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Skill-Biased Transition: The Role of Markets, Institutions, and Technological Change

By: Klara Sabirianova Peter

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Klara Sabirianova Peter

William Davidson Institute at the
University of Michigan Business School
(klaras@umich.edu)

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Abstract

This study attempts to explain why the transition to a market economy is skill-biased. It shows unequivocal evidence on increased skill wage premium and supply of skills in transition economies. It examines whether similar skill–favoring shifts in the Russian and U.S. economies are driven by the same set of factors. Our analysis elaborates on the model of alternative theories of the increased wage skill premium and then evaluates three main hypotheses: skill-biased technological change, the market adjustment hypothesis, and the institutional factor hypothesis. To test these hypotheses, the study uses unique linked employer-employee data that spans the 16 years of the Soviet and transition periods in Russia (1985-2000), with a special emphasis on data quality, measurement errors, and retrospective biases. The main conclusion is that there is no uni-causal and time-invariant explanation for skill-biased changes in wages and employment in the Russian economy. The increased skill wage premium has been driven mainly by institutional factors during the early period and by productivity and technological change during the late transition period, and reinforced by market adjustment of wage ratio to the true differences in labor productivity.

Key words: technological change, wage inequality, human capital, transition, Russia, linked employer-employee data

1. Introduction

There is general agreement that there has been a long-term rise in the supply of and market rewards for skills throughout the world. Overall as can be seen in Table 1 non-manual employment and university educated labor force have expanded rapidly and the relative wages of non-manual industrial workers have increased in most of the countries.

Table 1: Evidence on Skill Upgrading in Transition Economies.

The first point to note is that each country has its own path. The country-specific patterns of skill-biased changes in the wage structure do not always or necessarily overlap with the patterns of technological innovations and economic development. We see large differences in the rates of returns to skills among countries with the same level of technology (e.g., Finland and Italy). We also observe similar skill wage differences in the countries that stand far apart in terms of technological and institutional development (e.g., Russia and U.S.).

The question as to which factors determine cross-country differences in the returns to skills still remains unanswered. We have yet to learn to what extent the differences are driven by technology and to what extent they are due to country-specific wage determination processes and other institutional factors. The best countries to look at for these issues are those that have gone through substantial structural and institutional changes. In particular, transition countries that have moved to a market economy but have not yet achieved the level of technological advancement of the developed world would be useful "laboratories" to distinguish the contribution of various factors to the increased returns to skills.

This study is built upon two stylized facts concerning the changes in the relative wages and employment of high-skilled workers during the period of transition to a market economy.

First, there has been *an increase in the supply of skills* in transition economies. Our evidence here is unequivocal. We find that the share of labor force with university education has increased in most of the transition countries. For example, the Russian labor force survey reports a persistent year-to-year increase in the share of workers with tertiary education (technical colleges and universities) from 49% in 1992 to 55% in 2000 (Goskomstat, 2001a, p. 145). Similar changes can be found in other transition economies. We also observe an increase in the share of non-manual employment. Traditionally, employment in non-manual occupations was much lower in former socialist countries than in developed market economies, but it has rapidly grown during the transition period (Table 1A). Over the last ten years this increase has produced a major shift in the overall occupational structure towards market-oriented and more skill-demanding occupations (see Sabirianova, 2002).

Second, *relative wages of high-skilled workers and returns to schooling increased sharply* during the 1990s.[1] This stylized fact was widely documented from the data on several transition countries (see Svejnar (1999), and Boeri and Terrell (2002) for a comprehensive review of relevant studies). Figures 1 and 2 plot the existing estimates of the average returns to schooling and the returns to a year of university education for various transition countries from 1984 to 2000. Both figures illustrate a noticeable increase in the returns to schooling after market liberalization reforms in the early 1990s. A similar rise in the returns to skills can be seen in the data on the wage premium of more skilled non-manual workers in industry and manufacturing (see Table 1C). The magnitude of these changes in transition economies exceeds by far their magnitude in advanced market economies over the last decade. Another credible piece of evidence comes from Freeman and Oostendorp's study. Using the ILO survey on wages in 161 occupations in over 150 countries, they documented a sharp increase in skill differentials in countries moving from communism to free markets (see Freeman and Oostendorp, 2000).

Figure 1: Returns to a Year of Schooling in Transition Economies, 1984-2000.

Figure 2: Returns to a Year of University Education in Transition Economies, 1984-2000.

Overall, findings from various data sources are highly consistent in showing skill-biased changes in both employment composition and wage structure in transition countries.

There has been, however, less discussion of and even less agreement concerning the causes of these stylized facts. Several possible explanations have been proposed, including adjustment of relative wages to marginal products, increase in relative productivity of skilled workers, excessive demand for manual workers during the socialist period, technological change, price liberalization, and openness to trade (see e.g. Kertesi and Kollo (1999), Keane and Prasad (2002), and Vodopivec (2002) for discussion of a few of these hypotheses). Most of these explanations have yet to be modeled explicitly and tested thoroughly against the data.[2] Evidently more theoretical and empirical work is needed to evaluate the alternative theories of skill-biased transition.

This study elaborates on the model of alternative theories of the increased wage skill premium and then explicitly tests various theories based on Russian firm and individual-level data. The study uses unique linked employer-employee data that spans the 16 years of the Soviet and transition periods (1985-2000).

The rest of this paper is organized as follows: Section 2 documents skill upgrading within Russian industry during the 1990s and examines whether similar skill–favoring shifts in the Russian and U.S. economies are driven by the same set of factors. Section 3 presents a conceptual framework for understanding skill-biased changes documented in Section 2 and formulates the testable hypotheses. Section 4 develops an econometric model from which the testable implications of the alternative explanations are obtained. Data and summary statistics are described in Sections 5 and 6, respectively. Section 7 reports the results of the tests. Section 8 provides a brief discussion of additional factors which bear further exploration, and Section 9 summarizes the main conclusions of this study.

2. Skill Upgrading within Russian Industry and U.S. Manufacturing

I begin by documenting basic facts on skill upgrading in Russian industry[3] based on the enterprise reports submitted to Goskomstat (the federal statistical agency). Similar to the labor force survey, wage reports from industrial enterprises provide consistent evidence of an increased skill wage premium of industrial workers.

This study follows Berman, Bound and Griliches (1994) in treating non-manual/non-production workers as high-skilled and manual/production workers as low-skilled. The

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[1] The market returns to unobservable skills have also increased during the transition period. Convincing evidence of a rise in within-skill group inequality has been presented by Brainerd (1998) for Russia and by Keane and Prasad (2002) for Poland.

[2] Kertesi and Kollo (1999) provide evidence that the change in relative productivity cannot explain the general rise in the returns to schooling.

[3] According to the Russian classification of the branches of the national economy, "industry" includes manufacturing, mining and quarrying, electricity, gas, and selected industrial services such as car repair.

manual/non-manual worker distinction in Russian statistics is directly derived from the Russian Classification of Occupations and Activities.[4] It is also closely associated with educational categories. On average 72 percent of non-manual workers in industry had at least a secondary specialized or higher education (13+), while 78 percent of manual workers had a vocational/secondary education or less (12–) (RLMS, 1994-2000). Hence the wage ratio of non-manual to manual workers can be considered as a rough approximation of the skill wage premium.

Russian industrial statistics reveal a remarkably sharp increase in the wage ratio of non-manual to manual workers during the late Soviet and transition periods. Figure 3 shows that (reported) relative wages of non-manual workers rose by an average of 21 percent per year starting from very compressed differences (7.5%) in 1987 and almost converging to the current U.S. wage ratio (74.2% in Russia vs. 77.7% in the U.S.) in 2000.[5] The actual increase in skill wage premium would be even bigger if on top of officially accrued earnings one were to add the underreported wages disproportionately paid to managerial and professional workers, a fact well documented in the literature[6]. Interestingly, despite increasing relative costs of non-manual workers, industrial enterprises have managed to increase the share of their white-collar personnel from 17.8% in 1980 to 21.5% in 2000, as can be seen from Figure 4. This fact, together with evidence from the population and employment statistics on the increased number of

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[4] Goskomstat defines manual and non-manual workers according to the Russian Classification of Occupations and Activities (1986 and 1993). Manual workers ("rabochiye") are workers engaged in producing, storing, transporting goods, and providing so called "material services" such as repairing, janitorial and guard services, etc. Non-manual workers ("sluzhashchiye") include those engaged in supervision (all managers including heads of structural units and their immediate associates), engineers, economists, other professionals and associate professionals, their assistants, and clerical workers [see Goskomstat Instructions on Employment and Wage Statistics, 1987, 1993, and 1999].

[5] Observed spikes on the graph can be associated with several wage liberalization reforms. The 1986 wage reform (resumed in 1987) increased base wages by 20 percent for blue-collar workers and 30 percent for specialists. In the same year (1987) the Law on State Enterprises advocated the principle of "full self-financing" and gave managers power to allocate additionally earned funds among wages. Most wage controls were removed in 1992 as part of a major reform policy of market liberalization and mass privatization. Finally, the last regulatory rule concerning taxes on excessive wages was abolished as of January 1, 1996.

[6] "Payment 'under the table' is far more likely to occur in the case of senior managers and specialists or highly skilled manual workers, so that published data will be likely to underestimate the scale of pay differentials" (Clarke, 1999, p. 286).

graduates and the increased share of educated labor force, suggests that rapidly growing skill wage premium is unlikely to be supply driven.[7]

Figure 3: Percentage Wage Differences between Non-manual and Manual Workers in Russian Industry and U.S. Manufacturing, 1980-2000.

Figure 4: Non-manual Workers Share in Total Employment in Russian Industry and U.S. Manufacturing, 1980-2000.

Thus Russia, with its skill-favoring shifts in wages and employment, fits very well within the worldwide picture of changes in skill structure, drawn by Machin and Reenen (1998), and Berman, Bound, and Machin (1998). As in the Unites States and other advanced market economies, most of this shift in Russia has occurred within rather than between industries.[8] Yet it is puzzling why the trends in Russia and the United States are so similar. An even more important question to consider is whether the skill-favoring shifts in both countries are driven by the same factors.

A series of studies pointed to skill-biased technological change (SBTC) as a major explanation for the rise in wage inequality in the U.S. labor market. "The recent consensus is that technical change favors more skilled workers…and exacerbates inequality" (Acemoglu, 2002, p.7). Although alternative explanations such as the fall in the real value of the minimum wage, declining unionization, organizational change, and international trade have also been explored (e.g., Lee, 1999; Card and DiNardo, 2002), SBTC is widely viewed as the most significant contributor to the rise in skill wage premium.

This virtually uni-causal explanation would likely fail in the case of Russia. If technological innovations were the main reason for increased skill wage inequality, then Figure

[7] Supply factors might have influenced skill wage premium in the 1992-1993 period during which a significant part of non-manual workers moved from manufacturing to the service sector.

[8] I have decomposed the increase in the employment share of non-manual workers into between-industry and within-industry components using fairly standard methodology described in Berman, Bound, and Griliches (1994). 13 industrial categories were considered. Decomposition revealed that while in the 1980s 86% of the total skill upgrading was happening within industries (80.3% in 1980-1985 and 91.6% in 1985-1990), in the 1990s the entire increase in the share of non-manual workers was due to within-industry changes (104%). Moreover, "pure between-industry shifts" would even reduce the share of non-manual workers in the 1990s (e.g. due to the disproportionate labor outflow from skill-intensive machine building and military production).

3 would suggest that the pace of technological change in the 1990s was much higher in Russia than in most advanced market economies. As Section 6 will show, existing evidence does not support this conclusion.[9] Then the question becomes *why relative wages of high-skilled Russian workers have grown so fast*? I argue that there are at least three sets of possible factors that could produce a phenomenal rise in skill wage premium. The first, which I call the *productivity hypothesis,* suggests that the relative productivity of skilled workers has increased over the last ten years of transition due to domestically-generated within-industry SBTC, technology-enhancing foreign direct investment, between-industry product demand shifts, entry of new firms with the latest technology and management practices, and skill-favoring organizational change. The second possible set of factors comes from the *market adjustment hypothesis*, which implies that market liberalization decompresses earnings restrictions imposed by the old socialist wage-setting mechanism and adjusts wage ratio to the true differences in marginal productivity. Finally, the third set I characterize as the *institutional factor hypothesis*. According to this hypothesis, there are non-market institutional forces that produce skill-biased changes in the wage structure (labor market institutions and policies, ownership, and legal environment). The purpose of this study is to evaluate different hypotheses and provide a general methodology for understanding increased wage premium of skilled workers during the transition to a market economy.

Figure 5: Possession of Personal Computers per 100 Households.

Figure 6: Internet Usership per 1,000 Population.

3. A Conceptual Framework for Understanding Increased Wage Premium of Skilled Workers during the Transition to a Market Economy

The following graphical representation (Figure 7) borrowed from Bound and Johnson (1992) is useful in demonstrating how the same increase in relative wages of skilled workers can be achieved through demand-supply interactions, as well as through market adjustment and institutional forces. Data from Russia and the United States suggest that the share of skilled

[9] Some facts on the cross-country differences in the basic technology measures such as possession of personal computers, Internet use and mobile phones are documented in Figures 5 and 6.

employment and relative wages have increased in both countries during the last decade. Graphically, both economies moved from point A to point B achieving higher relative wages (W_h/W_l) and higher relative employment (N_h/N_l) of skilled workers.

Figure 7: Skill Wage Premium Decomposition: Supply, Demand, and Institutional Factors.

From a pure demand-supply story perspective for relative wages to go up an increased supply of skilled workers must be compensated by upward demand shifts favoring skilled workers. Hence, the natural candidates for explaining a simultaneous increase in relative wages and skilled employment lie on the demand side including skill-biased technological change and product demand shifts towards sectors with higher demand for skills. This explanatory approach assumes that an economy is functioning on the labor demand curve and wages are set to be equal to the worker's marginal product.

Because the Soviet economy did not function according to competitive market principles it seems unlikely that the wages reflected worker's marginal productivity. Although we lack the direct measures of workers' marginal productivity during the pre-transition period, indirect evidence suggests that the connection between earnings and labor efforts was weak. Several Soviet studies admitted that highly educated workers were underpaid. The wage growth of unskilled workers had been larger than for the skilled workers for 1968-87. Thus "…the direct link between earnings and qualifications, still noticeable in 1968, had been completely destroyed by 1978, and by 1989 only some positive movements in this field could be observed" (Rimashevskaya and Patsiorkovski, 1992, p.69).

Put another way, the movement of economy from point A to point B might simply reflect market corrections of distortions imposed by the old wage-equalizing policy. Without any shifts in the demand for skilled labor we can observe the same results by means of market forces that adjust wages towards the true value of marginal product.

So was the market adjustment responsible for the skill-biased changes in the structure of wages in Russia? While the *market adjustment hypothesis* is a very attractive explanation, the timing of wage liberalization reforms does not seem to be consistent with the general trend in the rise of wage inequality. While the first two sharp increases in relative wages of skilled workers coincide with two major wage liberalization reforms in 1987-88 and 1991-92, it is puzzling why the wage ratio continues to rise at a very high rate after 1992 when most of the wage controls were removed. I conclude from this that wage liberalization reforms cannot be the only cause of the skill-biased changes in wages.

Finally, institutional changes can also bring an economy from point A to point B. The most frequently mentioned examples in the U.S. economy are reduced value of minimum wages and de-unionization. In the case of Russia, it is also possible that the weakening of the unions might have contributed to an increase in overall wage inequality[10]. Among other potential factors of skill-biased changes in the wage structure are inadequate legal protection of low-paid workers, increased power of enterprise administration to extract earnings rents, and other structural and organizational changes which are not reflected in the increased skilled workers productivity.

Before further exploration of the proposed hypotheses, I will introduce a simple methodological framework that links wage ratio to supply of skills, to demand generated by increased productivity of skilled workers and technological change, to market adjustment, and to institutional change.

In modeling SBTC and wage inequality it is traditional to begin with the CES production function (see e.g. Bound and Johnson, 1992). It is generally assumed that total output in firm j (Q_j) depends on employment of high-skilled and low-skilled workers (N_{hj} and N_{lj}):

$$Q_j^{(s-1)/s} = A_j \left[g_{hj} \left(N_{hj} \right)^{(s-1)/s} + g_{lj} \left(N_{lj} \right)^{(s-1)/s} \right], \quad (1)$$

where g_{hj} and g_{lj} are firm-specific parameters of productive efficiency of high-skilled and low-skilled workers, A_j is technological efficiency of firm j, and σ is the elasticity of substitution between labor inputs ($s \geq 1$ if high-skilled and low-skilled workers are gross substitutes).

The high-skilled/low-skilled ratio of marginal products for a firm j is given by

$$\frac{m_{hj}}{m_{lj}} = \left(\frac{g_{hj}}{g_{lj}} \right) \left(\frac{N_{hj}}{N_{lj}} \right)^{-1/s}, \quad (2)$$

where m_{hj} and m_{lj} represent the marginal products of high-skilled and low-skilled workers.

According to Eq. 2, the wage ratio of high skilled to low skilled workers under competitive labor markets is completely determined by the differences in productivity and the relative supply of the two skill groups. As Card and DiNardo (2002) noted, "other features of the labor market that potentially affect relative wages such as rents, efficiency wage premiums or institutional wage floors are ignored" (p.4).

To take into account the possibilities of market disequilibrium, policy interventions, and institutional setting in the process of wage determination, suppose that actual wages deviate from the competitive level due to environment-specific (y) and firm-specific (m_j) components, as shown in Eq. 3. The component y can be treated as the index of wage compression or equalizing wage grid introduced by the government. It also can reflect institutional wage floors, labor market policies, legal regulations, and other environment characteristics that are common for all firms in the same market. The firm-specific productivity-unrelated component of wage differences (m_j) can capture various rents caused by employee ownership, within firm distribution of power, the strength of unions, intra-firm organizational changes, and other firm-specific institutional characteristics.

$$\frac{w_{hj}}{w_{lj}} = y\left(\frac{m_{hj}}{m_{lj}}\right)\left(\frac{g_{hj}}{g_{lj}}\right)\left(\frac{N_{hj}}{N_{lj}}\right)^{-1/s}, \qquad (3)$$

where $y<1$.

Taking logs of Eq. 3 and first differencing produces the function of the evolution of relative wages:

$$\Delta\ln\left(\frac{w_{hj}}{w_{lj}}\right) = \Delta\ln y + \Delta\ln\left(\frac{m_{hj}}{m_{lj}}\right) + \Delta\ln\left(\frac{g_{hj}}{g_{lj}}\right) - \frac{1}{s}\Delta\ln\left(\frac{N_{hj}}{N_{lj}}\right) \qquad (4)$$

An important point to note here is that, based on Eq. 4, the well-documented fact of the increase in the returns to unobservable skills based on the earnings residual analysis can not be interpreted as favoring the technological change hypothesis. In principle, all factors might contribute to the increased residual component. The challenging task is how to disentangle the

[10] Minimum wages in Russia were not significant over the period of transition to a market economy. According to Goskomstat (2001b), the percentage ratio of minimum wages to average wages was fluctuating between 3.76 to 8.79 percent in 1993-2000.

effects of competing explanations. Below I present an econometric methodology to test these explanations.

4. Econometric Methodology

This section offers two econometric approaches for two distinct types of data: the firm-level data and the linked employer-employee data. The first approach uses a production function framework and estimates the equations for relative wages. The second approach takes a standard wage function and augments it with firm-level productivity and other firm characteristics.

By transforming Eq. 3, the first approach leads to the simple econometric model of relative wages

$$\ln w_{jt} = \ln y_{t} + \ln m_{jt} + \ln g_{jt} - (1/d)\ln N_{jt} + e_{jt}, \quad (5)$$

where w_{jt} represents the wage ratio of high skilled to low skilled workers of firm j in period t, y_t and m_{jt} represent productivity-unrelated environment-specific and firm-specific factors of wage differences, g_{jt} stands for relative differences in productivity between two skill groups, the N_{jt} denotes the relative supply of the two skill groups, and e_{jt} is an error term with E(e)=0.

Being firm-invariant, the environment-specific factors can be captured through the set of year dummies ($\ln y_t = tT_t$).

The firm-specific productivity-unrelated component of wage differences between two skill groups is allowed to vary over firms and over observable time varying firm characteristics (Eq. 6)

$$\ln m_{jt} = a_{j} + g_{1}Z_{jt} + g_{2}Z_{jt}t + u_{jt}, \quad (6)$$

where a_j is a firm unobserved component, Z_{jt} is a vector of observable productivity-unrelated factors influencing skill wage premium, such as legal and organizational form of enterprise, the strength of unions, and contract enforcement, and u_{jt} is an error term with E(u)=0. Observable characteristics (Z_{jt}) are interacted with the time trend, which allows for time varying response of intra-firm wage differences to changes in observable characteristics. Because the equation is in log terms, $\ln m_{jt}$ measures the percentage by which the actual wage ratio of firm j deviates from its competitive level in a given institutional environment.

The estimation of Eq. 5 is complicated by the fact that the productivity component of wage differences is not directly observable. Instead, we can use proxy variables for g_{jt} such as the level of technological development observable through labor productivity, capital/output ratio, new products, contribution of high-tech industries, and technology transfer through foreign direct investment. It is convenient to present $\ln g_{jt}$ as a linear function of proxy variables G_{jt} and an error term: $\ln g_{jt}=qG_{jt}+r_{jt}$, assuming that $E(r)=0$ and $Cov(G,r)=0$. It is also reasonable to assume that r is not correlated with other explanatory variables, which makes the OLS estimates consistent.

Under the assumptions made, Eq. 5 can be rewritten as

$$\ln w_{jt} = tT_t + a_j + g_1 Z_{jt} + g_2 Z_{jt} t + qG_{jt} - (1/d)\ln N_{jt} + \left(e_{jt} + u_{jt} + r_{jt}\right) \qquad (8)$$

For the purposes of this study, the productivity measures (G_{jt}) are interacted with the time trend in order to test if relative wages are becoming more responsive to the changes in relative productivity over the period of transition to a market economy.

Thus, the base model of the relative wages is specified as follows

$$\ln w_{jt} = tT_t + a_j + g_1 Z_{jt} + g_2 Z_{jt} t + b_1 G_{jt} + b_2 G_{jt} t + d_1 \ln N_{jt} + u_{jt}, \qquad (9)$$

where the composite error term u_{jt} is uncorrelated with the explanatory variables and $d_1=-1/d$.

Eq. 9 can be consistently estimated by either the fixed effects or random effects methods. Assumptions on the correlation between unobserved firm heterogeneity and observable time varying variables can be formally tested by using a Hausman test. The estimation results will indicate whether the gap between relative wages and relative productivity is diminishing over the period of transition to a market economy. We can also see to what extent changes in wages of high-skilled workers are responsive to technological measures, institutional factors (rents), and relative supply shifts.

Our key hypotheses can also be tested by estimating the augmented wage functions in the panel data, in which individual observations are linked to corresponding firm characteristics.[11] Estimating wage equations in the linked employer-employee data has certain advantages over firm-level estimation. Individual data often give better measures of skills and rent-generating attributes by providing information on occupation, education, experience, computer skills, employee ownership, and other useful measures. In the linked employer-employee data, individual characteristics are complemented with firm-level information on firm performance, ownership, technology, and other firm characteristics.

To take into account the market inefficiencies and institutional factors, it is assumed that the actual wages (W_{ijt}) deviate from their competitive level (W^*_{ijt}) due to environment-specific and firm-specific factors. Individual rents could also contribute to the existing gap.

This leads to the following econometric model of wages:

$$\ln W_{ijt} = tT_t + a_i + x_{j(i,t)} + bX_{ijt} + cR_{ijt} + dZ_{jt} + eG_{jt} + e_{ijt}, \qquad (10)$$

where W_{ijt} represents wages of worker i employed by firm j in period t, a_i is time-constant individual heterogeneity, $x_{j(i,t)}$ is the pure firm effect for the firm j at which worker i is employed at period t, X_{ijt} is a vector of observable productivity skills of workers, R_{ijt} is a vector of attributes that potentially could generate rents such as employee ownership and managerial status, and Z_{jt} and G_{jt} are vectors of institutional and technological (productivity-related) firm-specific factors mentioned above.

Observable firm characteristics will be interacted with the time trend and a skill measure (S_{ijt}) to see changes in their effect on worker wages and returns to skills over the transition period.

$$\ln W_{ijt} = tT_t + a_i + x_{j(i,t)} + bX_{ijt} + cR_{ijt} + l_1 Y_{jt} + l_2 Y_{jt} t + l_3 Y_{jt} S_{ijt} + l_4 Y_{jt} S_{ijt} t + e_{ijt},$$

where $Y_{jt} = (Z_{jt}, G_{jt})$ (11)

The parameters of augmented wage equation can be consistently estimated by the fixed effects method. The random effects method is likely to produce inconsistent estimation given a foreseen correlation between the individual and firm heterogeneity and the independent variables, e.g. schooling and productivity.

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[11] Unfortunately such data rarely exist. It was not until recently that economists began exploring the greatest potential in developing the linked employer-employee data. See Abowd and Kramarz (1999) for

Linked employer-employee data provide a powerful tool to measure the extent to which changes in wages are attributed to individual human capital, individual rents, labor productivity, technological change, and institutional factors. In our case, the value of such data is even higher since this is the only source of wages of Russian workers in the pre-transition period (1985 and 1990).

5. Data

The previous section has shown that empirical analysis of the factors behind changes in the wage structure requires detailed information from both firms and workers. This study relies on two main sources of data: administrative enterprise reports and a survey of individuals.

The first data source is the Annual Registries of Russian Industrial Enterprises (RPP, *Registr Promyshlennykh Predpriyatii*). The RPP data contain information from the reports of enterprises submitted to the Russian Statistical Office (Goskomstat) for the period 1985-2000. This study uses the following RPP variables: the value of production net of tax, the value of fixed assets, profit/losses, the wage bill (net of taxes) for manual and non-manual workers, the average number of full-time equivalent manual and non-manual workers, foreign direct investment, 10-digit product code, 5-digit industry code, location, legal and organizational form of enterprise, and ownership (classified into state, private, and mixed categories).[12] No information on wages is available prior to 1992, which restricts the firm-level analysis of wage ratio to the period 1992-2000. Unfortunately, original data (especially for the early period) required intensive and careful cleaning, checking for consistency in variables, eliminating entering errors, and finding firms that changed their identification number due to re-organization.[13] During the process of cleaning, prisons, institutions for special medical

a comprehensive review of these data sources.

[12] Wage data from the enterprise reports are available for 1992-2000, product data for 1993-2000, and information on foreign direct investment for 1994-2000 only.

[13] I thank Dmitry Krutikov and Viktor Orekhov for their assistance with data preparation. The following consistency rules were implemented: 1) total employment is no less then the number of manual workers, 2) total wage bill must be higher than the wage bill of manual workers, 3) the value of production and the value of fixed assets are non-negative, and 4) maximum values of employment, wages, output, and

treatment, internal enterprise balances, reports by ministries in 1992-1993, firms with missing information on all continuous variables, and double counting due to reports from both production association and their master enterprise were removed. As the last two rows of Table 3 indicate, about 2.8 percent of enterprises from the original sample were eliminated, which reduced the final sample to 22,135-27,461 firms in a given year. Total employment in the final firm sample covers between 69 percent (1998-2000) to 87 percent (1993) of the total number of workers in Russian industry reported by Goskomstat (2001b). It is important to note, however, that our firm sample represents mainly the sector of large and medium-sized enterprises. Small firms with less than 100 employees account for 36.5 percent of the number of enterprises and 3.6 percent of total employment in the final sample.

Our second data source is the Russian Longitudinal Monitoring Survey (RLMS), a household survey based on careful probability sampling.[14] These data have been augmented in several ways: adding a number of questions, including better measures of the current wage and retrospective information on jobs held in 1985 and 1990; coding employer and job characteristics, including industry and occupation; and linking industrial and agricultural employees to the firm-level data.[15]

Although data are rich in variables (thousands of questions are asked), only a few variables can be constructed for pre-transition years (1985 and 1990). These include wages, industry, occupation, education, and experience. Another crucial data limitation is that it

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capital must be reasonable (obvious entering errors were corrected or eliminated). In addition, various coding systems have been checked for consistency, including: 1) changes in the methodology of classification of regions, industry, products, and ownership over time, 2) changes in measurement units, 3) entering errors in regional and industrial codes, 4) transitory changes in regions, industry, and ownership, and 5) duplicate observations in the registration number. Changes in the enterprise' IDs (OKPO) due to re-organization were found by the computer program that compared the previous-year reports and the current reports of the previous-year values. ID changes were also traced manually by comparing name and address of the enterprises. 3,295 enterprises in the final sample were found to have changed their registration numbers due to re-organization.

[14] See Swafford *et al* (1997) for a detailed description of RLMS sampling and interviewing procedures. The RLMS data consists of two longitudinal surveys: 1992-1993 (wave 1) and 1994-1996, 1998, and 2000 (wave 2). This study is restricted to wave 2, because no information on firm characteristics is available from wave 1. In 2000, respondents were also asked retrospective questions on jobs held in 1985 and 1990 (see Appendix 4 for discussion on the nature of retrospective questions and associated "recall bias").

[15] The coding and linking are described in Earle and Sabirianova (2002).

contains little information on firm-specific characteristics. No information on performance or technology is available. Because the firm-level information is important for this study, the individual sample is restricted only to those industrial employees that are linked to the firm-level data, thus reducing the total number of observations in the data set. Table 2 summarizes the process of creating the final sample which consists of between 423 and 547 firms and between 1,124 and 1,537 employees in a given year.

Table 2 shows that in addition to the Annual Registries of Industrial Enterprises (RPP), the firm-level variables in the linked employer-employee data are taken from the Annual Registries of Agricultural Enterprises (RSP, *Registr Sel'skokhozyaistvennykh Predpriyatii,* 1995-2000). Although the RSP data are not usable in the firm-level estimation (Eq.9) because of missing data on manual and non-manual workers, it could nevertheless be utilized in estimating the wage equation in the linked employer-employee data. It contains the same set of variables as the RPP data, e.g., the value of production net of tax, the value of fixed assets, profit/losses, the average number of full-time equivalent workers, etc. In the linked employer-employee data, only those RPP and RSP firms are selected that match the survey of individuals.

6. Descriptive Statistics

The pattern of rise in both wage and employment ratios of non-manual to manual workers in the RPP data is remarkably similar to the one that is observed at the level of the whole Russian industry (see Table 3). The average wage ratio of non-manual to manual workers has been steadily increasing over the last decade from 1.62 in 1992 to 2.06 in 2000. The average employment ratio also appears to have been rising from 0.25 in 1992 to 0.53 in 2000.

Table 3: Wage Ratio and Employment Ratio of Non-Manual to Manual Workers in the Firm Sample, 1992-2000.

However, the rise in wage and employment ratios has not been universal across different firms. During the period 1992-2000, 38.1 percent of firms experienced decline in wage ratio and 26.1 percent of firms reduced their share of non-manual workers. An interesting research question that will be explored later in this paper is why some firms but not others increase the pay for skilled labor, which thus drives up the average skill wage premium in the whole economy.

As the previous discussion has shown, technological change is often considered as a primary cause for the increased skill wage premium. While the dynamics are clearly positive in Western countries, on the contrary, in Russia the picture of recent technological development is quite ambiguous.

Table 4 presents trends in available technological measures from the Goskomstat of Russia. Some measures definitely show positive technological changes, e.g. growing number of patents, increasing R&D expenditures in the business sector, and increasing number of telephone lines and users of mobile phones. It is also not surprising that, along with the rest of the world, Russia is gradually computerizing. Despite a sharp decline in domestic PC production, possession of personal computers per 100 households rose from 1.7 in 1992 to 6.8 in 2000, and the total number of internet users also increased from one thousand to 3.932 million for the same period. The 2000 RLMS survey reports even higher proportions of workers used computers at work: 25.6 percent among all workers and 20.6 percent among industrial employees. However, as documented in Figures 5 and 6, the speed of computer-based technological development was much slower in Russia than in the European Union and the countries of Central and Eastern Europe.

Table 4: Measures of Technological Change in Russia.

Other trends in Table 4 are less consistent with the skill-biased technological change argument as applied to Russia. Goskomstat figures indicate that industrial equipment is becoming older and enterprises are investing less in new technology. Goskomstat also reports significant cuts in the federal budget for science, a decreased number of industrial enterprises with R&D departments, and a reduced total number of R&D workers (cut almost in half in 1992-2000).

Unfortunately, none of these common technology measures are available in our firm-level data. Instead, I offer five alternative measures that could serve as good proxies for the level of technological development: capital/output ratio, foreign direct investment (FDI) to Russian industry, investment abroad by Russian enterprises, high-technology industries, and production of new products. The capital/output ratio is included to test the hypothesis of skill-capital complementarity. FDI to Russia is likely to generate the transfer of advanced technology and more efficient management practices, given that most of foreign investment comes from developed OECD countries. Investment abroad could also indicate availability of advanced technology that allows some Russian enterprises to invest abroad. High-technology industries are defined on the basis of OECD classification for developed countries as the science-based industries whose products involve above-average levels of R&D such as aerospace, computers and office machinery, communications equipment, and pharmaceuticals (OECD, 1993). Corresponding industries found in the Russian classification of industries are listed in Appendix 1. Finally, the last but not least important measure of technological development is a dummy indicating that an enterprise produces new products. New products are defined as goods produced by Russian industrial firms in 1993-2000 but not produced in 1977 according to the 1977 Soviet Classification of Products (see Appendix 2).[16] Our premise here is that new products are likely to embody new technologies and methods of production and could serve as an indicator for technological change.

Table 5 reports descriptive statistics of all of these measures in 1995 and 2000, and for the sample of firms with declining and growing wage ratio. As we have already seen in Table 4, data in Table 5 also depict contradictory trends in technological development. Simultaneously, we observe an increase in the proportion of enterprises with FDI and a decline in the share of firms operating in high-technology industries and producing new products. What remains unambiguous though, is that firms with a growing wage ratio on average have higher levels of new technologies: bigger capital/output ratio, larger involvement with foreign investment, and higher probability of producing new and technology embodied products.

Table 5: Characteristics of the Firm Sample, 2000.

Among other variables included in the estimated wage ratio function are average labor productivity (output/employment) to control for productivity changes and a dummy indicating negative profit. In the transition context, the latter variable often serves not only as a

[16] No product information is available for 1992. Firms engaged in manufacturing of new products in 1993 are assumed to produce them in 1992.

performance measure but also as an indicator of soft budget constraints and accessibility to subsidies and soft money (see Lizal and Svejnar, 2002). Otherwise, it would be hard to explain why negative profits are so persistent over time. For instance, in the balanced 5-year panel of enterprises with non-missing profit values (1996-2000), almost 50 percent of enterprises reported negative profit for 2 years and more, and 27.8 percent had negative profit for 4-5 years in a row. Only under soft budget constraints such firms are able to survive in the market economy.

I also look at the variation of skill wage premium across different forms of ownership and industries. A category for state ownership includes enterprises that are owned 100 percent by federal, regional, and municipal governments. Domestically-owned private enterprises, NGOs, and foreign companies are combined in a category of "private ownership". Finally, a category for mixed ownership represents any combination of domestic forms of ownership. Table 5 shows considerable changes in the ownership structure over the five-year period, with a clear pattern of a rise in private ownership.

Overall, summary statistics indicate that the firms with a growing wage ratio on average tend to have positive profits and higher levels of technological development and labor productivity. These firms are less likely to be state owned and more likely to operate in metallurgy and machine building.

We bring all of these firm characteristics to the wage function estimation in the linked employer-employee data described in Section 4 (Eq. 11).[17] The main disadvantage of these data is the small sample size which is compensated by the richness of variables, the longer time-series spanned from the socialist period, and the separability of individual and firm effects. Table 6 presents summary statistics of our rich set of variables for the sub-samples of manual and non-manual workers. Non-manual workers are more likely to be employed in machine-building, high-technology industries, manufacturing of new goods, the state sector, and enterprises with higher labor productivity and non-negative profit. No significant differences

[17] Because product information is not available for 1985 and 1990, the variable "Produced new products in a given year" was substituted by the variable "Ever produced new products during 1993-2000".

between manual and non-manual workers are found with respect to capital/output ratio and foreign investment.

Table 6: Characteristics of the Individual Sample (Russian Industry, Linked Employer-Employee Data, 2000).

Table 6 also exploits a set of variables that could proxy for potential earnings rents gained through the strength of workers' organizations or due to the power of managerial control. On the worker's side, I use the number of strikes by region and year. On the manager's side, one option is to consider different legal and organizational forms of the enterprises. Based on the full legal name, all enterprises were classified into four categories: state unitary enterprises, partnerships (including limited liabilities) and cooperatives, open joint-stock companies, and closed joint stock companies. Earnings rents should be less difficult to extract when there are no market pressures and no controls by outside shareholders. For example, many enterprises in Russia initially were organized in the form of closed joint-stock companies with no shares circulating in the stock exchange. Typically, insiders (enterprise administration) have full control over such a company. Higher wage ratio in closed joint-stock companies would likely support the rent explanation of increased skill wage premium.

Another rent-related variable to exploit is the extent of labor contract violations in the form of unpaid or late wages.[18] Russian transition brought this unusual phenomenon to the remarkably mass level, with 60 percent of workers reporting wage arrears in 1998 (RLMS, 1998). Wage arrears were widespread in many industries, in different forms of ownership, in both profitable and loss-making firms. At the same time, many studies pointed out the high regional variation in wage arrears—from almost no wage arrear regions to regions with nearly 100 percent workers receiving late or no payments. I utilize this regional variation in wage arrears to distinguish between legal environments of different regions. My argument here is that extraction of earnings rents would be easier in the environment in which legal enforcement is weak and contract violations are taking place. Regional wage arrears are calculated for each RLMS district (county) as the average number of overdue monthly wages.

[18] The phenomenon of wage arrears during Russian transition has been explored by Desai and Idson (2000), Earle and Sabirianova (2002), and Lehmann, Wadsworth, and Acquisti (1999), among others.

Finally, Table 6 gives the mean individual characteristics of manual and non-manual workers. The dependent variable is log of real average monthly wages at the primary job. Questions on average monthly wages were directly asked in the 1998 and 2000 surveys. The 2000 survey also contains retrospective questions on average monthly wages for 1985 and 1990. Measurement and recall errors associated with retrospective questions are discussed in Appendix 4. In 1994-1996, average wages were imputed in the following way: for employees without wage arrears, I use the actual earnings received last month from the primary job; for employees with wage arrears, actual earnings received last month are not an appropriate measure because of irregular and late payments; instead, I use the total wage debt owed to the worker divided by the number of monthly wages owed.[19] Wages have also been deflated by regional CPI to control for inflation and to equate regional differences in cost of living. As to other RLMS variables, I use all available time varying characteristics such as years of schooling, potential labor market experience measured as age minus years of schooling minus 6 pre-school years, occupation, industry, and employee ownership. The latter variable is interesting since it can show potential rents coming from employee ownership. We see that non-manual workers on average have higher wages, higher years of schooling, lower years of labor market experience, and are more likely to be shareholders of their enterprises.

7. Econometric Results

Although Eq. 9 is estimated by different methods, conclusions will be drawn primarily from the firm fixed effects estimation. The results from the pooled OLS estimation are not presented in Table 7 since the estimation does not control for the time-constant unobserved firm heterogeneity and contains the omitted variable bias. The results from the random effects estimation are presented for referral purpose only, bearing in mind that the estimation assumes no correlation between the constant firm unobserved heterogeneity and the observed explanatory variables. Such an assumption could be declined intuitively and the Hausman test also confirms that the random effects method would produce inconsistent estimates in this case.

Table 7: Equation for Relative Wages, Russian Industrial Firms, 1992-2000.

[19] See Earle and Sabirianova (2002) for further discussion of this measure.

Table 7 presents two model specifications that use alternative measures of technological variables. In all specifications, the key variables of interest are interacted with the time trend. To control for some data problems, two additional variables are included. The first variable indicates missing or zero values on profits.[20] The second variable is an interaction term between a dummy for year 1992 and the capital/output ratio. The year 1992 was problematic in terms of accurate measures of capital since it was the first year of high inflation and the proper end-year capital re-valuation began only in 1993. To reduce the effect of measurement error of capital in 1992, the interaction term with a year dummy was included. Appendix 3 also discusses the magnitude and direction of measurement error in other variables.

Consistent with the theory described in Section 3, the elasticity of wage ratio with respect to changes in employment ratio is negative. As we would expect, the relative demand curve for skills is downward sloping and skill premium increases when skilled workers become more scarce. The estimated elasticity of substitution between manual and non-manual workers (σ=3.17) is above typical estimates for the U.S., the majority of which are between σ=.5 and 2.5 (see, for example, Katz and Autor, 1999). An important implication of higher elasticity of substitution in Russia is that in order to achieve equivalent changes in relative wages and employment, Russia would require smaller supply shifts and greater demand shifts than in the U.S.

The fixed effect analysis verifies the skill-capital complementarity hypothesis, which is consistent with similar findings from studies on other countries (for example, Griliches, 1969; Bound and Johnson, 1992; Berman, Bound, and Griliches, 1994). Average labor productivity and all time varying technological factors such as high-technology industry and new products are found to have a negative or zero effect on the wage ratio at the beginning of the transition period. However over time, the response of wage ratio to productivity shocks and technological change has become positive and significant. The effect of time-constant foreign direct investment and investment abroad by Russian enterprises on wage ratio is also increasing

[20] Because in the RPP data we cannot distinguish between actual zero profit and missing values coded as zero, all observations with zero and missing values are combined in one category.

over time. A positive rate of growth of the skill wage premium is observed among non-state firms and firms with positive profit.

It is not surprising to obtain zero or even negative correlation between productivity/technology factors and skill wage differences during the early transition period. This confirms various speculations on the loose connection between tariff differentials inherited from the socialist period and the actual productivity contribution of workers at that time. What I find puzzling is that skill wage differentials in the early 90s were growing not in the private sector but, rather, in the old state sector and among enterprises with a negative profit. At this point I can only speculate why an early increase in skill wage premium was generated by least performing firms. On the one hand, state-owned enterprises (SOEs) became less constrained by the government tariff system and other wage floor policies. On the other hand, compared to new private firms, SOEs operated under soft budget constraints and less market pressure that allowed them to have persistent negative profits over time. Thus, managers of SOEs at the early stage of transition were able to increase salaries to themselves and their skilled personnel without productivity considerations.

From the first set of estimations, I conclude very cautiously that the increased wage premium has been driven by different factors during early and late transition periods. At the beginning of reforms it seems that market liberalization and institutional changes played an important role, whereas during the late transition period the skill wage premium evidently becomes more responsive to productivity and technological changes. The next series of estimations will show whether these findings will hold in the workers' sample.

In the linked employer-employee data, I begin by estimating the augmented wage function (Eq. 11), in which firm characteristics and time are interacted with each other and a dummy for non-manual workers (Table 8). Next, firm characteristics and time are interacted with two categories of non-manual workers – managers and other skilled employees (Table 9). Managers are isolated into a separate category in order to see if our earlier suppositions on the role of inter-firm distribution of power are supported by the data. To control for an unobserved constant individual and firm productivity, Eq. 11 is estimated by including individual fixed effects, firm fixed effects, and both individual and firm fixed effects.[21] Appendix 4 shows that the effect of recall error on the estimated equations does not appear to be significant. Because of a smaller number of firms and a larger selection of variables in the linked employer-employee data, I present five model specifications that have at least one productivity/technology measure and one measure of institutional change whenever possible.

Table 8: Augmented Wage Functions and Returns to a Skilled Job in the Linked Employer-Employee Data (Individual and Firm Fixed Effects, Russian Industry, 1985-2000).

Table 9: Augmented Wage Functions and Returns to a Managerial Job in the Linked Employer-Employee Data (Individual and Firm Fixed Effects, Russian Industry, 1985-2000).

All model specifications show positive and increasing over time returns to schooling, which is in line with the skill-biased transition picture. Without individual fixed effects, the wage function with respect to potential labor market experience is positive and concave. Controlling for individual heterogeneity, the effect of potential labor market experience typically disappears because of weak variation in deviation of experience from its mean over time. The positive and significant coefficients on employee ownership suggest the possible wage rent effect for owners of the enterprise.

Across all estimation methods, four of six previously used productivity/technology variables have significant coefficients that are consistent with firm-level analysis. Both econometric approaches provide coherent evidence on negative or zero returns to a skilled job in the socialist and early transition period and a consecutive rise in skill wage premium among firms with higher labor productivity, positive profit, foreign direct investment, and new products. It is interesting that measures of technological change such as foreign direct investment and new products have a sizeable effect only on wages of non-managerial skilled workers. The data do not show any significant relationship between firm technological advancements and managerial wage premium at any point of time. However, Table 9 reveals

[21] The model is also estimated by pooled OLS and random effects methods. Results are available upon request keeping in mind that estimates are inconsistent due to the omitted variable bias in OLS and imposed assumptions in the random effect estimation. First differencing transformation cannot be applied because of discontinuous and uneven time spells between the surveys.

stronger association of managerial wage rewards with enterprise's profit and labor productivity during the late transition period.

The wage effects of two other technology measures are not straightforward. Returns to having a manual job in a high technology industry were high under socialism and then diminished over time. For skilled labor, the results are ambiguous. The signs of coefficients on the cross term between high technology industries and non-manual jobs are consistent with firm-level results but most of the coefficients are statistically insignificant. Findings on the effect of investment abroad disagree with firm-level estimation. Evidently, enterprises that invested abroad have significantly higher wage returns. However, no evidence is found in the individual sample of the impact of investment abroad on skill wage premium and managerial rewards.

Turning to institutional factors, two findings are robust and hold throughout all estimation techniques. First, no matter what estimation methods are used, I did not find any indication of the effect of strikes on skill wage premium. Possibly, it just reflects inefficient and weak labor organizations inherited from the socialist times when almost 100 percent of workers were formally unionized. Second, data show substantial variation across legal and organizational forms of enterprises. The hypothesis is that earnings rents should be easier to extract in the companies with lower control of outside shareholders. Results unambiguously indicate that insider-controlled closed joint stock companies had the largest wage differences between manual and non-manual workers at the beginning of the transition period. However, over time wage returns to skilled jobs in closed joint stock companies declined relative to other legal forms.

Concerning firm ownership, wage growth is estimated to be higher in mixed and private firms, relative to state-owned enterprises, but the differences among these groups with respect to skill wage premium are much smaller than they were in our firm-level analysis. Finally, with respect to the effect of legal environment, regional wage arrears are estimated to lower average wages but no firm conclusion could be made with respect to average skill wage differences. At the same time, the firm fixed effect estimation suggests that wage returns to a managerial job during the early transition period are higher in locations where violations of labor contracts in the form of wage arrears are more common.

8. Additional Sources of the Rise in Skill Wage Inequality

The previous sections examined the multiple sources of increased skill wage premium during the transition to a market economy. One might argue though that the list of potential sources is not complete and omits important factors such as within-firm organizational change, the transformation of the composition of firms, firm turnover, etc. Each of these factors are worthy of a special study and require better data than those that we have. Here I discuss only briefly the potential importance of some alternative explanations for the rise in skill wage inequality in transition economies.

Organizational Change

The nature of organizational changes in the advanced market economies is often directly linked to technological change. It is commonly believed that "…these factors by themselves are not the major cause of the increase in inequality. Instead they become powerful actors only by interacting with technical change…" (see Acemoglu, 2002). I argue that in a transforming economy, organizational changes are not necessarily related to technological development and could have an independent effect on skill prices. The transition to a market economy brought a variety of skill-favoring organizational changes within and between firms. Old socialist firms have been transformed rapidly into new types of organizations with different incentives, management practices, ownership control, and organizational innovations. Old departments of planning and socialist competition have been replaced by new departments of marketing, finance, logistics, pricing, etc. Firms suddenly faced an increased demand and higher prices for lawyers, accountants, tax advisors, sellers, human resource managers, interpreters, and other market-needed skilled workers.

In addition to organizational reforms within firms, important changes in the overall composition of firms occur, for instance, workers of different skills become more segregated across firms. Kremer and Maskin (1996) and Acemoglu (2002) describe this kind of structural changes in the U.S. economy over twenty-five years. They argue that as the productivity of skilled workers increases, it becomes more profitable for them to work by themselves in separate organizations rather than in the same workplace as unskilled workers, and as a result, unskilled wages fall. After eight years of transition, Russia exhibits similar changes in the structure of firms. Figure 8 plots the distribution of firms by the share of non-manual workers in 1992, 1996, and 2000. A clear pattern of an increase in the proportion of firms at the bottom and at the top of distribution indicates a higher segregation of workers of different skills across firms in 2000.

Figure 8: Distribution of Firms by the Share of Non-Manual Workers, Russian Industry.

The effect of these and many other organizational changes on skill wage inequality is beyond the scope of this study and deserves further research when better data on management practices, organizational innovations, and firm internal structure become available.

Firm Entry, Exit, and Decomposition of Skill Wage Differences

Skill-favoring firm turnover is another promising area to analyze the sources of increased skill wage inequality in a transition economy. Until now we examined changes in relative skill prices within existing firms. To understand better the aggregate dynamics of skill wage difference at the level of the whole industry, it is also important to look at the changes between firms and at the role of firm entry and exit in skill wage determination (see Abowd *et al*, 2002). New firms are more likely to enter the market with new technology, new organizational practices, and thus higher demand for skilled workers. By decomposing the wage ratio of non-manual to manual workers, we can see if the observed changes in skill wage inequality come from changes within the firm or from replacing old firms by new firms.

The relative contribution of within and between changes in the wage ratio can be determined using the following decomposition proposed by Abowd *et al* (2002) with respect to the human capital index:

$$\begin{aligned}\Delta\overline{w}_t = & \sum_{j\in C} e_{jt-1}\Delta w_{jt} + \sum_{j\in C}\Delta e_{jt}\left(w_{jt-1}-\overline{w}_{t-1}\right)+\sum_{j\in C}\Delta e_{jt}\Delta w_{jt} \\ & + \sum_{j\in N} e_{jt}\left(w_{jt}-\overline{w}_{t-1}\right)-\sum_{j\in D} e_{jt-1}\left(w_{jt-1}-\overline{w}_{t-1}\right)\end{aligned} \tag{12}$$

where $\overline{w_t}$ is the average wage ratio in the industrial sector; w_{jt} is the wage ratio for an individual firm *j*; e_{jt} is the share of employment for firm *j*; *C* is the set of continuing firms; *N* is the set of newly created firms; and *D* is the set of exiting firms. The last two terms indicate that changes in w might reflect differences in the wage ratio among newly created and exiting firms. Thus, sources of change in the wage ratio in the country industrial sector include within-firm changes, inter-firm shifts in employment distribution, covariance between the wage ratio and employment shares, and changes due to net entry. Table 10 summarizes the decomposition of changes in the wage ratio in Russian industry between 1992 and 2000.

Table 10: Decomposition of Changes in the Wage Ratio of Non-Manual to Manual Workers in the Russian Industry between 1992 and 2000.

The within-firm component is significant, suggesting that the rise in skill wage premium is attributed mainly to inter-firm changes within the set of continuing firms. The between effect is small and it is positive only for the late transition period. The negative cross term indicates that downsizing firms reduce wages of manual workers relative to non-manual workers. Exiting firms do not appear to contribute to increased skill wage inequality. But entry yields a systematic rise in skill wage differences. The contribution of net entry is positive with new firms having substantially larger skill wage differences than the exiting firms.

The large within-firm component justifies studies like ours that focus primarily on within-firms changes in skill wage differences. However, positive contribution of net entry also suggests that further research needs to be done with respect to the role of new firms in rising skill wage inequality in transition economies.

9. Conclusions

This study attempts to explain why the transition to a market economy is skill-biased. It shows unequivocal evidence on increased skill wage premium and supply of skills in transition economies. It documents skill upgrading within Russian industry during the 1990s and examines whether similar skill–favoring shifts in the Russian and U.S. economies are driven by the same set of factors.

The main conclusion is that there is no uni-causal and time-invariant explanation for skill-biased changes in wages and employment in the Russian economy. The increased wage premium has been driven by different factors during the early and late transition periods. Jointly, three sets of factors produce a phenomenal rise in skill wage premium – from very compressed differences (7.5%) in 1987 to almost converging to the current U.S. wage percentage ratio (74.2% in Russia vs. 77.7% in the U.S.) in 2000.

The major explanation for the rise in wage inequality in the U.S. labor market – *skill-biased technological change* – is not found to be important during the socialist and early transition periods. Moreover, the statistical relationship between technology factors and skill wage differences in early 90s was often zero or even negative. However, at the late stage of transition, wages for non-manual workers are becoming more responsive to domestically-generated skill-biased technological change and technology-enhancing foreign direct investment.

Our analysis provides strong support for the *market adjustment hypothesis*, which implies that market liberalization decompresses earnings restrictions imposed by the old socialist wage-setting mechanism and adjusts wage ratio to the true differences in marginal productivity. There is strong evidence showing the adjustment of skill wage premium to labor productivity and the time effect on skill wage premium.

Finally, this study has shown that *non-market institutional forces* also produce skill-biased changes in the wage structure, especially during the early stage of the transition period. However, traditional institutional factors that are most frequently mentioned in the U.S. studies of wage inequality – reduced value of minimum wages and de-unionization – do not appear to be significant in the case of Russia. The contribution of institutional factors to wage inequality during the early transition is attributed mainly to managerial power to extract earnings rents without productivity considerations under soft budget constraints, the lack of control by outside shareholders, and weak legal environment. Legal and organizational structure of the enterprise, access to subsidies, and in some instances ownership and violations of labor contracts are found to be important causes for increased skill wage premium in Russia.

This study evaluated all of these factors and provided a general theoretical and empirical methodology for understanding increased wage premium of skilled workers during the transition to a market economy. Empirical analysis has been carefully designed and implemented on the base of administrative enterprises' reports and linked employer-employee data, with a special emphasis on data quality, variable definitions, measurement errors, and retrospective biases. Unique data were allowed to exploit the rich set of variables, many of which have never or rarely been used in the Western studies of wage inequality, such as manufacturing of high-technology and new products, foreign direct investment, investment abroad, ownership, legal organizational forms, and legal environment.

U.S. experts in wages and employment might notice that Russia today experiences changes that are quite similar to the ones that the U.S. economy went through over the last decades, including a decline in low-skilled workers, an increase in skill wage inequality, and higher responsiveness of relative wages to organizational and technological change accompanied by productivity growth. In Russia all these changes are more compressed in time and reinforced by market adjustment and some peculiar non-market institutions. Although there is a long way to go, however, the fact that markets began to work gives certain optimism on future organizational and technological development that could hopefully lead to the decades of increased productivity and performance.

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Table 1: Evidence on Skill Upgrading in Transition Economies

1A: Share of Non-Manual Workers (percentage of total employment), 1990-2000

	1990	*1992*	*1994*	*1996*	*1998*	*2000*
Transition economies						
Croatia	…	…	…	52.2	55.4	58.6
Czech Republic	…	…	52.7	54.7	55.7	56.8
Estonia	47.1	48.4	51.5	54.0	53.3	55.0
Hungary	…	…	…	54.3	54.3	55.5
Latvia	…	…	…	47.7	48.4	53.4
Lithuania	…	…	…	…	46.5	47.5
Poland	…	…	…	43.8	46.4	48.2
Romania	…	…	26.2	27.8	27.4	27.3
Russian Federation	50.4	…	52.7	54.2	55.7	56.1
Slovak Republic	…	…	51.5	52.5	52.4	54.5
Slovenia	…	…	52.2	53.3	51.4	55.0
Ukraine	…	…	…	46.2	50.2	50.5
Developed market economies (for comparison)						
Canada	65.0	66.9	66.6	66.4	66.3	66.6
Finland	63.0	65.5	65.8	66.4	67.4	65.8
Italy	…	…	56.0	57.7	59.0	60.6
Japan	57.0	58.3	58.8	59.5	60.5	61.0
Spain	50.4	52.4	49.6	51.8	52.4	53.5
Sweden	67.2	69.4	71.1	71.0	69.3	70.5
United Kingdom	…	67.0	68.3	69.4	70.3	…
United States	70.3	71.3	71.6	72.1	72.5	72.9

Source: RLMS for Russia; the ILO Laborstat database (available at www.ilo.org) for other countries

Notes: Original data come from national labor force surveys. Non-manual workers include legislators, managers, professionals, technicians, clerks, service workers, and army specialists. Numbers in white cells are calculated based on ISCO-88. Numbers in gray cells are based on ISCO-68.

Table 1: Evidence on Skill Upgrading in Transition Economies
1B: Share of the Employed with Higher Professional Education (percentage of total employment), 1992-2000

	1992	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Transition economies									
Bulgaria	…	20.1	21.3	21.3	20.7	21.5	…	…	…
Czech Republic	…	10.5	10.1	10.9	10.8	10.8	10.8	11.4	11.8
Hungary	14.6	14.7	14.6	15.8	16.5	15.1	16.1	16.4	17.5
Poland	14.2	13.7	14.8	15.2	15.0	15.4	16.2	17.2	17.3
Romania	…	…	8.0	8.1	7.8	8.1	…	…	…
Russian Federation	16.1	16.9	18.0	18.4	18.8	20.1	20.7	20.2	21.6
Slovak Republic	…	13.3	12.7	12.5	12.6	11.9	11.8	11.8	12.3
For comparison									
United States	26.4	27.0	27.3	28.3	28.5	28.6	29.1	30.0	…

Sources: OECD, Statistical Abstract of the United States/The National Data Book, Goskomstat (1999 and 2001a).

Notes: Higher professional education in former socialist countries includes only universities and does not include technical colleges and vocational schools. Typically technical schools train associate professionals, e.g. nurses, technicians, teachers for elementary school and kindergartens. For U.S. – percentage of civilian labor force.

Table 1: Evidence on Skill Upgrading in Transition Economies

1C: Percentage Wage Differences between Non-Manual and Manual Employees in Industry/ Manufacturing

	1980	*1985*	*1990*	*1995*	*2000*	*Notes*	*Sources*
Transition economies							
Bulgaria	0.048	0.066	0.109	…	…	Industry	IIS
Czechoslovakia	0.087	0.081	0.068	…	…	Industry	IIS
Czech Republic	0.071	0.057	0.058	0.521	0.771	Industry	NSY
Hungary	0.218	0.355	0.763	…	…	Industry	IIS
Hungary	…	…	0.647	1.022	1.229	Industry	NSY
Poland	0.012	-0.029	0.177	…	…	Industry	IIS
Romania	0.310	0.172	0.196	…	…	Industry	IIS
Romania	0.313	0.173	0.191	0.336	0.493	Industry, 99	NSY
Russian Federation	0.101	0.060	0.197	0.541	0.742	Industry	NSY
Developed market economies (for comparison)							
Canada	0.292	0.387	0.419	0.422	…	Manufacturing, 94	IIS, OECD
Finland	0.492	0.506	0.467	…	…	Industry	IIS
Finland	0.463	0.500	0.466	0.399	0.385	Industry, 98	NSY
Italy	0.308	0.416	0.645	…	…	Industry, 89	IIS
Spain	0.387	0.499	0.642	…	…	Manufacturing	IIS
Sweden	0.553	0.492	0.508	…	…	Manufacturing	IIS
United Kingdom	0.308	0.366	0.488	…	…	Manufacturing	IIS
United States	0.533	0.559	0.640	…	…	Manufacturing	IIS
United States	0.534	0.557	0.641	0.699	0.777	Manufacturing	NSY
West Germany	0.530	0.587	0.614	…	…	Manufacturing	IIS

Source: "NSY" stands for national statistical yearbooks. "IIS" denotes United Nations Industrial Statistics Yearbooks, 1980-1991. "OECD" denotes OECD Structural Statistics for Industry and Services - Industrial Surveys. After 1991 the UN stopped collecting data on wages and salaries of manual workers. Industry includes mining, quarrying, manufacturing, electricity, and gas.

Table 2: Linked Employer-Employee Data: Sample Construction and Variable Availability

	1985	*1990*	*1994*	*1995*	*1996*	*1998*	*2000*
Initial number of RLMS respondents Of which:	7,074	7,076	8,893	8,417	8,342	8,701	9,074
Number of RLMS industrial employees Of which:	1,465	1,504	1,369	1,270	1,163	1,109	1,140
- matched with the RPP data (%)	80.7	81.1	82.1	84.3	85.8	82.1	77.0
Number of RLMS agricultural employees Of which:	690	659	554	513	486	416	440
- matched with the RSP data (%)	…	…	…	90.8	88.3	86.5	83.9
Number of firms in the linked employer-employee sample*	452	471	489	547	531	472	423
Number of workers in the linked employer-employee sample	1,182	1,219	1,124	1,537	1,427	1,270	1,247
RLMS variables: wages, gender, schooling, occupation, industry, experience, employee ownership	+	+	+	+	+	+	+
Regional variables: strikes, wage arrears	+	+	+	+	+	+	+
RPP variables: employment of manual and non-manual workers, output, fixed assets, ownership, location, industry	+	+	+	+	+	+	+
RPP variables: wages of manual and non-manual workers, new products, foreign direct investment	…	…	+	+	+	+	+

Notes: RLMS = Russian Longitudinal Monitoring Survey; RPP = the Registry of Industrial Enterprises; RSP = the Registry of Agricultural Enterprises. (*) The firms in the linked employer-employee data are drawn from the RPP and RSP data and matched with RLMS industrial and agricultural employees; (…) variables are not available; (+) variables are available.

Table 3: Wage and Employment Ratios of Non-Manual to Manual Workers in the Firm Sample, 1992-2000

	1992	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Wage ratio of non-manual to manual workers	1.62	1.73	1.72	1.79	1.88	1.88	1.92	1.94	2.06
	(1.79)	(2.34)	(0.83)	(1.45)	(1.67)	(2.63)	(2.53)	(2.40)	(3.31)
Employment ratio of non-manual to manual workers	0.25	0.27	0.28	0.29	0.34	0.37	0.44	0.51	0.53
	(0.37)	(0.48)	(0.64)	(0.40)	(0.44)	(0.78)	(1.02)	(1.62)	(1.91)
N	18,185	22,017	23,425	24,171	22,474	23,546	23,734	24,500	24,193
For reference:									
Number of unique IDs in the original data set	24,792	23,052	24,359	24,894	27,985	25,194	27,026	26,984	27,337
Number of firms after the process of cleaning	23,013	22,135	23,617	24,350	27,461	24,763	26,354	26,551	26,903

Notes: Standard deviations are shown in parentheses. Sample (N) consists of industrial firms with non-missing values of the wage ratio.

Table 4: Measures of Technological Change in Russia

Technology Measures	*1992*	*1994*	*1996*	*1998*	*2000*
Share of industrial equipment less than 5 years old (%)	22.8	14.7	7.2	4.1	4.7
Number of R&D workers, thousands of people	1532.6	1106.3	990.7	855.2	887.7
Federal budget for science in percent of GDP (%)	0.50	0.39	0.27	0.23	0.24
Number of industrial enterprises with R&D departments	340	276	342	240	284
R&D expenditures in the business sector in percent of GDP (%)	0.74	0.84	0.90	0.92	1.09
Number of new patents, thousands	13.2	20.6	19.7	23.3	17.6
Number of valid patents, thousands	44.3	60.3	109.5	173.1	144.3
Possession of personal computers per 100 households	1.7	2.4	3.1	5.1	6.8
Domestic production of personal computers, thousands of units	137	82.1	118	62	26.5
Number of internet users, thousands	1.0	80	300	1,000	3,931.8
Number of mobile phone users, thousands	6.0	27.7	233.5	761.7	3,331.2
Telephone lines in use per 100 people	16.7	17.6	18.7	20.6	22.8

Sources: Goskomstat (2001b) and Euromonitor (www.euromonitor.com).

Notes: Information on patents is for 1993.

Table 5: Characteristics of the Firm Sample, 1995 and 2000

Variable Name	***1995***	***2000***	***Declining wage ratio 1995-2000***	***Growing wage ratio 1995-2000***
Capital/output ratio	26.323	40.678	28.640	93.048
	(1722.797)	(2940.708)	(801.139)	(5132.683)
	[23,402]	[21,967]	[5,876]	[7,061]
Ever received FDI during 1994-2000	0.016	0.045	0.016	0.031
Ever invested abroad during 1994-2000	0.005	0.005	0.004	0.010
Produced new products in a given year	0.030	0.012	0.012	0.017
	[18,976]	[17,439]	[5,145]	[6,247]
High-technology industries	0.047	0.026	0.026	0.029
Labor productivity (thousands rubles, in constant 1990 prices)	4.879	6.029	4.967	5.921
	(8.795)	(30.115)	(7.388)	(9.502)
	[23,751]	[23,279]	[5,984]	[7,164]
Profit				
Profit negative	0.235	0.335	0.366	0.331
Profit zero or missing	0.084	0.114	0.075	0.056
Profit positive	0.682	0.551	0.559	0.613
Ownership	[24,163]	[24,193]	[6,212]	[7,371]
State	0.191	0.279	0.186	0.161
Mixed	0.458	0.240	0.295	0.316
Private	0.351	0.482	0.519	0.523
Industry				
Energy / Fuel	0.054	0.071	0.049	0.062
Metallurgy	0.026	0.019	0.015	0.026
Chemicals	0.026	0.027	0.027	0.032
Machine building	0.244	0.224	0.203	0.238
Building materials	0.122	0.110	0.113	0.096
Wood processing	0.106	0.089	0.107	0.110
Light	0.119	0.127	0.136	0.105
Food	0.237	0.204	0.259	0.252
Other manufacturing	0.066	0.130	0.090	0.078
N	24,171	24,193	6,212	7,371

Notes: Sample (N) consists of industrial firms with non-missing values of the wage and employment ratios. Standard deviations for continuous variables are shown in parentheses and number of observations for variables with missing values is in brackets.

Table 6: Characteristics of the Individual Sample

Variable Name	*Manual Workers (2)*	*Non-Manual Workers (1)*	*t-test for difference (1)-(2)*
Capital/output ratio	31.596 (969.656) [4286]	93.750 (2420.229) [2263]	-1.472
Ever received FDI during 1994-2000	0.072	0.077	-0.815
Ever invested abroad	0.087	0.086	0.119
Produced new products during 1993-2000	0.128 [4816]	0.154 [2644]	-3.101[a]
High-tech industries	0.063	0.095	-5.391[a]
Labor productivity (thousands rubles, in constant 1990 prices)	12.390 (25.260) [4153]	13.438 (21.623) [2209]	-1.654[c]
Profit			
Negative	0.220	0.182	4.103[a]
Zero or missing	0.226	0.259	-3.269[a]
Positive	0.553	0.560	-0.541
Ownership			
State	0.401	0.450	-4.313[a]
Mixed	0.280	0.318	-3.550[a]
Private	0.319	0.232	8.297[a]
Legal Form			
State unitary	0.398	0.441	-3.682[a]
Partnerships and coops	0.142	0.071	9.537[a]
Open joint stocks	0.360	0.410	-4.410[a]
Closed joint stocks	0.099	0.078	3.111[a]
N	5225	2862	

Variable Name	*Manual Workers (2)*	*Non-Manual Workers (1)*	*t-test for difference (1)-(2)*
Log of real monthly average wages	9.422 (0.921)	9.481 (0.838)	-2.854[a]
Schooling (years)	10.194 (2.327)	12.760 (2.076)	-49.231[a]
Experience (years)	23.724 (12.560)	20.770 (10.889)	10.590[a]
Regional wage arrears	1.992 (2.908)	1.632 (2.552)	5.553[a]
Regional strikes	64.328 (139.275)	64.998 (146.406)	-0.203
Employee ownership			
Employee has no shares	0.735	0.715	1.885[c]
Employee has shares	0.181	0.234	-5.752[a]
No information	0.084	0.050	5.642[a]
Industry			
Energy / Fuel	0.092	0.106	-1.900[c]
Metallurgy	0.087	0.100	-1.937[c]
Chemicals	0.061	0.057	0.745
Machine building	0.293	0.381	-8.108[a]
Building materials	0.055	0.037	3.506[a]
Wood processing	0.050	0.058	-1.521
Light	0.047	0.049	-0.339
Food	0.075	0.084	-1.470
Other manufacturing	0.034	0.028	1.584
Agriculture	0.206	0.101	12.119[a]
N	5225	2862	

Notes: Sample (N) consists of industrial firms with non-missing values of individual wages and schooling. Standard deviations for continuous variables are shown in parentheses and number of observations for variables with missing values is in brackets. [a] significant at 1% level; [b] significant at 5% level; [c] significant at 10% level.

Table 7: Equations for Relative Wages in the Firm Sample, Russian Industry, 1992-2000

Dependent Variable - Log (Wage ratio)	*Firm Fixed Effect*				*Firm Random Effect*			
	(1)		*(2)*		*(1)*		*(2)*	
	Coeff.	***t***	***Coeff.***	***t***	***Coeff.***	***t***	***Coeff.***	***t***
Log(employment ratio)	-0.316^{a}	-112.50	-0.346^{a}	-104.64	-0.247^{a}	-111.21	-0.284^{a}	-106.09
Log(capital/output)	0.019^{a}	6.16	0.022^{a}	5.80	-0.005^{b}	-1.97	-0.002	-0.54
Log(capital/output)*time	0.003^{a}	5.78	0.002^{a}	3.67	0.004^{a}	9.39	0.003^{a}	6.52
High-tech industries	-0.062^{b}	-2.39	?	?	-0.041^{a}	-3.16	?	?
High-tech industries*time	0.018^{a}	6.88	?	?	0.020^{a}	8.68	?	?
Ever received FDI*time	0.010^{a}	3.80	?	?	0.012^{a}	7.81	?	?
New products	?	?	-0.039^{b}	-2.43	?	?	-0.046^{a}	-3.43
New products *time	?	?	0.007^{b}	2.16	?	?	0.011^{a}	3.49
Ever invested abroad*time	?	?	0.010^{c}	1.79	?	?	0.006	1.48
Log(labor productivity)	-0.010^{a}	-2.66	-0.013^{a}	-3.01	-0.036^{a}	-13.14	-0.039^{a}	-11.46
Log(labor productivity)*time	0.002^{a}	3.39	0.002^{a}	3.47	0.005^{a}	10.06	0.005^{a}	8.69
Profit (negative profit is omitted)								
Positive	-0.024^{a}	-3.43	-0.019^{b}	-2.45	-0.015^{b}	-2.30	-0.012^{c}	-1.64
Positive*time	0.004^{a}	2.73	0.003^{b}	2.28	0.003^{b}	2.38	0.003^{b}	2.16
Missing or zero	-0.025^{b}	-2.02	-0.016	-1.02	-0.012	-1.08	-0.010	-0.73
Missing or zero*time	0.001	0.25	-0.002^{a}	-0.53	-0.002	-0.86	-0.002	-0.91
Ownership (state is omitted)								
Mixed	-0.031^{a}	-5.11	-0.029^{a}	-4.19	-0.022^{a}	-3.93	-0.021^{a}	-3.28
Mixed*time	0.009^{a}	6.06	0.009^{a}	5.24	0.006^{a}	4.81	0.005^{a}	3.25
Private	-0.020^{a}	-2.87	-0.017^{b}	-2.04	-0.015^{b}	-2.39	-0.015^{b}	-2.06
Private*time	0.006^{a}	4.15	0.005^{a}	3.33	0.004^{a}	3.27	0.003^{c}	1.93
Intercept	-0.071^{b}	-2.06	-0.104^{b}	-2.51	0.013	1.25	-0.049^{a}	-4.22
Hausman test of RE vs. FE ? chi2(33)	?		?		1928.41		1271.45	
R^2 overall	0.055		0.074		0.081		0.097	
N	190,235		143,315		190,235		143,315	

Note: ^{a} significant at 1% level; ^{b} significant at 5% level; ^{c} significant at 10% level. Year dummies, 9 industry dummies, and a dummy for 1992 capital/output mismeasurement are included but not shown here (see description in the text).

Table 8: Augmented Wage Functions and Returns to a Skilled Job in the Linked Employer-Employee Data (Individual and Firm Fixed Effects, Russian Industry, 1985-2000)

	Individual Fixed Effect		*Firm Fixed Effect*		*Individual and Firm Fixed Effects*	
	Coeff.	***t***	***Coeff.***	***t***	***Coeff.***	***t***
Specification 1:						
Schooling (years)	0.005	0.09	0.017[b]	2.15	0.008	0.14
Schooling*time	0.003[a]	2.93	0.002[a]	3.10	0.003[a]	2.63
Experience (years)	0.041	0.78	0.024[a]	9.75	0.043	0.81
Experience squared / 100	-0.026[b]	-2.56	-0.041[a]	-8.30	-0.023[b]	-2.08
Employee has shares	0.048[c]	1.89	0.114[a]	5.15	0.046[c]	1.75
No information on employee shares	-0.006	-0.16	0.020	0.62	-0.013	-0.35
High-tech industries	0.045	0.38	0.411[a]	2.61	0.288[c]	1.67
High-tech industries*time	-0.017[c]	-1.79	-0.020[b]	-2.31	-0.020[b]	-2.00
High-tech industries*SKL	-0.187	-1.17	-0.328[a]	-2.79	-0.185	-1.00
High-tech industries*SKL*time	0.010	0.70	0.009	0.72	0.012	0.80
Profit zero or missing	0.171[a]	4.39	0.191[a]	4.88	0.196[a]	4.78
Profit positive	0.154[b]	2.42	0.258[a]	4.33	0.155[b]	2.31
Profit positive*time	-0.008[c]	-1.75	-0.010[b]	-2.23	-0.009[c]	-1.67
Profit positive*SKL	-0.237[a]	-3.33	-0.349[a]	-6.06	-0.237[a]	-3.17
Profit positive*SKL*time	0.019[a]	3.27	0.018[a]	3.45	0.020[a]	3.25
Intercept	8.502[a]	6.48	8.715[a]	25.35	8.720[a]	5.94
N	8087		8087		8087	
R^2 within/ R^2 overall	0.096/0.170		0.092/0.050		0.150/0.086	
Specification 2:						
Ever received FDI*time	0.004	0.60	0.000	0.04	0.011	1.21
Ever received FDI*SKL	-0.392[b]	-2.12	-0.544[a]	-4.01	-0.231	-1.04
Ever received FDI*SKL*time	0.036[a]	2.68	0.041[a]	3.44	0.028[c]	1.93
Regional wage arrears	-0.072[b]	-2.08	-0.080[b]	-2.40	-0.067[c]	-1.91
Regional wage arrears*time	0.003	1.29	0.003	1.50	0.003	1.25
Regional wage arrears*SKL	-0.038	-0.82	-0.125[a]	-3.06	-0.028	-0.59
Regional wage arrears*SKL*time	0.003	0.91	0.008[a]	2.88	0.002	0.66
Intercept	8.103[a]	6.23	8.947[a]	27.05	8.401[a]	5.79
N	8087		8087		8087	
R^2 within/ R^2 overall	0.091/0.156		0.083/0.070		0.143/0.030	
Specification 3:						
Ever invested abroad*time	0.028[a]	4.15	0.036[a]	4.97	0.033[a]	4.16
Ever invested abroad*SKL	-0.352[c]	-1.79	0.045	0.33	-0.321	-1.41
Ever invested abroad*SKL*time	0.005	0.42	-0.002	-0.16	-0.002	-0.16
Legal form (Closed joint stocks are omitted)						
State unitary	0.551[a]	2.57	0.582[a]	2.80	0.503[b]	2.30
Partnerships and coops	0.739[a]	2.78	0.823[a]	3.30	0.702[a]	2.57
Open joint stocks	0.346[c]	1.68	0.470[b]	2.36	0.347[c]	1.64
State unitary*time	-0.045[a]	-2.66	-0.039[b]	-2.32	-0.034[c]	-1.93

Partnerships and coops*time	-0.064[a]	-3.10	-0.071[a]	-3.68	-0.062[a]	-2.91
Open joint stocks*time	-0.026[c]	-1.65	-0.030[c]	-1.95	-0.021	-1.27
State unitary*SKL	-0.262[a]	-4.29	-0.390[a]	-8.72	-0.295[a]	-4.53
Partnerships and coops*SKL	-0.386	-0.94	-0.199	-0.57	-0.295	-0.70
Open joint stocks*SKL	-0.342[b]	-2.08	-0.632[a]	-4.25	-0.359[b]	-2.14
State unitary*SKL*time	0.030[a]	4.55	0.024[a]	4.67	0.032[a]	4.60
Partnerships and coops*SKL*time	0.037	1.10	0.017	0.61	0.028	0.83
Open joint stocks*SKL*time	0.025[b]	2.00	0.037[a]	3.26	0.026[b]	2.05
Intercept	7.869[a]	6.00	8.353[a]	21.55	8.174[a]	5.56
N	8087		8087		8087	
R^2 within/ R^2 overall	0.098/0.176		0.097/0.087		0.153/0.089	
Specification 4:						
Log(labor productivity)	-0.006	-0.16	0.062[c]	1.70	-0.006	-0.14
Log(labor productivity)*time	0.012[a]	3.59	0.007[b]	2.55	0.012[a]	3.61
Log(labor productivity)*SKL	-0.098[a]	-3.83	-0.126[a]	-6.71	-0.104[a]	-3.85
Log(labor productivity)*SKL*time	0.008[a]	2.73	0.007[a]	3.31	0.008[b]	2.56
Ownership (State is omitted)						
Mixed	-0.495[b]	-2.36	-0.555[a]	-2.76	-0.518[b]	-2.42
Private	-0.442[b]	-2.15	-0.327[c]	-1.64	-0.490[b]	-2.33
Mixed*time	0.048[a]	2.76	0.051[a]	3.02	0.050[a]	2.80
Private*time	0.042[a]	2.59	0.026[c]	1.65	0.046[a]	2.71
Mixed*SKL	-0.128	-0.58	-0.262	-1.31	-0.140	-0.62
Private*SKL	-0.138	-0.59	-0.202	-0.94	-0.073	-0.31
Mixed*SKL*time	0.009	0.49	0.014	0.85	0.010	0.51
Private*SKL*time	0.008	0.46	0.015	0.89	0.003	0.19
Intercept	7.660[a]	5.19	8.340[a]	29.85	7.909[a]	4.75
N	6362		6362		6362	
R^2 within/ R^2 overall	0.118/0.171		0.107/0.078		0.151/0.035	
Specification 5:						
Produced new products*time	-0.004	-0.68	-0.010	-1.55	-0.013[c]	-1.90
Produced new products*SKL	-0.208[c]	-1.63	-0.394[a]	-3.95	-0.485[a]	-3.09
Produced new products*SKL*time	0.016[c]	1.66	0.017[c]	1.87	0.027[a]	2.59
Regional strikes/100	-0.101	-1.37	-0.062	-0.85	-0.121	-1.62
Regional strikes*time	0.008	1.42	0.005	0.88	0.010[c]	1.72
Regional strikes*SKL	0.050	0.48	-0.054	-0.56	0.055	0.51
Regional strikes*SKL*time	-0.003	-0.41	0.004	0.48	-0.004	-0.48
Intercept	7.307[a]	5.00	8.586[a]	29.43	7.055[a]	3.62
N	7460		7460		7460	
R^2 within/ R^2 overall	0.088/0.073		0.080/0.034		0.136/0.039	

Notes: [a] significant at 1% level; [b] significant at 5% level; [c] significant at 10% level. SKL= non-manual workers including managers, professionals, associate professionals, clerks, service workers, and army specialists. Year dummies and 9 industry dummies are included but not shown here. Specifications 2 through 5 also include schooling, experience, and employee ownership. Time-invariant variables such as gender and location are dropped. The individual fixed effect model is estimated for 2,729-3,214 individuals. The firm fixed effect model is estimated for 764-891 firms.

Table 9: Augmented Wage Functions and Returns to a Managerial Job in the Linked Employer-Employee Data (Individual and Firm Fixed Effects, Russian Industry, 1985-2000)

	Individual Fixed Effect		*Firm Fixed Effect*		*Individual and Firm Fixed Effects*	
	Coeff.	***t***	***Coeff.***	***t***	***Coeff.***	***t***
Specification 1:						
Schooling (years)	0.004	0.07	0.015[b]	1.97	0.007	0.13
Schooling*time	0.003[a]	2.79	0.002[a]	3.07	0.002[b]	2.53
Experience (years)	0.040	0.76	0.024[a]	9.69	0.042	0.80
Experience squared / 100	-0.027[a]	-2.65	-0.041[a]	-8.36	-0.024[b]	-2.15
Employee has shares	0.048[c]	1.89	0.114[a]	5.13	0.046[c]	1.74
No information on employee shares	-0.006	-0.16	0.020	0.63	-0.013	-0.35
High-tech industries	0.046	0.39	0.411[a]	2.60	0.289[c]	1.67
High-tech industries*time	-0.017[c]	-1.78	-0.020[b]	-2.31	-0.020[b]	-1.99
High-tech industries*MGR	-0.203	-0.27	-0.826	-1.46	-0.180	-0.24
High-tech industries*MGR*time	0.002	0.03	0.040	0.77	-0.007	-0.11
High-tech industries*SKL	-0.190	-1.19	-0.312[a]	-2.64	-0.188	-1.02
High-tech industries*SKL*time	0.010	0.71	0.008	0.70	0.012	0.80
Profit zero or missing	0.171[a]	4.40	0.191[a]	4.88	0.196[a]	4.80
Profit positive	0.154[b]	2.42	0.260[a]	4.36	0.155[b]	2.31
Profit positive*time	-0.008[c]	-1.75	-0.010[b]	-2.27	-0.009[c]	-1.67
Profit positive*MGR	-0.403[b]	-2.51	-0.263[c]	-1.89	-0.367[b]	-2.24
Profit positive*MGR*time	0.028[b]	2.00	0.036[a]	2.90	0.025[c]	1.78
Profit positive*SKL	-0.219[a]	-3.00	-0.353[a]	-6.00	-0.223[a]	-2.91
Profit positive*SKL*time	0.018[a]	3.02	0.016[a]	3.09	0.019[a]	3.06
Intercept	8.531[a]	6.50	8.727[a]	25.41	8.792[a]	5.97
N	8087		8087		8087	
R^2 within/ R^2 overall	0.096/0.175		0.095/0.051		0.150/0.011	
Specification 2:						
Ever received FDI*time	0.004	0.60	0.001	0.06	0.011	1.21
Ever received FDI*MGR	-0.400	-0.65	-0.296	-0.84	-0.215	-0.35
Ever received FDI*MGR*time	0.048	1.36	0.055[c]	1.64	0.040	1.14
Ever received FDI*SKL	-0.375[b]	-1.97	-0.558[a]	-3.99	-0.211	-0.93
Ever received FDI*SKL*time	0.035[b]	2.45	0.041[a]	3.31	0.027[c]	1.74
Regional wage arrears	-0.070[b]	-2.03	-0.075[b]	-2.27	-0.066[c]	-1.87
Regional wage arrears*time	0.003	1.24	0.003	1.36	0.003	1.2
Regional wage arrears*MGR	-0.030	-0.21	0.220[c]	1.89	-0.028	-0.2
Regional wage arrears*MGR*time	0.004	0.45	-0.012	-1.50	0.004	0.43
Regional wage arrears*SKL	-0.029	-0.60	-0.128[a]	-3.00	-0.017	-0.35
Regional wage arrears*SKL*time	0.002	0.61	0.008[a]	2.69	0.001	0.35
Intercept	8.286[a]	6.34	8.972[a]	27.17	8.999[a]	6.21
N	8087		8087		8087	
R^2 within/ R^2 overall	0.091/0.185		0.086/0.071		0.143/0.040	

Specification 3:						
Ever invested abroad*time	0.028[a]	4.17	0.036[a]	5.00	0.033[a]	4.17
Ever invested abroad*MGR	0.408	0.71	0.590	1.58	0.438	0.75
Ever invested abroad*MGR*time	-0.022	-0.66	-0.028	-0.86	-0.028	-0.83
Ever invested abroad*SKL	-0.394[b]	-1.97	-0.003	-0.02	-0.369	-1.59
Ever invested abroad*SKL*time	0.008	0.61	0.002	0.19	0.001	0.04
Legal form (Closed joint stocks are omitted)						
State unitary	0.546[b]	2.54	0.598[a]	2.88	0.494[b]	2.26
Partnerships and coops	0.734[a]	2.76	0.839[a]	3.37	0.693[b]	2.54
Open joint stocks	0.339[c]	1.65	0.479[b]	2.41	0.337	1.60
State unitary*time	-0.045[a]	-2.63	-0.040[b]	-2.42	-0.033[c]	-1.89
Partnerships and coops*time	-0.064[a]	-3.09	-0.072[a]	-3.74	-0.061[a]	-2.89
Open joint stocks*time	-0.026	-1.62	-0.032[b]	-2.02	-0.020	-1.23
State unitary*MGR	-0.662[a]	-4.71	-0.364[a]	-3.13	-0.685[a]	-4.68
Partnerships and coops*MGR	0.173	0.15	0.386	0.33	0.008	0.01
Open joint stocks*MGR	-0.340	-0.73	-0.673	-1.61	-0.405	-0.87
State unitary*MGR*time	0.069[a]	4.32	0.047[a]	3.33	0.066[a]	3.90
Partnerships and coops*MGR*time	-0.020	-0.22	-0.017	-0.18	-0.009	-0.09
Open joint stocks*MGR*time	0.013	0.37	0.066[b]	2.08	0.017	0.47
State unitary*SKL	-0.217[a]	-3.46	-0.388[a]	-8.46	-0.250[a]	-3.75
Partnerships and coops*SKL	-0.451	-1.05	-0.241	-0.68	-0.338	-0.77
Open joint stocks*SKL	-0.321[c]	-1.90	-0.601[a]	-3.95	-0.335[c]	-1.95
State unitary*SKL*time	0.025[a]	3.75	0.023[a]	4.24	0.028[a]	3.94
Partnerships and coops*SKL*time	0.043	1.26	0.019	0.69	0.033	0.94
Open joint stocks*SKL*time	0.024[c]	1.91	0.033[a]	2.81	0.025[b]	1.97
Intercept	7.914[a]	6.04	8.360[a]	21.62	8.575[a]	5.94
N	8087		8087		8087	
R^2 within/ R^2 overall	0.101/0.183		0.101/0.089		0.155/0.031	
Specification 4:						
Log(labor productivity)	-0.004	-0.10	0.053	1.46	-0.003	-0.08
Log(labor productivity)*time	0.011[a]	3.56	0.008[a]	2.73	0.012[a]	3.56
Log(labor productivity)*MGR	-0.180[a]	-3.39	-0.092[b]	-2.07	-0.180[a]	-3.24
Log(labor productivity)*MGR*time	0.014[b]	2.31	0.007	1.51	0.014[b]	2.13
Log(labor productivity)*SKL	-0.087[a]	-3.28	-0.130[a]	-6.69	-0.093[a]	-3.35
Log(labor productivity)*SKL*time	0.007[b]	2.38	0.007[a]	3.40	0.007[b]	2.27
Ownership (State is omitted)						
Mixed	-0.493[b]	-2.35	-0.558[a]	-2.78	-0.520[b]	-2.43
Private	-0.436[b]	-2.12	-0.336[c]	-1.69	-0.487[b]	-2.32
Mixed*time	0.048[a]	2.75	0.051[a]	3.02	0.050[a]	2.79
Private*time	0.042[b]	2.55	0.027[c]	1.71	0.045[a]	2.69
Mixed*MGR	-0.203	-0.30	-0.990[c]	-1.83	-0.230	-0.34
Private*MGR	0.047	0.07	0.153	0.25	0.053	0.08
Mixed*MGR*time	0.001	0.02	0.096[b]	2.23	0.003	0.06
Private*MGR*time	-0.008	-0.17	0.002	0.05	-0.008	-0.17

Mixed*SKL	-0.125	-0.55	-0.170	-0.83	-0.134	-0.58
Private*SKL	-0.172	-0.71	-0.215	-0.98	-0.097	-0.40
Mixed*SKL*time	0.010	0.54	0.004	0.26	0.011	0.55
Private*SKL*time	0.011	0.59	0.013	0.79	0.005	0.28
Intercept	7.646[a]	5.17	8.398[a]	30.07	6.548[a]	3.35
N	6362		6362		6362	
R^2 within/ R^2 overall	0.119/0.171		0.112/0.080		0.152/0.175	
Specification 5:						
Produced new products*time	-0.004	-0.68	-0.010	-1.56	-0.013[c]	-1.89
Produced new products*MGR	0.209	0.18	-0.281	-0.48	0.053	0.05
Produced new products*MGR*time	-0.021	-0.22	0.056	0.94	-0.033	-0.33
Produced new products*SKL	-0.207	-1.62	-0.395[a]	-3.96	-0.485[a]	-3.09
Produced new products*SKL*time	0.016[c]	1.67	0.017[c]	1.88	0.027[a]	2.60
Regional strikes/100	-0.101	-1.38	-0.060	-0.83	-0.121	-1.62
Regional strikes*time	0.008	1.42	0.005	0.86	0.010[c]	1.72
Regional strikes*MGR	0.065	0.17	0.334	1.09	0.112	0.30
Regional strikes*MGR*time	-0.003	-0.09	-0.017	-0.71	-0.007	-0.23
Regional strikes*SKL	0.052	0.49	-0.085	-0.85	0.054	0.50
Regional strikes*SKL*time	-0.004	-0.43	0.005	0.71	-0.004	-0.48
Intercept	7.330[a]	5.01	8.996[a]	50.90	6.897[a]	3.44
N	7460		7460		7460	
R^2 within/ R^2 overall	0.088/0.074		0.083/0.030		0.136/0.047	

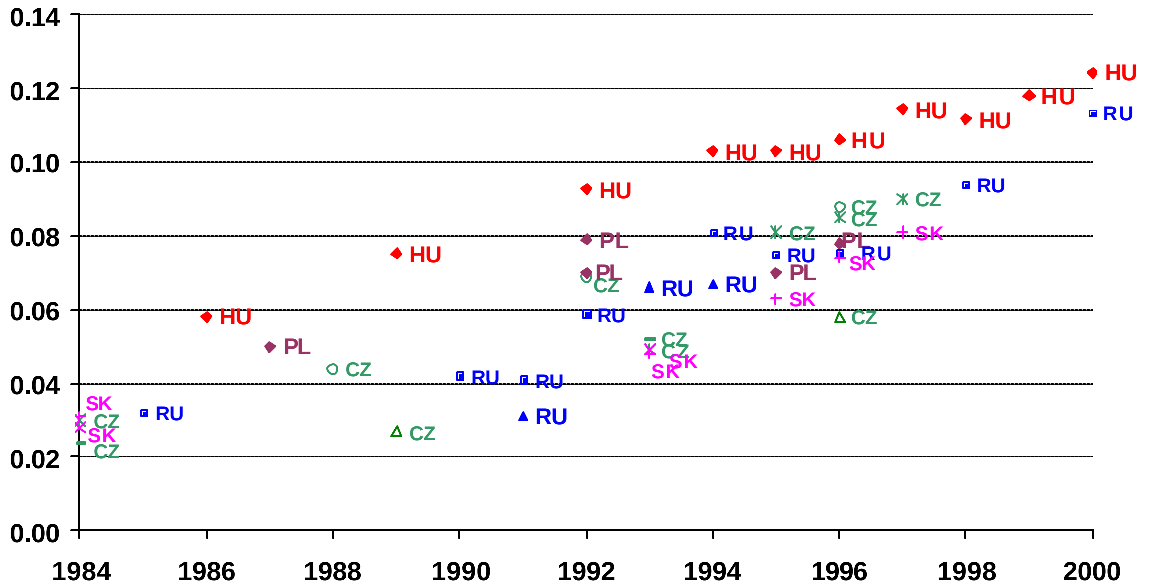
Notes: [a] significant at 1% level; [b] significant at 5% level; [c] significant at 10% level. MAN=managers; SKL=other non-manual workers including professionals, associate professionals, clerks, service workers, and army specialists. Year dummies and 9 industry dummies are included in all specifications but not shown here. Specifications 2 through 5 also include schooling, experience, and employee ownership. Time-invariant variables such as gender and location are dropped. The individual fixed effect model is estimated for 2,729-3,214 individuals. The firm fixed effect model is estimated for 764-891 firms.

Table 10: Decomposition of Changes in the Wage Ratio of Non-Manual to Manual Workers in the Russian Industry between 1992 and 2000

Period	*Total*	*Within*	*Between*	*Cross*	*Entry*	*Exit*	*N*
1992-2000	0.385	0.331	-0.019	-0.052	0.127	-0.002	38,919
1992-1996	0.146	0.139	-0.014	-0.015	0.039	-0.002	35,113
1996-2000	0.240	0.231	0.026	-0.053	0.045	-0.010	42,359

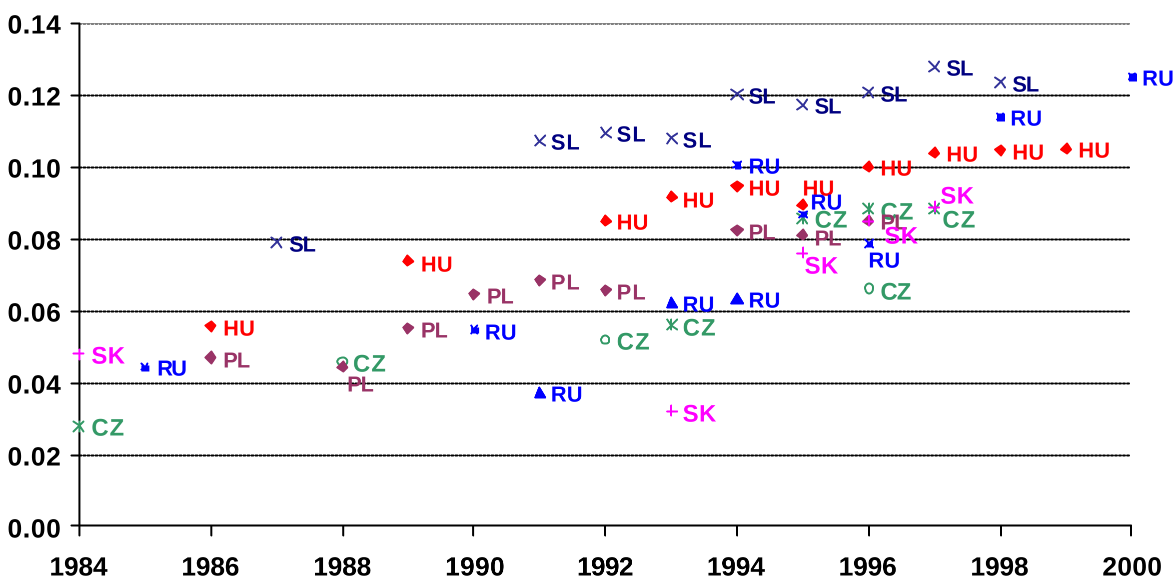
Notes: Decomposition has been performed on the set of industries and regions for which information is available for all years. Partially missing industries, such as defense industry and production of gold and precious metals, and partially missing regions, such as Ingush and Chechen Republics, are excluded from decomposition calculations.

Figure 1: Returns to a Year of Schooling in Transition Economies, 1984-2000



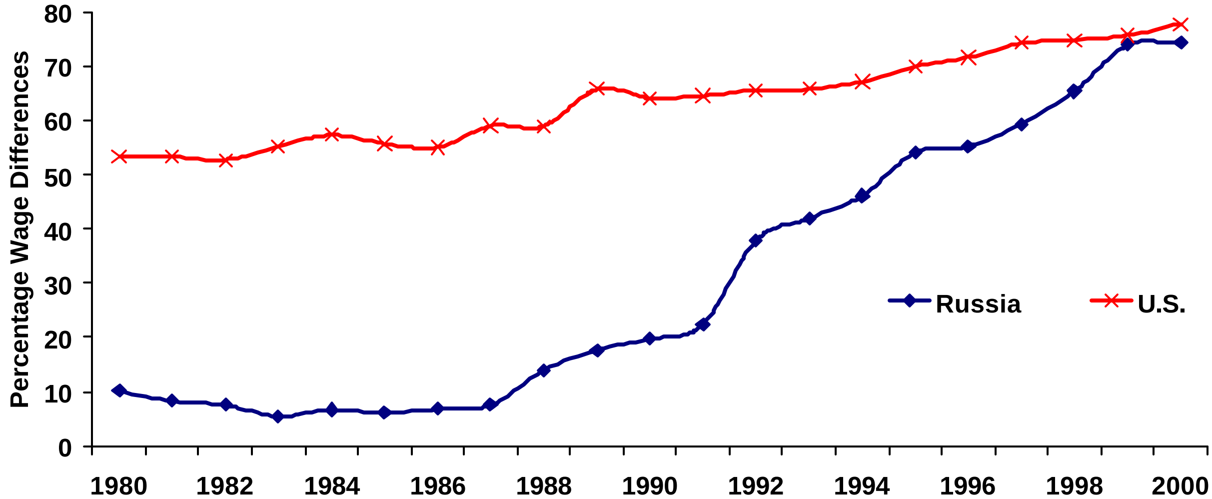
Notes: CZ=Czech Republic (Chase, 1998; Filer et al., 1999; Munich et al., 1999; Vecernik, 2001); HU=Hungary (Kertesi and Kollo, 2002); PL=Poland (Rutkowski, 1996); RU=Russia (Brainerd, 1998; author's calculations); SK=Slovak Republic (Chase, 1998; Filer et al., 1999).

Figure 2: Returns to a Year of University Education in Transition Economies, 1984-2000



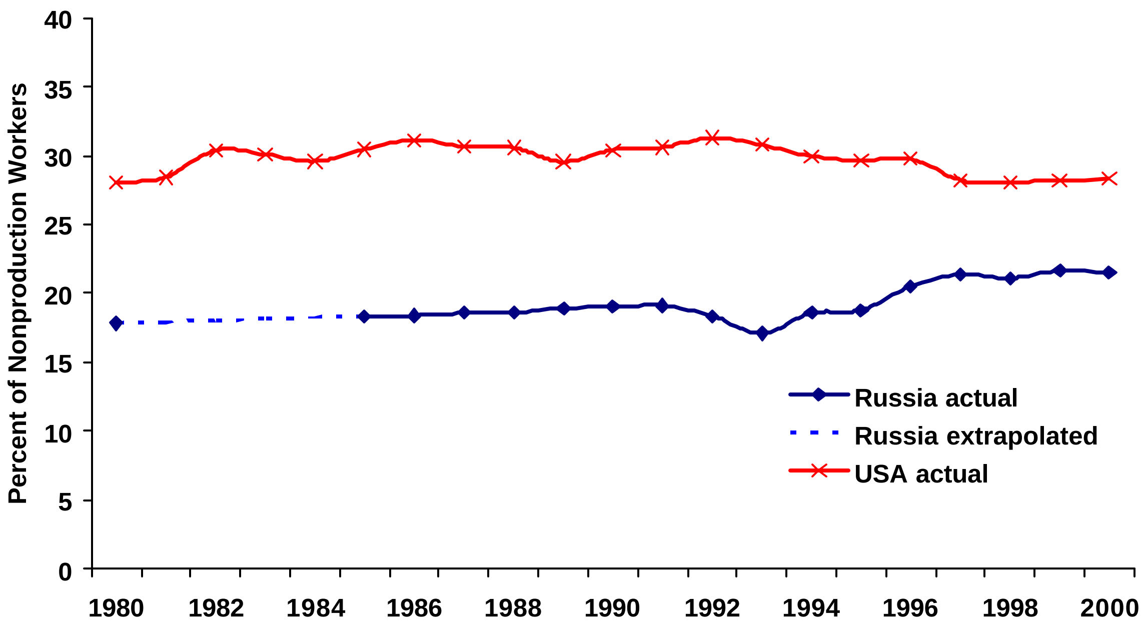
Notes: CZ=Czech Republic (Filer et al., 1999; Vecernik, 2001); HU=Hungary (Kertesi and Kollo, 2002); PL=Poland (Rutkowski, 1996); RU=Russia (Brainerd, 1998; author's calculations); SK=Slovak Republic (Filer et al., 1999); SL=Slovenia (Vodopivec, 2002).

Figure 3: Percentage Wage Differences between Non-Manual and Manual Workers in Russian Industry and U.S. Manufacturing, 1980-2000



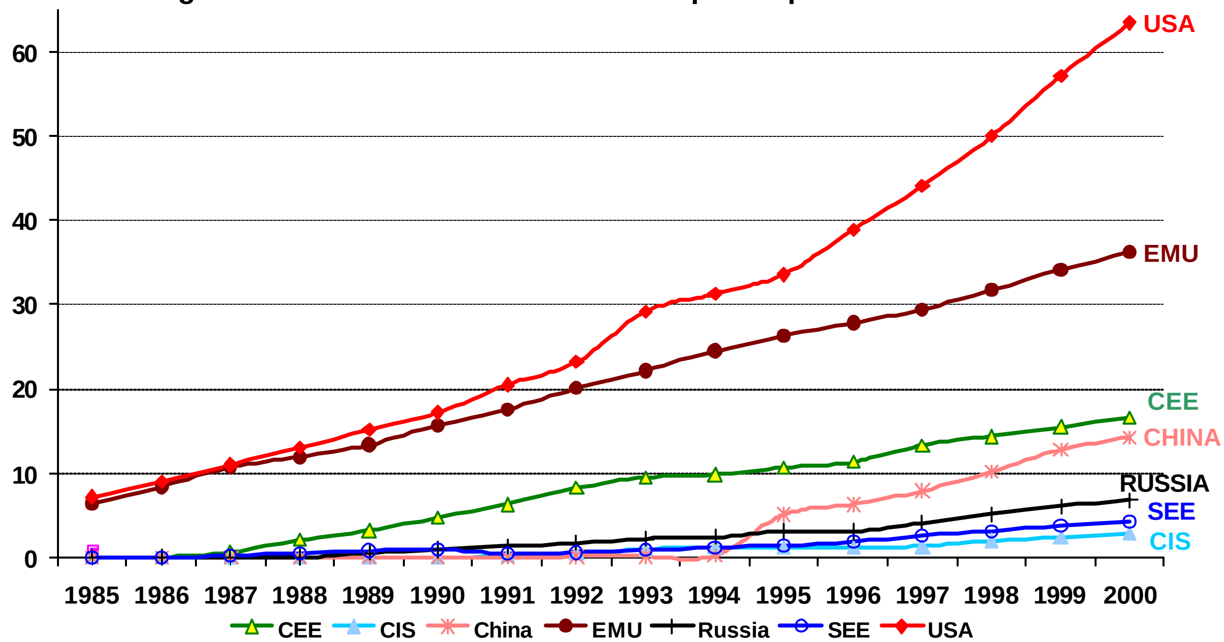
Sources: Goskomstat (1999 and 2001a); U.S. Annual Survey of Manufactures, February 2002.

Figure 4: Non-Manual Workers Share in Total Employment in Russian Industry and U.S. Manufacturing, 1980-2000



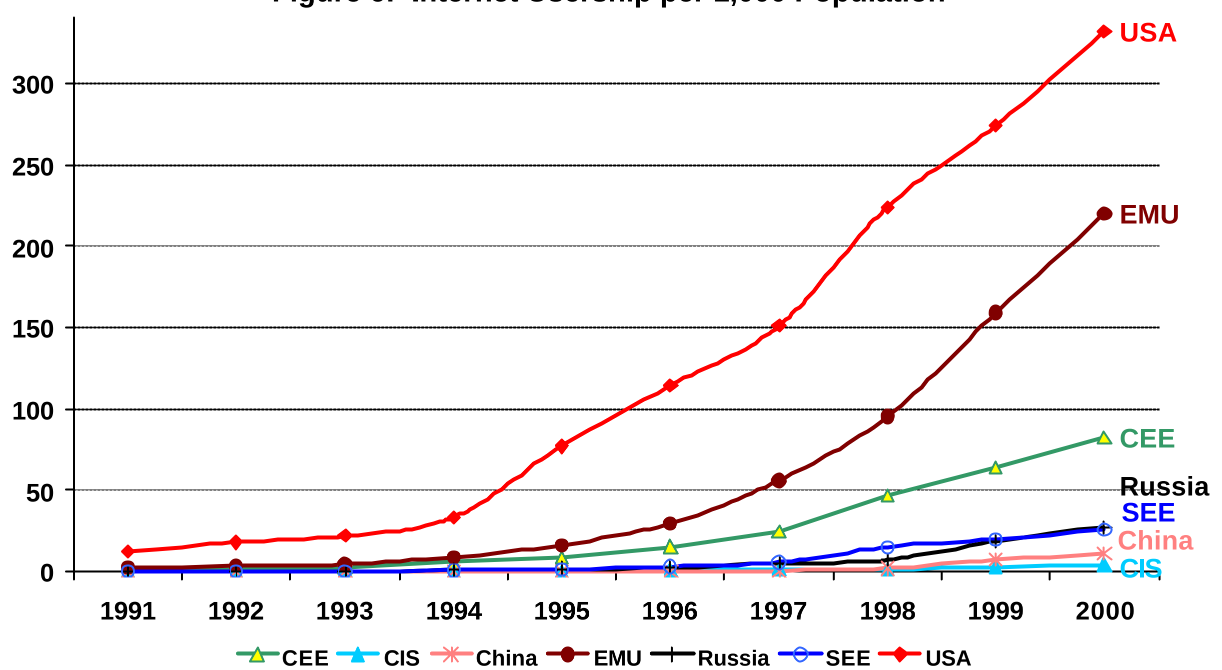
Sources: Goskomstat (2001b); U.S. Annual Survey of Manufactures, February 2002.

Figure 5: Possession of Personal Computers per 100 Households



Source: Euromonitor (www.euromonitor.com) and the author's calculations.
Notes: EMU=European Monatery Union; CEE=Central Eastern Europe (Czech Republic, Hungary, Poland, Slovakia, Slovenia, and former Czechoslovakia); SEE=South Eastern Europe (Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Macedonia, Romania, and Serbia and Montenegro); CIS=Commonweatlh of Independent States (all countries of the former Soviet Union except for Russia and the Baltic States).

Figure 6: Internet Usership per 1,000 Population



Source: Euromonitor (www.euromonitor.com) and the author's calculations.
Notes: EMU=European Monatery Union; CEE=Central Eastern Europe (Czech Republic, Hungary, Poland, Slovakia, Slovenia, and former Czechoslovakia); SEE=South Eastern Europe (Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Macedonia, Romania, and Serbia and Montenegro); CIS=Commonweatlh of Independent States (all countries of the former Soviet Union except for Russia and the Baltic States).

Figure 7: Skill Wage Premium Decomposition: Supply, Demand, and Institutional Factors

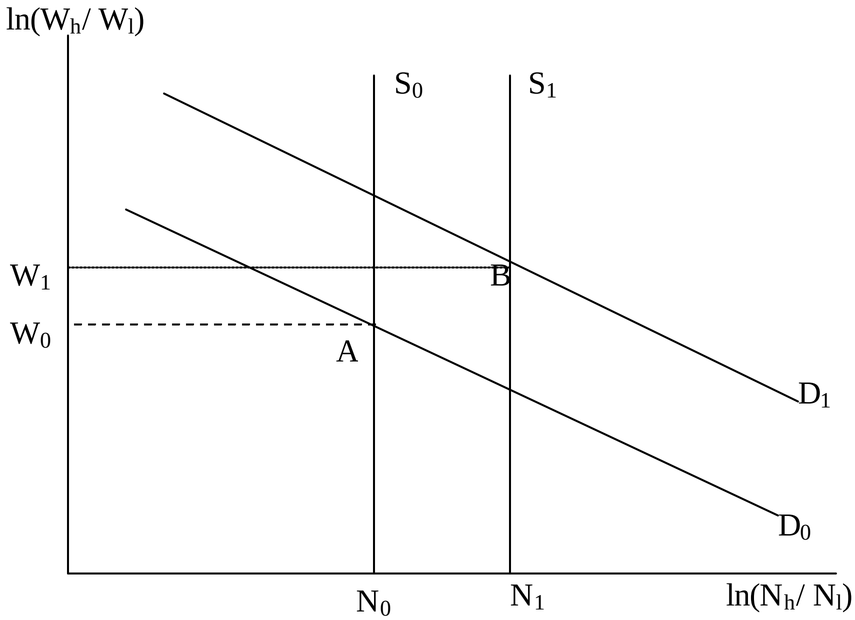
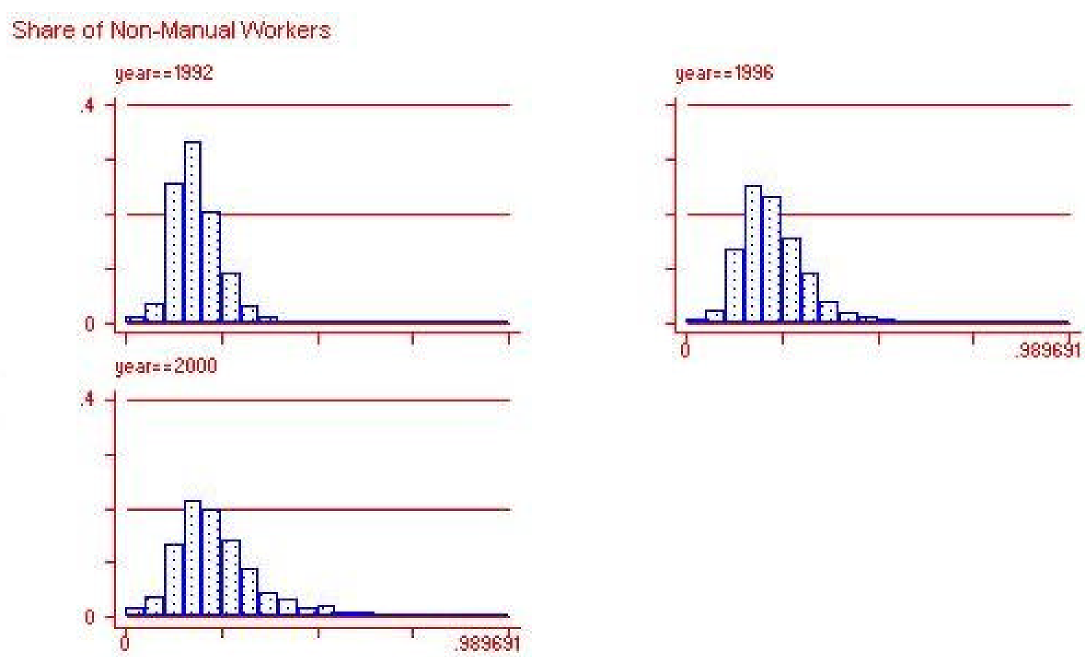


Figure 8: Distribution of Firms by the Share of Non-Manual Workers, Russian Industry



Appendix 1

High-Technology Industries in the Russian Industrial Classification

No single methodology for identifying high-technology industries exists. Most calculations rely on a comparison of R&D expenditures or the number of scientists, engineers, and technicians with industry value added or output. For instance, OECD identifies four industries as science-based industries whose products involve above-average levels of R&D: aerospace, computers and office machinery, communications equipment, and pharmaceuticals (OECD, 1993). Our classification of high-technology industries for Russia includes all 4- and 5-digit OKONH industries in which these four products are produced.

Industry	***Description***	***Industry Codes***
Aerospace	Manufacture and services (repair) of aircraft, helicopters, their equipment, and engines	14720 14961
Computing and High Precision Equipment	Manufacture of high precision equipment (14320 14913) - Manufacture of high-precision equipment for monitoring and regulation of technological processes - Manufacture and services of measurement equipment - Manufacture of optical equipment - Office machinery - Manufacture of equipment for research in physics, medicine, physiology, and biology Manufacture and centralized services of computing equipment, its parts, software, and other information technology (14330 14965)	14320 (14321-14329) 14330 (14331-14333) 14913 14965
Communications Equipment	Manufacture of electronic components, television, radio, and other communications equipment	14750 14760 14770 (14771 14772)
Microbiological and Medical Industry	Manufacture of medical equipment and microbiological products, including pharmaceuticals, medicinal chemicals, and botanical products	19100 (19110-19123) 19300 (19310-19330)

Other industries to consider as high-technology are manufacture of semi-conductors (12313), electrode components (12710), cables (17172), CDs (13145), and defense industry (14730).

Appendix 2
Identification of New Products[22]

This is the first study that identifies new products for all Russian industries. "New products" are defined as goods produced by Russian industrial firms in 1993-2000 but not produced in 1977 according to the 1977 Soviet Classification of Products. Specifically, new goods are detected by comparing the 1977 Soviet Classification of Products (1977 OKP) and the 2000 edition of the 1994 Russian Classification of Products (2000 OKP). The hard copy of the 1977 OKP was found in the Library of the State Standardization Committee of the Russian Federation (RF Gosstandart) and then it was scanned into an electronic database. This product classification is the oldest existing classification known to be stored in the government archive.

The latest classification of products (2000 OKP) was initially introduced in 1994 (with subsequent editions). It is created on the base of the previous Soviet Classification of Products, which was revised also in 1985. The two classifications have a similar general structure and employ the same methodology of product classification. Both OKP classifications represent the six-level hierarchical structure, in which the first level (2-digit OKP) stands for the product classes, the second level (3-digit OKP) - the subclasses of products, the third level (4-digit OKP) – the product groups, the fourth level (5-digit OKP) - the product subgroups, the fifth level (6-digit OKP) - the product types, and the sixth level (10-digit OKP) – the technical conditions of product manufacturing.[23]

The matching process of two classifications began with the merging of two files by their 6-digit product OKP and comparing the names of products. The computer program detected identical text entries for a significant number of the matched codes. Computer searches for key words identified a few additional matched pairs that represent the same products but have different spelling or word order, for instance "Box-calf ore - Ores for box-calf production". Finally, manual comparison detected extra pairs for the same product but with different wording (e.g., "Materials from polyvinyl chloride, in sheets – Sheets from polyvinyl chloride"). 2,497 of 2,932 product entries from the Registry of Industrial Enterprises are matched by this method with certainty.

This leaves us with the 435 codes from the 2000 OKP that have different name in the 1977 OKP or do not exist in the old classification. Because of possible changes in the OKP codes between 1977 and 2000 classifications, we had to search the remaining products in the rest of the 1977 OKP. This method detected 134 additional matched pairs.

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[22] Appendix 2 is prepared jointly with Viktor Orekhov. An idea of identifying new products by this methodology came from Chong Xiang who implemented a similar approach in determining new products in U.S. manufacturing (Xiang, 2002).

[23] For example, 91 0000 0000 – products of food industry,
91 1000 0000 – products of sugar and bread industry,
91 1100 0000 – sugar
91 1110 0000 – raw sugar
91 1111 0000 – raw sugar from beats
91 1111 0001 – raw sugar from beats produced by the tolling scheme

The residual 301 products in the 2000 OKP are checked manually and classified as follows:

- **New (N=106):** These entries have no key words or equivalent definitions in the old 1977 OKP. They also belong to the aggregate groups that are highly sensitive to technological changes. In addition, this category includes entries that were added during 1995-2000 revisions. Examples include video recorders, video cameras for individual consumers, CDs for laser digital recorders, etc.
- **Possibly new (N=30):** These entries have no key words or equivalent definitions in the old 1977 OKP. They typically belong to the aggregate groups and subgroups that exist in the 1977 OKP but represent products in addition to the existing product types. Examples include air cleaners for individual consumers, home freezers, chewing gums, etc.
- **Old (N=165):** These entries are not matched with the 1977 OKP but they cannot be considered as new. Typically these products have similar (but not the same) names in the old 1977 OKP. Some of them are obviously old products.

Appendix 3
Measurement Error in the RPP Data

Even after applying considerable effort toward data cleaning and consistency checks (see footnote 12), one has to pay attention to potential measurement errors in the data. Especially long-term longitudinal data from the transition economies are likely to suffer from reporting errors caused by numerous changes in statistical forms, classifications, methodology, and data collection process. It is commonly known that fixed effect estimates may aggravate inconsistencies due to the measurement error (see Griliches and Hausman, 1984; Baltagi, 1995). To understand the effect of measurement error on our estimates, we can use additional information on the same variable as instrumental variables. This solution to the measurement error problem is sometimes called the multiple indicator solution (see Wooldridge, 2002).

Suppose that X_{jt} is a true unobservable measure of our variable of interest. Instead of the true measure, we observe current year values reported by firm *j* in current year $t\left(X_{jt}^{t}\right)$ and current year values reported by firm *j* in next year $t{+}1\left(X_{jt}^{t+1}\right)$. Without the measurement error, the difference between these two measures could be due to either changes in firm boundaries $\left(B_{jt+1}\right)$ or changes in reporting methodology $\left(M_{jt+1}\right)$.[24]

Thus, we have two error-contained measures of true values of X_{jt}:

$$X_{jt}^{t} = X_{jt} + e_{jt}^{t} \text{ and } X_{jt}^{t+1} = X_{jt} + B_{jt+1} + M_{jt+1} + e_{jt}^{t+1},$$

where *e*'s are pure measurement (misreporting) errors.

Assuming that both measures have uncorrelated error terms, we can use one measure as a valid IV for another one to correct for the measurement error.

$$Corr\left(e_{jt}^{t}, e_{jt}^{t+1}\right) = 0$$

Unfortunately, such method would lead to a significant reduction of our sample because of missing previous year reports and dropping the last year (2000), for which no current year reports from next year are available. As an alternative, at least we can try to determine the magnitude and direction of the measurement bias by comparing two sets of estimates for the smaller sample.

First, I note that two measures of output, capital, employment, wage bill, and profit are highly correlated.

$$Corr\left(X_{jt}^{t}, X_{jt}^{t+1}\right)$$

Output	= 0.9042	Total wage bill	= 0.9685
Capital	= 0.9518	Profit	= 0.9364
Employment	= 0.9898	Profit dummy	= 0.8582

[24] According to Goskomstat rules, enterprises have to report the previous year values based on the current year firm boundaries and current year reporting methodology.

Table A1 shows the re-estimated equation 9, in which alternative measures of average labor productivity, capital/output ratio, and a profit dummy are used as instruments. Based on the Hausman test, we can not reject H_0 that the differences in coefficients are not systematic. The effect of measurement error on the estimated equations does not appear to be statistically significant. Although coefficients are quite close to each other, we observe that some fixed effect coefficients tend to be attenuated due to classical error-in-variables.

Table A1: The Effect of Measurement Error on the Estimated Equations for Relative Wages, Russian Industrial Firms, 1992-1999

Dependent Variable – Log (Wage ratio)	***Firm Fixed Effect***		***Firm Fixed Effect with IV***	
	Coeff.	***t***	***Coeff.***	***t***
Log(employment ratio)	-0.3318[a]	-97.91	-0.3330[a]	-97.58
Capital/output	0.0192[a]	5.38	0.0237[a]	4.14
Capital/output*time	0.0031[a]	5.34	0.0038[a]	5.10
High-tech industries	-0.0110	-0.36	-0.0103	-0.34
High-tech industries*time	0.0191[a]	6.26	0.0187[a]	6.12
Ever received FDI*time	0.0085[a]	2.66	0.0083[a]	2.62
Labor productivity	-0.0055	-1.34	0.0003	0.04
Labor productivity*time	0.0007	1.10	0.0010	1.30
Profit (negative profit is omitted)				
Positive	-0.0276[a]	-3.46	-0.0482[a]	-2.34
Positive*time	0.0050[a]	3.09	0.0081[a]	2.35
Missing or zero	-0.0289[a]	-1.76	-0.0445[a]	-2.02
Missing or zero*time	0.0001	0.02	0.0026	0.59
Ownership (state is omitted)				
Mixed	-0.0405[a]	-6.18	-0.0403[a]	-6.14
Mixed*time	0.0137[a]	8.04	0.0135[a]	7.88
Private	-0.0363[a]	-4.66	-0.0366[a]	-4.71
Private*time	0.0123[a]	7.16	0.0123[a]	7.13
Intercept	-0.0711[a]	-1.87	-0.0590	-1.39
Hausman test – IVFE vs. FE	$chi^2(30) = 34.45$ (Prob>chi^2 = 0.2633)			
R^2 overall	0.065		0.063	
N	142,973		142,973	

Note: [a] significant at 1% level; [b] significant at 5% level; [c] significant at 10% level. Year dummies, 9 industry dummies, and a dummy for 1992 capital/output mismeasurement are included but not shown here (see description in the text). The estimated equation contains the same set of variables as specification 1 in Table 7. Sample (N) consists of industrial firms with non-missing reports of previous year values. Capital/output ratio, labor productivity, a profit variable, and their interactions with time trend are instrumented with alternative measures taken from next year reports of previous year values.

Appendix 4
Recall Bias in RLMS

The information on occupation and jobs in the pre-transition era (1985 and 1990) is based on retrospective data collected in 2000. Respondents' answers may suffer, therefore, from recall errors (see Akerlof and Yellen, 1985; Evans and Leighton, 1995). Although stable salaries and strong attachment of Russian worker to one job in the Soviet period reduce the recall error, one has to consider potential retrospective biases.

Our approach in analyzing the effect of the recall error on the estimates is to use the multiple indicator solution, as described in Appendix 3. I exploit the fact that identical questions on occupations and jobs in 1985 and 1991 were asked the same respondents two years earlier, in 1998.

Suppose that $\left(X_{it}\right)$ is a true unobservable occupation or job in year *t* (*t*=1985 or *t*=1990). Instead of the true measure, we observe two answers of respondent *i* in 1998 and 2000 $\left(X_{it}^{2000} \text{ and } X_{it}^{1998}\right)$:

1985	*1990*
$X_{i,1985}^{2000} = X_{i,1985} + r_{i,1985}^{2000}$	$X_{i,1990}^{2000} = X_{i,1990} + r_{i,1990}^{2000}$
$X_{i,1985}^{1998} = X_{i,1985} + r_{i,1985}^{1998}$	$X_{i,1990}^{1998} = X_{i,1990} + \Delta J_{i,1990-91} + r_{i,1990}^{1998}$

where *r*'s are recall errors.

For 1985, the difference between these two measures is the difference between two recall errors. For 1990, the difference could be also due to real changes in jobs and occupations between 1990 and 1991 $\left(\Delta J_{i,1990-91}\right)$.

Table A2 shows a relatively high percentage of identical answers given by respondents during two different surveys on occupation and job in the pre-transition period. Table A2 does not reveal any discrepancies between occupational measures at the 1-digit level that I use in classifying manual and non-manual employees. Thus, occupational variables are unlikely to cause retrospective biases in the estimates. However, biased estimates might arise from inconsistent answers concerning the name of the employer. This could lead not only to different firm characteristics but also to a different sample of firms in the linked employer-employee data.

To determine the effect of recall error on the augmented wage functions and returns to a skilled job, one solution is to estimate alternative specifications with the set of firms and firm characteristics taken from the 1998 survey and then to apply the Hausman test to see how significant the differences in coefficients are.

Table A3 reports alternative estimates of augmented wage functions that use two job measures from 1998 and 2000 surveys. Based on the Hausman test, we can not reject H_0 that the differences in coefficients are not systematic in four of five specifications. Only the last specification shows statistically significant differences in coefficients. Because the coefficients in the last specification have the same sign and they are close in their magnitude, these differences will not effect interpretation of our results. Thus, the effect of recall error on the estimated equations does not appear to be significant.

Table A2: Percent of Identical Answers on Occupation, Industry, and Firm Name

		All Sample		*Linked Employer-Employee Sample*	
		1985	***1990-1991***	***1985***	***1990-1991***
Occupation	4-digit	72.3	69.9	70.6	67.4
	3-digit	74.7	72.6	73.4	70.4
	2-digit	78.3	76.9	77.0	75.4
	1-digit	100.0	100.0	100.0	100.0
N		[3666]	[3644]	[996]	[1004]
Industry	4-digit	87.8	87.1	88.5	86.7
	3-digit	88.2	87.6	88.6	87.0
	2-digit	89.1	88.9	89.8	88.5
	1-digit	91.0	91.3	92.4	91.7
N		[3562]	[3557]	[992]	[1001]
Identification of firm		89.1	88.8	88.2	86.0
N		[2220]	[2247]	[994]	[1005]

Table A3: The Effect of Recall Error on Augmented Wage Functions and Returns to a Skilled Job in the Linked Employer-Employee Data
(Individual Fixed Effects, Russian Industry, 1985-2000)

	Primary Job Measures (2000 Survey)		***Alternative Job Measures (1998 Survey)***	
	Coeff.	***t***	***Coeff.***	***t***
Specification 1:				
Schooling (years)	0.002	0.04	0.004	0.08
Schooling*time	0.003[a]	2.92	0.003[a]	3.37
Experience (years)	0.043	0.81	0.053	1.00
Experience squared / 100	-0.029[a]	-2.65	-0.032[a]	-2.92
Employee has shares	0.058[b]	2.24	0.058[b]	2.24
No information on employee shares	-0.004	-0.11	-0.004	-0.11
High-tech industries	0.025	0.20	0.066	0.52
High-tech industries*time	-0.015	-1.54	-0.016[c]	-1.66
High-tech industries*SKL	-0.192	-1.18	-0.292[c]	-1.77
High-tech industries*SKL*time	0.007	0.50	0.012	0.87
Profit zero or missing	0.170[a]	4.27	0.189[a]	4.79
Profit positive	0.137[b]	2.05	0.143[b]	2.13
Profit positive*time	-0.008	-1.47	-0.008	-1.57
Profit positive*SKL	-0.230[a]	-3.03	-0.158[b]	-2.12
Profit positive*SKL*time	0.018[a]	2.97	0.013[b]	2.08
Intercept	8.595	6.58	8.495[a]	6.49
N	7729		7682	
R^2 within/ R^2 overall	0.095/0.162		0.095/0.144	
	Hausman Test		***P-value***	
Specification 1	Chi^2 (29) = 10.09		0.9996	
Specification 2	Chi^2 (26) = 29.48		0.2898	
Specification 3	Chi^2 (34) = 21.22		0.9572	
Specification 4	Chi^2 (30) = 30.11		0.4600	
Specification 5	Chi^2 (24) = 47.81		0.0027	

Notes: [a] significant at 1% level; [b] significant at 5% level; [c] significant at 10% level. SKL= non-manual workers including managers, professionals, associate professionals, clerks, service workers, and army specialists. Year dummies and 9 industry dummies are included but not shown here. All specifications contain the same set of variables as in Table 8. The sample (N) consists of respondents participated in both surveys.

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