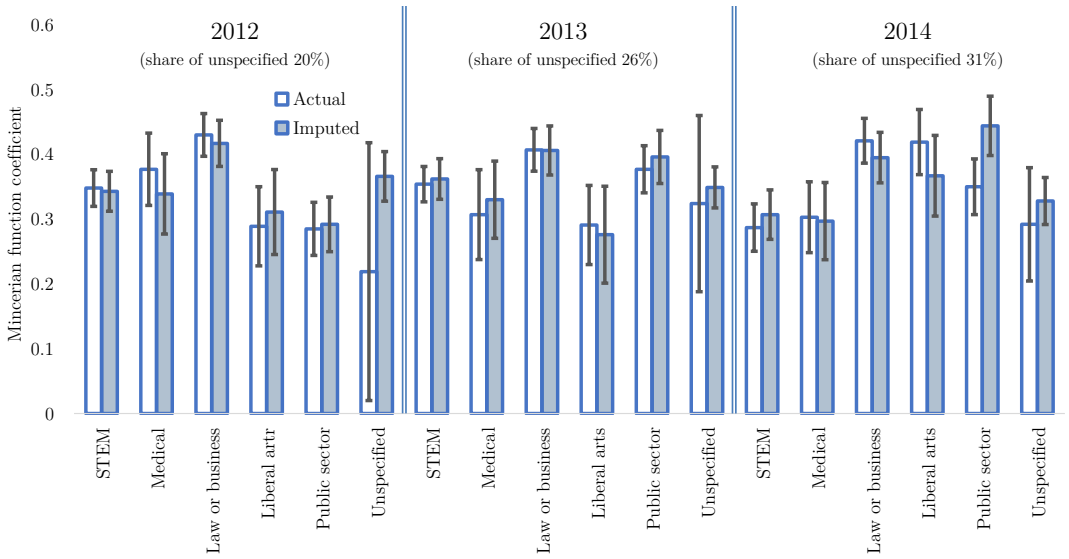



*Notes:* Years with a star contain actual information on specializations of higher education; information for other years is taken from the closest year with information, with priority given to later years.
*Source:* RLMS.

*Unspecified* category becomes more precise with the imputed information, but has no interpretation, as it includes a non-random collection of graduates. The assessment shows that no significant problem arises even if the figure reaches 31%. Somewhat unfortunately, more than 31% of information on specializations is missing for the 1994 and 1995 waves. Luckily, for the 1996 wave, only 27% is missing, which permits a probing of the transition period with confirmed certainty.

Finally, Table 5 shows the sample structure of graduates with HE if the *Unspecified* category is excluded. As the composition clearly remains almost identical, the *Unspecified* category is excluded to generate Figure 4.

Figure 14: Comparing estimates with actual and imputed information




*Notes:* Last 5 years have information on specializations which permits imputation assessment. Coefficients are estimated with Specification (8). Black vertical lines are respondent clustered 95% confidence intervals.
*Source:* RLMS.

Table 5: Assessment of specialization imputation in aggregate

| | Law or business | STEM | Medical | Liberal arts | Public sector | Unspecified |
|---|---|---|---|---|---|---|
| | | | 2012 (share of *Unspecified* 20%) | | | |
| Actual | 31.4% | 34.3% | 5.9% | 9.2% | 17.9% | 1.4% |
| Imputed | 27.3% | 26.5% | 4.2% | 8.3% | 13.6% | 20.2% |
| Dropping | 33% | 34% | 5% | 10% | 18% | 0% |
| | | | 2013 (share of *Unspecified* 26%) | | | |
| Actual | 33.2% | 33.0% | 5.9% | 9.5% | 18.0% | 0.4% |
| Imputed | 26.2% | 23.8% | 4.2% | 7.7% | 12.4% | 25.7% |
| Dropping | 34% | 32% | 6% | 10% | 18% | 0% |
| | | | 2014 (share of *Unspecified* 31%) | | | |
| Actual | 34.1% | 33.0% | 5.4% | 9.1% | 17.8% | 0.6% |
| Imputed | 25.3% | 21.9% | 3.6% | 7.3% | 11.0% | 30.9% |
| Dropping | 36% | 32% | 5% | 10% | 17% | 0% |

*Notes:* *Actual* proportions are taken from the data; *Imputed* contains proportions generated from information contained in 2010 and 2011, ignoring actual information in years 2012, 2013 and 2014; *Dropping* represents proportions of *Imputed* after dropping category *Unspecified*.
*Source:* RLMS.

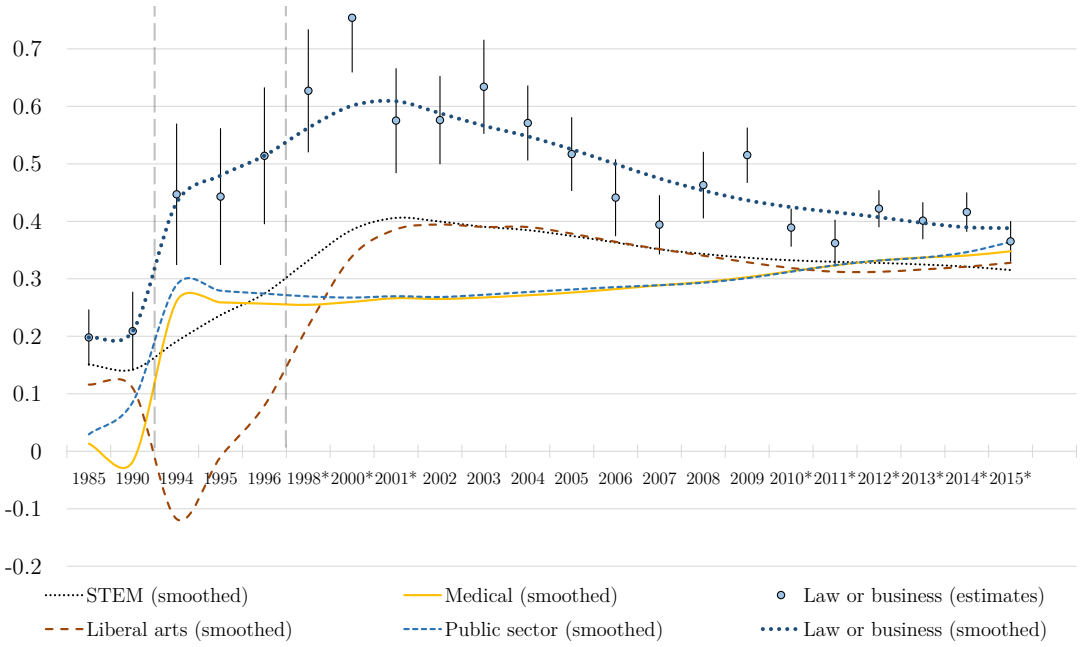
# B Additional Results

To confirm the uniqueness of the size of the transitory wage differential for the $\ell b$ specialization, the following estimates for the returns for all groups of specializations are made for each year:

$$\begin{aligned} \ln Wage_{it} =& \beta_0^t + \sum_{j=1}^{27} \zeta_j^t Controls_{it}^j + \varepsilon_{it} \\ &+ \sum_r \beta_r^t \mathbb{1}\Big\{ Higher\ education_{it} \times r_{it} \Big\} \\ & t \in \{1985, 1990, 1994-1998, 1998, 2000-2015\} \\ & r \in \{STEM, Medical, Law\ or\ business, \\ & \quad Liberal\ arts, Public\ sector\}. \end{aligned} \tag{12}$$

Figure 15 depicts returns in relation to all specializations. The government is practically the sole employer of the skilled *Medical* and *Public sector* graduates. This explains the stability of the observed returns. During the transition period, *Liberal arts* graduates had the same wage premium as high school students; however, *STEM* graduates performed somewhat better. Later, *Liberal arts* graduates caught up with *STEM* graduates.

Figure 15: Returns on various groups of specialization




*Notes:* Returns are from Specification (12). Years marked with * do not use specialization imputation. Dotted lines are locally weighted scatterplot smoothers. Respondent clustered 95% confidence intervals are shown. Vertical grey dashed lines separate the periods.
*Source:* RLMS.

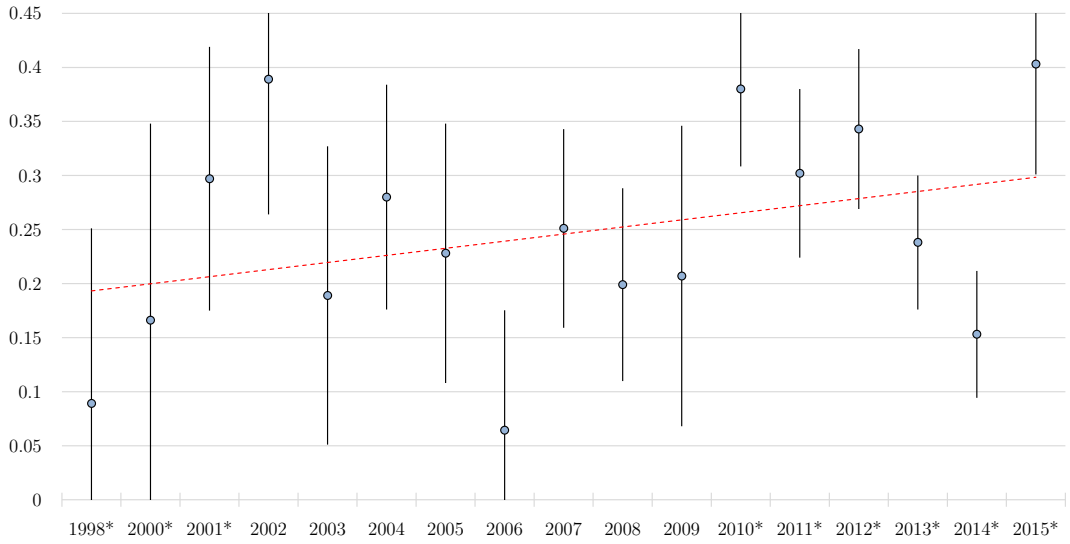
The results are intuitive with the exception of *Liberal arts*. The occupation structure shows that *ℓb* and *Liberal arts* graduates replaced *STEM* graduates. Ideally, the returns for *ℓb* and *Liberal arts* graduates should be higher, and the returns for *STEM* graduates should be lower. It may be that the wage equation shows gross returns. It is clearly easier to graduate with a *Liberal arts* degree than a *STEM* degree. Thus, the net returns for *Liberal arts* are higher than the net returns for *STEM*. However, the data during the recession of the transition period does not fit this narrative well. The estimates for that period can probably be dismissed due to data limitations. There were very few *Liberal arts* graduates and imputation worsened the problem. Alternatively, given that the wage equation ran at an even lower level than HE, there could be a severe endogeneity problem. Companies might know more about *Liberal arts* graduates trained in the late Soviet Union than the data reveals.

To confirm that the unusually high returns for *ℓb* graduates are responsible for a drop in the wage premium in 1998–2008, the baseline Specification (7) is used to reestimate college wage premiums after excluding respondents with *ℓb* specializations (including those hidden in the *Unspecified* category), namely:

$$\begin{aligned}
\ln Wage_{it} =& \beta_0^t + \sum_{n=1}^{4} \beta_n^t \mathbb{1}\left\{ Education\ level_{it}^n \right\} + \beta_5^t Experience_{it} + \beta_6^t Experience_{it}^2 \\
&+ \beta_7^t \mathbb{1}\left\{ Female_{it} \right\} + \beta_8^t Tenure_{it} + \beta_9^t Tenure_{it}^2 \\
&+ \sum_{k=1}^{3} \gamma_k^t \mathbb{1}\left\{ Residency_{it}^k \right\} + \gamma_4^t \mathbb{1}\left\{ Federal\ city_{it} \right\} \\
&+ \sum_{p=1}^{3} \theta_p^t \mathbb{1}\left\{ Ownership_{it}^p \right\} + \sum_{q=4}^{10} \theta_q^t \mathbb{1}\left\{ Employer\ size_{it}^q \right\} + \varepsilon_{it} \\
& t \in \{1998, 2000 - 2015\} \\
& i \setminus \{Law\ or\ business,\ Unspecified\}.
\end{aligned} \tag{13}$$

As Figure 16 shows, the returns do not decrease; however, an issue arises in relation to this approach, as, for a number of years (i.e., 1998, 2000 and 2006), the returns are statistically indistinguishable from zero. The reason for the drastic drop in the efficiency is the exclusion of those additional respondents with graduate degrees who also have a HE.

Figure 16: Premium for higher education without $\ell b$ respondents




*Notes:* Returns are from Specification (13). Years marked with * do not use specialization imputation. Dotted lines are locally weighted scatterplot smoothers. Respondent clustered 95% confidence intervals are shown.
*Source:* RLMS.

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