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Do Wages Grow with Experience? Deciphering the Russian Puzzle

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DISCUSSION PAPER SERIES

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Deciphering the Russian Puzzle**

Yevgenia Chernina
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ABSTRACT

Do Wages Grow with Experience? Deciphering the Russian Puzzle

The study explores how wages grow with experience in the Russian Federation. In all available cross-sectional data, the trajectory of the observed wage–experience profile is flat, peaks early, and declines sharply afterwards. This shape looks puzzling since it differs starkly from that observed in both developed and developing countries. We show that a proper interpretation of the wage–experience profile is hindered by the APC problem, when the effects of time, cohort, and experience are mixed. Our study uses data from the RLMS-HSE household survey covering the years 2000-2019. Relying on human capital theory, we apply a procedure suggested by Heckman et al. (1998) and advanced in Lagakos et al. (2018) to disentangle the APC effects. With certain assumptions concerning human capital depreciation due to aging, our results show that Russian wages do grow monotonically with experience. However, this growth is partially offset by the cohort effect that proceeds in the opposite direction, thus reflecting massive depreciation of the human capital of workers from older cohorts. Meanwhile, the time effect mirrors the general GDP path as well as all booms and busts over the period.

JEL Classification: J24, J31

Keywords: the human capital, wages, experience, wage–experience profile, Russia

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1. Introduction¹

The positive and concave relationship between log earnings and experience has been, starting probably with the seminal work of J. Mincer, and still is one of the stylized facts of labor economics. As Mincer wrote, “The basic features of the age profiles are easily summarized: except for the initial years of gainful activity, earnings are higher at higher levels of schooling, and increase with age through much of the working life. The absolute and, more consistently, relative rate of increase in annual earnings diminishes with age, becoming negative, if it changes at all, during the last decade of working life. There is no visible decline at these later ages in weekly earnings. Apparently, declines in weeks worked per year are the main factor in the decline of annual earnings during the preretirement years” (Mincer 1974). Twenty years later, Neumark (1995) mentioned that the rising and concave earnings profile over much of the life-cycle is “one of the most robust findings in labor economics”. The recent OECD work, where key adult skills such as literacy, numeracy, and problem-solving are thoroughly controlled for, provides additional confirmation of this association (Pacagnella 2016). The conventional profile was confirmed once again in a large-scale cross-country study of the World Bank (see Jedwab et al. 2021). The list of empirical evidence in support of this finding is extensive.

The consensus view has a well-established basis both in theory and in empirical work. On the theoretical side, as pointed out by Rubinstein and Weiss (2006) in their thorough review of the literature, virtually all well-established theories have similar predictions regarding the shape of the post-school wage growth. Both human capital theory, which was the original source of inspiration for Mincer’s work, and search and matching models make similar predictions regarding the overall shape of wage profiles over the life cycle. The same is true for agency models with deterred remuneration in which employers need time to learn about the true ability of workers.

On the empirical side, almost all evidence on wage growth profiles have overwhelmingly verified the early findings of an increasing and concave relationship between earnings and age or experience (Rubinstein, Weiss 2006; Hutchens 1989; Johnson, Neumark 1996; Myck 2010; OECD 2016, among many others). However, most (if not all) studies focus on a handful of rich and most developed countries.

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The recent paper by Lagakos et al. (2018a) is probably the first to systematically compare life-cycle wage growth across countries with different income levels. In this study, the authors also try to identify the contribution of experience, isolating it from contaminating cohort and time effects. They find that although the increasing and concave earnings–experience relationship is present in all countries in their sample, the profiles’ trajectories are substantially steeper in richer countries than in poorer ones. The variation in profile shapes may reflect the differences in both quality of supplied human capital as well as demand for it and job-related opportunities for its accumulation. If a job provides little room for learning and advancement, new skills are unlikely to emerge. According to Lagakos et al. (2018a), “Workers in poor countries may simply have fewer opportunities for learning because of the nature of occupations or tasks they perform” (p.845). “Fewer opportunities” can mean that the explanation, at least partially, relates to the demand side and the quality of available jobs. This can affect the quantity as well as the quality of human capital. Confirming the finding, their companion article explores the utilization of human capital by immigrants in the U.S. labor market, which was partially accumulated in their native countries (Lagakos et al. 2018b).

None of the post-transition countries have been rigorously explored from this angle, although their cases can illuminate how human capital is accumulated and utilized under different politico-economic regimes. There are multiple reasons to believe that in these economies, wage profiles can have specific properties and that they are likely to differ from those in both advanced and developing economies. The transition from planned to market economy strongly affected the previously accumulated human capital and its further accumulation and utilization. As a result, much of the human capital in the form of knowledge and skills became obsolete and was offered at much lower market prices. This initial wage experience profile is expected to mirror this process.

This paper focuses on Russia, the largest and most populated country in the post-socialist world. Some empirical evidence documents that Russian wages peak early and then decline rapidly (Gimpelson, Kapeliushnikov 2011; Gimpelson 2019; Gimpelson, Zinchenko 2019), thus creating the pattern that diverges from the stylized one.

If the existing cross-sectional evidence was interpreted as showing how wages evolve over the working life, it would suggest that the loss of the Russian human capital, owing to depreciation, starts too early and is not compensated by new investments in education and skills. It results in very low market values for the obsolete skills, and there is evidence in favor of this interpretation. According to Gimpelson (2019), Russian workers receive little on-the-job training, have low wage-enhancing job mobility in later years of the career (Gimpelson et al. 2016), and experience age-related health problems that affect productivity (Kaneva et al. 2019). Still, all these reasons do

not seem to be convincing enough for explaining such drastic and early wage decline that we have been observing in the data. Many countries facing the same problems exhibit quite conventional wage profiles.

However, any cross-sectional wage–experience profile mixes two different effects. One reflects the actual effect of experience (or age) brought by the human capital accumulation and depreciation. The other one mirrors belonging to particular cohorts. That is, the effect of skills, ideas, values, and norms of that time when individuals are socialized, educated, and enter the labor market. Growing up during a recession or boom, or under a particular politico-institutional regime can make the difference (Giuliani, Spilimbergo 2014; Alesina, Fuchs-Schündeln 2002). We also see a mix when we follow the wage evolution within the same cohort; in this case, the effects of experience and time.

Strong multicollinearity of age-period-cohort, known as the APC problem, cannot be solved by purely technical means. For disentangling the APC effects, one needs to introduce certain identifying assumptions. In this paper, we employ the idea suggested by Heckman et al. (1998) that relies on life-cycle predictions of the human capital theory (Ben-Porath 1967). According to this idea, human capital investments depend on the period over which individuals expect to gain returns. As an individual approaches retirement age, the period of return shortens, disincentivizing further human capital investments. Therefore, the effect of experience on wage growth without additional investments tends to evaporate. Looking at this pre-retirement period from within a cohort, we set the cohort effect to zero. Thus, the whole observed wage growth within this spell can be attributed to the time effect plus the depreciation of the existing human capital stock. Once identified, the other two effects can also be derived. Lagakos et al. (2018a) put this idea to the test by using large empirical data sets.

Our analysis utilizes a series of cross-sections from the 2000-2019 RLMS-HSE data. At first glance, the “raw” profile, without controlling for other characteristics and without separating the APC effects, looks rather flat and does not show an expected increase in wages with experience. Moreover, workers’ earnings by the end of their working career appear to be significantly lower than earnings observed in the middle of the life cycle. Profiles separated by education, as well as those obtained using the Mincer equation, tell us a similar story. This depicts a situation that differs significantly from that observed in advanced market economies. However, the separation of the APC effects may give a clue to this seemingly non-standard pattern. The strong cohort effect, acting oppositely to the experience/age effect, nets out the latter and makes the “raw” profile flat and decreasing during the second half of working life.

We contribute to the discussion on human capital accumulation in the post-transition countries by disentangling the effects of experience, cohort, and time for Russia. To our knowledge, this study is among the first that separates these effects. Our results suggest that cross-sectional evidence exaggerates the extent of aging-driven human capital destruction. As we show, the early peak and decline in the Russian wage profile hide a superposition of experience and cohort effects that act in the opposite directions. While a longer labor market experience boosts the human capital and, correspondingly, wages, belonging to older cohorts nets out these advantages. We suggest that this reflects the obsolescence of knowledge and skills acquired by individuals before or at the early stages of their transition to the market economy. Our results call for a deeper analysis of how older cohorts, that gained their experience working in the planned economy, adapt to the new market conditions.

The paper is structured in the following way. It consists of seven sections, including the introduction and conclusion. In Section 2, we overview relevant theoretical and empirical literature. In particular, we explain in detail how the experience, cohort, and time effects can be interpreted and understood. Section 3 provides a concise insight into the post-soviet development of the Russian labor market and its implications for wage growth. Section 4 introduces the data sets and main variables of interest. In Section 5, we present and discuss empirical results. Section 6 reports the results of the robustness checks.

2. Overview of the literature

Early evidence on relationships between wage/experience and earnings documented in the literature relied on cross-sectional data. Rodgers et al. (1997) refer to the cross-sectional age–wage profile as mentioned in Alfred Marshall’s “Principles ...”. Starting with Mincer (1974), researchers have derived the experience-earnings profile from the Mincerian-type equation. All cross-sectional data reveal an inverse U-shaped profile with a steep increase at the early stage of working life, followed by a slow-down and a modest decrease in the pre-retirement age. Later scholars began to separate general labor market experience from job-specific experience or tenure (Hutchens 1989), but this did not change the basic pattern.

Though these findings seem very robust, the estimates can vary depending on whether one looks at annual, monthly, or hourly earnings, whether part-time workers are included or not, and what functional form in the econometric specification is used (Murphy, Welch 1990; Casanova 2013; Rupert, Zanella 2015). Another important issue is whether the stock of human capital is properly controlled for. The recent OECD study that utilizes the PIAAC data for controlling skills of adults shows wage growth over the whole working life (Paccagnella 2016). Finally, there is an issue of

non-random selection into employment, specifically at later stages of the career (Rupert, Zanella 2015; Myck 2010).

The question of falling wages in pre-retirement years received special attention in the literature. Early studies relying on cross-sectional data document some decline in earnings at the end of the working career (see Willis 1986). A potential explanation for this decline is the productivity gap between younger and older cohorts, besides other factors. Some studies relied on longitudinal data and analyzed separate cohorts to receive more consistent results (Rupert, Zanella 2015; Johnson, Neumark 1996). Although this approach does not allow researchers to isolate the wage profiles by experience from the confounding effect of time. There are also studies that try to clear the effect of experience from both effects of time and cohort (Hanoch, Honig 1985; Lagakos et al. 2018a; Jedwab et al. 2021). These studies show that any wage decline, if this emerges, starts at later age and appears to be small in size.

Among all above-mentioned studies, only the contributions of Lagakos et al. (2018a), Jedwab et al. (2021), and Fang and Qiu (2021) used data from developing economies. The recent work by Lagakos et al. (2018a) presents probably the first systematic cross-country examination of the life-cycle wage evolution beyond the OECD countries. All countries included in their sample have conventional rising and concave profiles, but the profiles of the rich countries are significantly steeper than the profiles of the poorer ones. The differences may reflect variation in initial human capital endowments as well as differences in human capital accumulation over the period of the working life. As the authors note, workers in poor countries have fewer opportunities for education, training, and learning due to the nature and lesser complexity of jobs they occupy.

Components of life-cycle wage growth: experience, cohorts, and time

A well-known complexity in interpreting life-cycle wage growth using cross-sectional or panel data is in perfect multicollinearity of age/experience, cohort, and period/time. The relationship between these three variables makes an identity as $P(\text{period}) = A(\text{age/experience}) + C(\text{cohort})$. We mix age/experience and cohort effects in any cross-section, while in a panel data, the effect of age/experience is merged with the time effect. Each of these effects has its own interpretation and can contribute to shaping the observed wage profile. Disentangling their contributions becomes an important and non-trivial research task. Therefore, we provide an explanation of how we understand separate APC effects before moving on to the empirical part of the paper.

Experience effect

In the course of working lives, individuals tend to learn their skills by doing and through on-the-job training. The accumulated experience leads to higher personal productivity and,

correspondingly, higher wages. We call this the *labor market experience effect* (Thornton, Rodgers, 1997).

In their detailed survey, Rubinstein and Weiss (2006) note that at least three major theoretical approaches explain the concavity of wage profiles, suggesting particular channels through which experience affects earnings.

The first one is rooted in the human capital theory (Becker 1975; Ben-Porath 1967; Mincer 1974). The offered wage can be thought of as a product of the human capital stock and the market renting rate for a unit of human capital. Wage evolution over the life cycle reflects the dynamic nature of human capital accumulation (formal education and on the job training, learning by doing) and its depreciation (loss of health and cognitive decline, costs of retraining growing with age, etc.). As retirement gets closer, potential gains from investments in the human capital shrink and the stock of knowledge and skills acquired earlier is becoming obsolete. Under these conditions, labor productivity is likely to stagnate, if not decline. Wage value follows along the same path.

Another way to explain the wage evolution is to look through the lens of the search theory (Pissarides 1985; Mortensen 1986; Mortensen 1988; Mortensen, Pissarides 1999). This type of a model incorporates search and mobility costs as well as other factors that can affect workers' mobility. Within this framework, labor mobility drives earnings growth but is likely to subside with age/experience as costs of job change increase and expected gains decrease. Decline in mobility throughout the life cycle can explain decaying wage growth in the pre-retirement stage.

The third approach addresses the evolution of earnings through the contract theory (see the survey in Rubinstein and Weiss (2006). Unlike the first two, it does not assume unambiguous association between wages and productivity but it describes wage growth as an outcome of long-term interaction between firms and workers. This type of a model accounts for different risk attitudes among workers and employers and informational asymmetry concerning the workers' productivity. Employers monitor observed productivity for updating their evaluation of workers' abilities, so that the most efficient workers are likely to get promoted. This strategy prevents quitting and opportunistic behavior. In this framework, the key factor driving the wage growth is updated information about workers' productivity, not additional investments or job offers. Therefore, longer experience brings additional information and contributes to wage growth over the life cycle. However, this approach is useless in predicting a particular shape of the wage profile.

There are also studies that decompose empirically the growth of wages with experience into components associated with the theories described above. According to Altonji et al. (2013), in the U.S. around 70% of the wage growth over the first 30 years of career comes from the life-cycle

accumulation of human capital. According to their calculations, the rest is almost equally divided between job mobility and the accumulation of tenure. Topel and Ward (1992) found that job to job mobility explains about one-third of the wage growth during the first 10 years of labor market experience. Bowlus and Liu (2013) estimated that human capital accumulation accounts for 50% of total earnings growth over the life cycle, job search accounts for 20%, while the remaining 30% is due to the interactions of the two.

Cohort effect

Cohorts are defined by birth years. Sherwin Rosen uses the term “vintage”, and in his model the cohort effect reflects conditions in which the initial stock of human capital was generated and utilized and the cohort-specific component of returns to human capital (Rosen 1975). All individuals belonging to a particular cohort grow up at the same time, get educated at the same knowledge frontier, absorb values of their generation, and face the same shocks at the same age. Between-cohort wage differences at particular moments of time, or cohort effects, reflect cohort-specific technological change and accumulation of cohort-specific human capital.

Previous research focuses on various aspects of the cohort effect. One strand of the literature explores how entrance conditions affect further labor market outcomes. Belonging to an unlucky cohort that happens to enter the labor market during the recession produces life-long scarring effects (see Giuliano, Spilimbergo 2014; Oreopoulos et al. 2012; Schwandt, Von Wachter 2020; Altonji et al. 2016; Kahn 2010; etc.). On the contrary, cohorts that entry during the boom experience a long-lasting, if not persistent, advantage compared to the less lucky cohorts.

Another aspect of the cohort effect is the size of the cohort. Members of relatively large cohorts may experience lower earnings, higher unemployment rates, and sometimes lower employment levels due to supply-side effects (Korenman, Neumark 1997; Jimeno, Rodriguez-Palenzuela 2002; Brunello 2010; Garloff et al. 2013; Moffat, Roth 2016; Morin 2015).

Over time, technological change, if it shifts the knowledge frontier, makes human capital, obtained through formal education, fully or partially obsolete (Neuman, Weiss 1995; Lentini, Gimenez 2019). This process affects different cohorts to different degrees. First, the content and quality of education influences the rate of its obsolescence (Gould et al. 2002). Second, the process of technological change is not homogeneous over time. However, new skills can complement already existing skills and enhance returns to experience (see Weinberg 2004).

Finally, Kambourov and Manovskii (2009) note that the cohorts differ in their occupational mobility. As a part of the human capital accumulated over the life cycle is occupation specific,

higher occupational mobility translates into flatter profiles. That is the case for the recent cohorts on the U.S. labor market.

Although in most cases differences between adjacent cohorts are relatively small, there are obvious exceptions. Among them are life-changing events like revolutions and wars, large famines, deep and prolonged recessions that impact a particular cohort more than others. The Russian plan to market transition in the 1990s can be one of these, and it provides a natural example of jumping from one politico-economic system into another. This change had profound implications for both supply and demand sides. The transition shock affected education, skills, employment, and earnings, and could not be cohort neutral. Its impact goes through both channels, i.e., by downsizing the stock of the human capital in forms of underutilization due to nonemployment, underemployment, or downward occupational change, and by decreasing its renting rate for the same human capital unit (unit price). Massive labor reallocation caused by transition requires painful and costly adjustment for which cohorts differ in their capacity to change jobs and learn new skills (Sabirianova 2002). Employing the EU-SILC data on 22 countries, Brunello et al. (2012) show how the returns to education differ between the cohorts that studied before and after the communist regime. Interestingly, those who received primary and secondary education under communism are penalized, while those who received post-secondary education are rewarded. Fuchs-Schündeln and Masella (2016) show that an additional year of school education under the communist regime decreases the probability of obtaining a college degree and affects longer term labor market outcomes for men.

In the post-communist countries, cohorts differ by the length of work experience in the non-market economy, which can also translate into earnings. There is some evidence that this experience is valued less in the new market economy (Gimpelson, Kapeliushnikov and Ostchepkov 2016 for Russia; Orlowski, Riphahn 2009 for Germany; Chase 1998 for the Czech Republic and Slovakia; Flanagan 1998 for the Czech Republic). Cohorts differ by their attitudes and preferences, including those affecting career choices and labor market outcomes. Campa and Serafinelli (2019) show that women who lived in East Germany before the reunification value professional careers more than those who lived in West Germany. Lippmann and Senik (2018) show that girls and boys who lived in East Germany had smaller gaps in math achievements compared to those in West Germany due to differences in girls' "attitudes, confidence and competitiveness".

Time effect

In panel or repeated cross-sectional data, *time effect* captures non-cohort-specific and non-experience/age-specific factors acting over time. It reflects how returns to human capital evolve due to general changes in labor demand and supply, non-cohort specific shocks, technological

change, physical capital accumulation, etc. Fast growth of the labor productivity in an economy is likely to lift wages across the spectrum of groups, like “the tide lifts all boats”. This time-induced change applies equally to all age/experience and cohort groups.

Any economy will periodically face various shocks that affect wage evolution. Their role in shaping the wage profile deserves special attention. Shocks can hinder the human capital accumulation, decrease its utilization, and reduce potential gains. Those types of shocks that are not selective and hit all cohorts and age groups are part of the time effect.

To motivate our empirical research, we rely on the theoretical model of human capital investment over the life cycle. Its important advantage over the alternative theories is in its provision of an intuitively clear and simple identification of the APC parameters.

3. The Russian labor market development: a concise story with an application to wage growth

The history of the Russian labor market development during the last 30 years was extremely turbulent, with multiple negative and positive shocks (Gimpelson, Kapeliushnikov 2013). The labor market absorbed each of these shocks largely by labor prices, and these wage adjustments could be not cohort or experience neutral. For the sake of simplicity, we can divide this period in three sub-periods, each lasting approximately one decade. Even though the data span we use in the empirical part is 10 years shorter than the entire period, it is important to bear in mind that shocks and events of the preceding period affected how the human capital was accumulated, utilized, and rewarded in the following years.

The first decade (the 1990s) started with the collapse of the Soviet Union, and it marked the beginning of the transition from the planned economy to market economy. During this decade, the Russian economy faced three strong macro-shocks, which caused a deep and prolonged recession. By the end of the decade, the Russian GDP made only about two-thirds of what it was at the start in 1991, and the real wage plummeted following the GDP path.

The transformation crisis had a varied and possibly prolonged effect on the cohorts in the labor market at that time. The human capital of the labor force obtained before the transition experienced a strong hit. The realities of the emerging market economy made the education and skills accumulated within the planning system largely obsolete. First of all, this affected workers with longer experience. Having faced job destruction due to the radical economic transformation, many workers had to change jobs and occupations. The reallocation resulted in massive underutilization of the human capital accumulated prior to the transition. As shown in Sabirianova (2002), almost 45% of Russian workers changed their occupation during this decade. If one believes in the

principle “use it or lose it” in relation to skills, the underutilization leads to losses in human capital. Though new jobs were also created, a deep recession is always a bad environment for young cohorts entering the labor market and is likely to negatively affect their careers (Kahn 2010; Von Wachter 2020). That is, the cohorts entering the labor market in the 1990s are likely to experience losses in the following decades. At the same time, these cohorts were educated in the post-Soviet period and, therefore, could obtain more relevant skills for the new market economy.

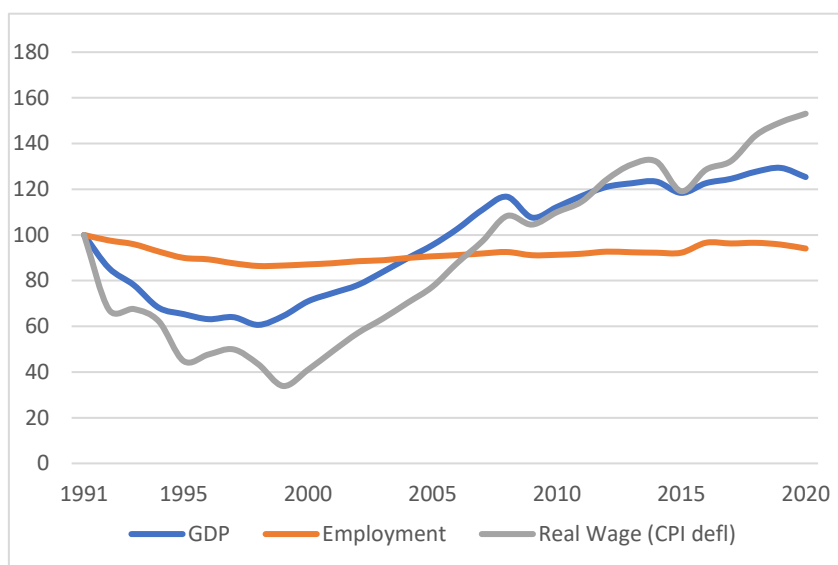
The second decade, which we date the 2000 to 2008 period², was markedly different when compared to the first one. It brought a real economic boom that was reflected in all major indicators. The Russian GDP nearly doubled within this period, and the real wage increased even more (see Figure 1). The fast growth generated many new job openings and created optimistic expectations about the future. Much of this gain was acquired by the cohort that entered the labor market during these years. In the 2000s, investments in technological modernization and R&D intensified (Granville, Leonard 2010). This accelerated the natural process of human capital obsolescence due to technological change, which was likely cohort-specific. However, the positive development did not last long and was stopped by the financial crisis that trimmed the GDP by 8.5% in 2009 (see Figure 1).

During the third decade, from 2009 to 2019, the path of development took a steep turn once again. Although the losses in terms of GDP and wages brought about by the crisis were recovered within a few years, the annexation of the Crimean peninsula, followed by Western sanctions and Russian counter-sanctions, coinciding with a deep plunge in the world hydrocarbon prices, pushed the Russian economy towards the new recession and stagnation. The accumulated GDP growth over this decade barely reached 9.5% and the real wage growth was 28%, primarily during the recovery in 2010-2013. These rates were insubstantial after 2013 (Figure 1).

Summing up this short and highly stylized description, we can say that this 30-year period contains the events of the recession, the boom, and the stagnation. Unsurprisingly, they have affected the accumulation of human capital, its utilization, and wage returns accrued to workers. Though all age/experience and cohort groups face the common time trend, they have been exposed to shocks and stagnation to a different degree. If experience can bring additional skills regardless of the business cycle phase, negative shocks causing technological and structural change speed up the process of human capital obsolescence.

² The 2008 world financial crisis hit Russia in 2009.

Figure 1. Stylized Story of the Russian Labor Market Development: GDP, Employment and Real Wage, 1991-2020



Source: Rosstat, authors' calculations

4. Data

Our analysis utilizes the individual micro-data from the Russian Longitudinal Monitoring Survey of Higher School of Economics (RLMS-HSE). The RLMS is a series of nationally representative surveys that covers, over time, around 10,000 adults in approximately 5,000 households.

Our data set covers the 20-year period from 2000 to 2019. The baseline sample we are using in the study consists of male, full-time wage employees. A few additional criteria apply. Workers should be between 20 to 60 years of age, have work experience of up to 40 years, are not currently enrolled in full-time educational institutions, and are not early pension recipients. Below we explain the reasons for this censoring as well as some other details on the composition of the sample. The resulting data set consists of 32,500 observations, with complete information available for 27,500 observations.

Full-time wage employment. We exclude the self-employed from our baseline sample because returns from labor and capital are mixed within their income, and when there is a family business it is impossible to separate earnings for each family member. An individual is defined as self-employed if they work in a firm he/she owns and considers this activity as an entrepreneurial one. For one robustness check, we include all those employed in the non-corporate sector where the border between self-employed and salary/wage workers is not clear. As another check, we use the reduced time span of 2000-2014, for which the survey allows us to directly identify those “involved in entrepreneurial or individual labor activity” that is not incorporated. Nevertheless,

the fraction of self-employed individuals has been relatively low over the whole period (see Table 1).

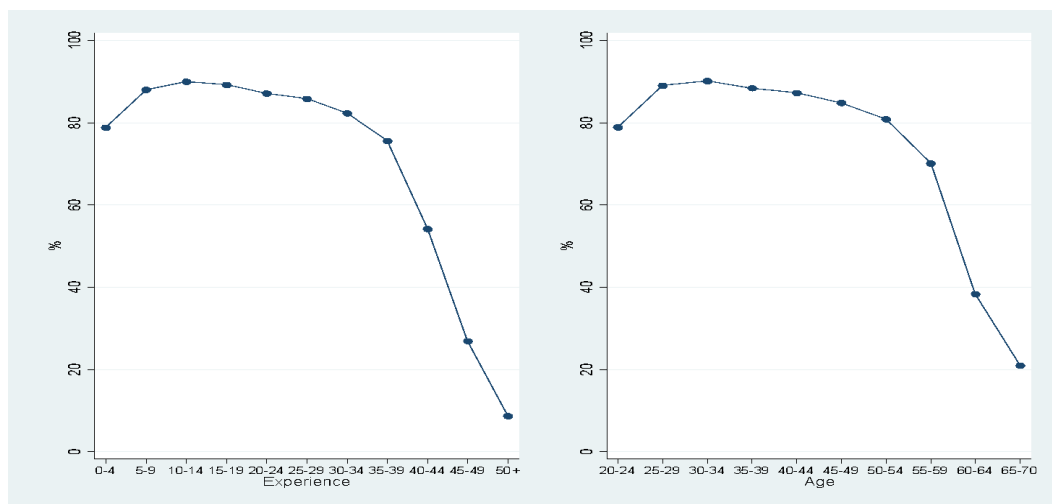
Table 1. Share of self-employed at the main job, % of the total employment

Definition of self-employment	Share of self-employed
(1) Owns a firm & involved in entrepreneurship	2.4
(2) = (1) + self-employed in the non-corporate sector (2000-2014)	4.6
(3) = (1) + any employment in the noncorporate sector	12.4

As full-time workers, we define those who work at least 30 hours during a normal working week. Switching to part-time employment in older age can lead to a reduction in hourly wages (Aaronson, French 2004; Hurd 1996).

Age restrictions. Constraining the age range to between 20 and 60 years old, we weaken the problem of selection into employment. During the period considered in the study, the statutory retirement age was 60 for men and 55 for women. Just beyond this threshold, the employment rate decreases drastically – from about 70% at the age of 55-59 years to below 40% at the age of 60-64 years (see Figure 2). This reduction is not random.

Figure 2. Labor force participation by age and potential experience



Gender. The reason for focusing only on men in the main sample comes from the fact that female labor supply is not continuous, and female labor market participation can have interruptions due to maternity leave. In this case, applying the same (as for men) formula for estimating potential experience introduces measurement error. In addition, lasting career breaks lead to human capital depreciation due to its underutilization and introduce additional noise in human capital measurements (Blundell et al. 2021).

Experience. Duration of the post-schooling labor market experience is one of our key independent variables. Since the RLMS does not offer its direct measure, we calculate potential experience by applying the conventional formula as $(AGE - 6 - N \text{ years in full-time education})$. The duration of full-time education can be derived in two ways. One way is to infer its duration from the time needed to obtain the highest level of education that individual reports. This measure is widely used in studies similar to ours (Lagakos et al. 2018a). Unfortunately, it can underestimate years of schooling in cases of unfinished education, or overestimate full-time schooling if part-time or distance education are not properly accounted for. Another way to obtain the schooling duration is to summarize all spells of full-time education reported by respondents. This is our preferred measure since it is free from the drawbacks mentioned above, in that respondents answer correctly about their full or part-time education. Still, it can potentially overestimate the total length of schooling if a person is enrolled simultaneously in more than one educational program. On average, the potential duration of schooling is the same as the one reported by respondents (see Table 2).

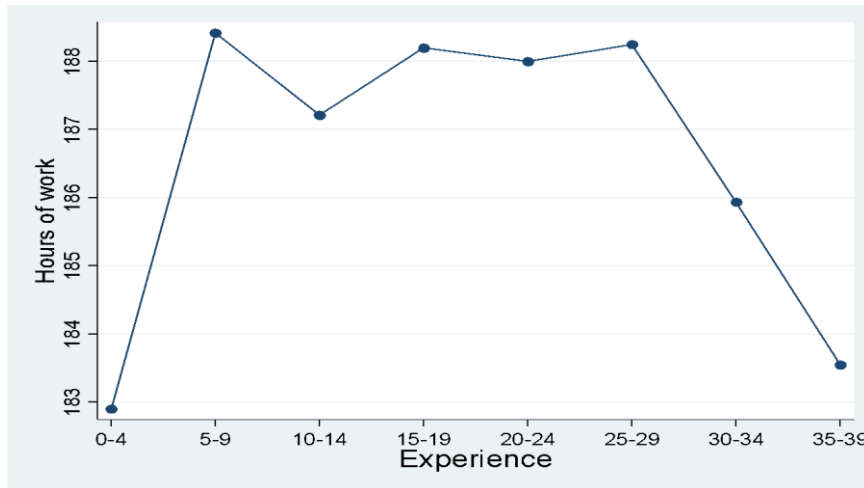
However, combining full-time education with paid work has become widespread in Russia. This leads to underestimation of the total length of the labor market experience and to overestimation of the average wages for workers with a shorter experience on the labor market.

Earnings and hours of work. Our main dependent variable is the hourly wage. Constructing it, we use all earnings-related information available in the RLMS. The questionnaire asks about actual earnings and hours for the last 30 days, and about respondents' typical average monthly earnings over the last year, and typical weekly working hours. These measures are available for the main and secondary jobs. There is also an additional question about some occasional/casual work activity in the last 30 days, accompanied by earnings- and working hours-related measures.

Our preferred variable for earnings here is the measure of how much workers actually made during the last 30 days. For the robustness check, we modify this variable by substituting missing values with values about typical average monthly earnings during the last year. We also exclude observations where actual hours and usual hours differ by more than 20 hours per a week. This is done to reduce measurement error when respondents have fewer than usual working hours, due to periods of vacation or sick leave.

In our regressions, the LHS is the hourly wage, not the monthly earnings. This reduces volatility of earnings caused by the volatility of hours. For example, older workers in older age groups may reduce their hours as a gradual transition to retirement, which would affect their monthly earnings but less so their hourly wage. Figure 3 plots mean working hours across 5-years bins, by length of labor market experience.

Figure 3. Mean monthly working hours by labor market experience



As a further step, in order to reduce the influence of wage outliers, we drop, by 0.25%, observations at both extremes of the earnings distribution. All wage variables are then deflated using the annual regional CPI, setting December 2011 as 100. The difference in regional prices is corrected by applying the price of a fixed basket of goods and services³.

Table 2. Descriptive statistics for the core variables, 2000-2019

Variable	Mean	SD
Hourly wage (Rubles in 2010 prices)	94.4	73
<i>Education level</i>		
Higher	24.4	0.5
Secondary professional	20.3	0.4
Vocational education and below	55.3	0.5
Potential experience (reported schooling)	19.5	10.5
Potential experience (predicted schooling)	19.5	10.7

Source: RLMS, authors' estimates

5. Empirical analysis

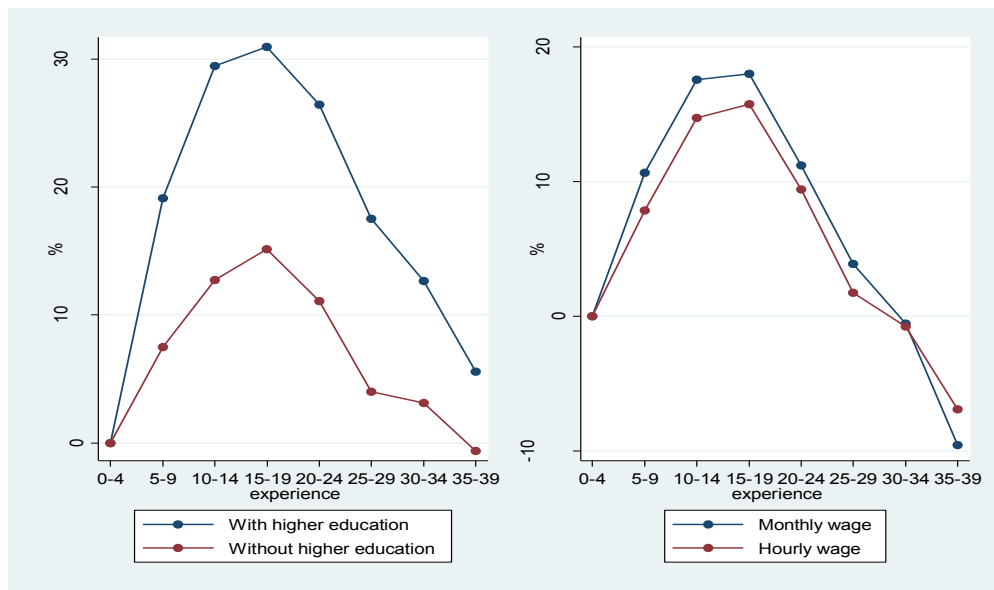
The starting point: evidence from pooled cross-sections. Our analysis begins with plotting wage–experience profiles using the data pooled together from the 2000-2019 rounds of the RLMS. We calculate mean wages for each of the 5-year experience bins {0-4, 5-9, 10-14, and so up to 35-39} and plot them along the experience scale. Figure 4 shows how the mean wage changes with experience, relative to that in the least experienced group. It suggests that both monthly and hourly wage profiles tell us a similar story (see Figure 4, Figure A-1).

³ https://www.gks.ru/bgd/regl/b09_13/IssWWW.exe/Stg/html6/24-11.htm

Wages peak early (at 15-19 years of experience) and decline steeply afterwards. The mean wage in the pre-retirement 5-year bin appears at the level below the starting one in the cross-section. Another specific feature observed in the profiles is that they are quite flat in comparison to those documented for advanced countries (Lagakos et al. 2018a; Jedwab et al. 2021). The rise in monthly wage is a bit steeper than the hourly one but the patterns are qualitatively similar.

Figure 4 presents profiles for workers with and without a university diploma. Even though university graduates experience a steeper growth in their earnings profile, the wage growth ultimately peaks at a level lower than 30%. For those without higher education, the peak is half as high, at about 15%⁴. These are surprisingly low numbers when compared to other countries, for which comparable estimates are available. Compared to countries in the Lagakos et al. (2018a) sample, Russian workers have the lowest rate of wage growth for the first 20 years of their potential experience. If the steepness of the wage profile trajectory correlates with the per capita GDP, as it usually does (Lagakos et al. 2018a), Russia takes a position below the level that can be expected.

Figure 4. Wage–experience profiles



Note: Left panel. Monthly and hourly wage growth with potential work experience compared to average wage at 0-4 years of experience. Right panel. Hourly wage growth with potential work experience compared to average wage at 0-4 years of experience for individuals with higher education versus those without higher education.

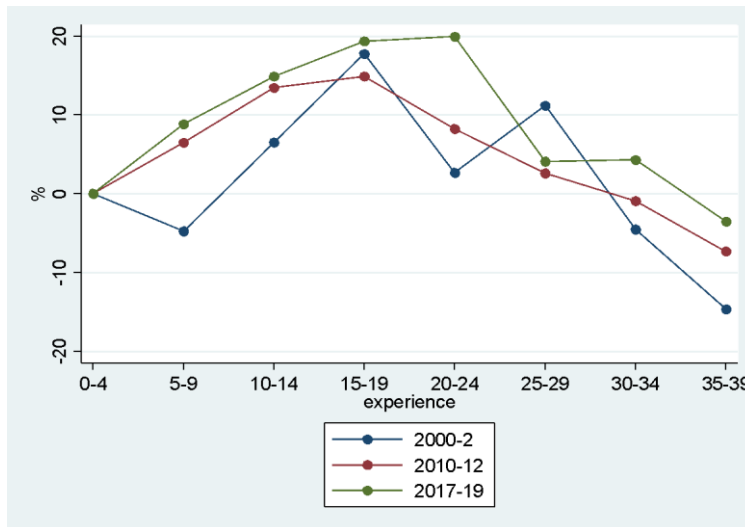
⁴ We are likely to underestimate the wage growth as we are overestimating the average wage in the 0-4 years of experience bin. An overestimation can happen because we set the lower age restriction at 20 years, and because of underestimating experience for those who combine full-time study and work. In the absence of a lower age restriction, the curve preserves its shape. Its height at 15-19 years of experience, for an average worker, is around 20%.

The stark difference between these profiles and those documented in multiple studies of other countries raises an obvious question of whether we are observing a statistical artefact. Are these results robust to using alternative data sets and definitions? The same patterns are reproduced in a number of studies focusing on the Russian labor market and utilizing different data sets and methodologies. Some scholars use the same data source as we do (Aistov 2018; Bessudnov 2011; Gimpelson 2019), but Gimpelson and Zinchenko (2019) utilize the 2016 round of the Survey of Incomes and Social Programs Participation (SISPP) conducted by Rosstat. This survey collects annual earnings data and has a much larger sample than the RLMS. Although the profile in their study is somewhat steeper than the one found here, the main conclusions also apply. Estimates from Gimpelson (2019) are based on data from the Occupational Wage Survey (Rosstat), where earnings information comes from firms' administrative sources and, therefore, is free from recall bias or other distortions inherent in household surveys. The robustness and persistence of the pattern, regardless of the data source, leads us take it seriously.

If considering the wage–experience profile as a reflection of the human capital accumulation, then the early decline can mean that, either the stock of useful skills starts diminishing early, or the rate of return falls rapidly. Both need additional arguments as to why this fracturing can happen at the mid-career, and they are hard to offer. A more convincing hypothesis assumes that what shapes the profile is the interaction of three different and independent effects – experience, cohort, and time.

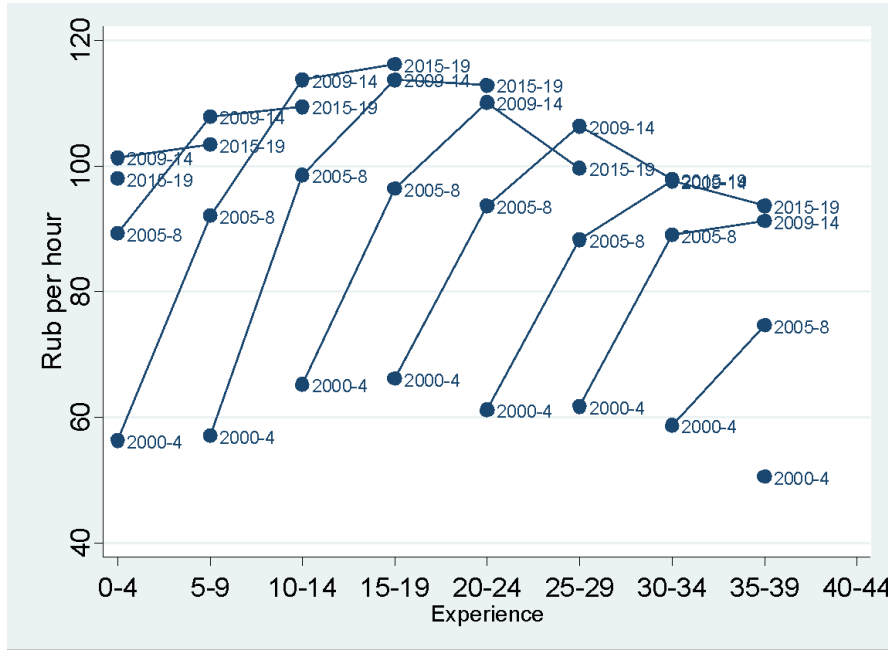
The first step in deciphering these effects is to visually inspect whether the profile shapes differ across years. If they do, this might imply the presence of a cohort effect (Kupper et al. 1985). Figure 5 depicts wage–experience profiles at different points in time of the period under study. Smaller subsamples for each sub-period produce quite noisy profiles. Despite their similar appearance, the profile based on the latest sub-period of 2017-19 peaks later. This is what one would expect if older cohorts, with obsolete skills acquired before the transition, are replaced by younger cohorts that are endowed with a more appropriate skill mix. The decline during the second half of working life remains.

Figure 5. Wage–experience profiles in three-year time periods (2000-2002, 2010-2012, 2017-2019)



As the next step, we explore wage growth across experience bins by cohorts. This eliminates the effect of cohort, but the effect of experience is still mixed with the effect of time. Cohort is defined here by the timing of entry into the labor market. Our data span allows tracing the cohorts during the four consecutive periods, defined according to the logic of Russian development described in Section 3. Figure 6 presents the evolution of wages within the separate cohorts in levels rather than in growth rates. A strong time effect is evident from the graph. For different cohorts, the wage growth curves between periods have more similarity than the growth between experience bins. Also notable is the huge difference in wages for different cohorts at the same career stage that takes place in the 2000s. The economic boom, during the first decade of this century, brought significant benefits to all cohorts, but the youngest ones emerged as the main beneficiary. Usually, the most rapid wage growth happens in the early stages of a career. In the 2000s, this coincided with fast economic growth, which offered favorable job and income opportunities to new entrants. In the 2010s, mostly a period of economic stagnation, an inter-cohort difference is also evident. The youngest cohorts show a moderate wage growth, even in the post-2014 period, which was the worst for the Russian economy during this decade.

Figure 6. Wage–experience profiles for separate cohorts, mean wage in Rubles on the y-axis



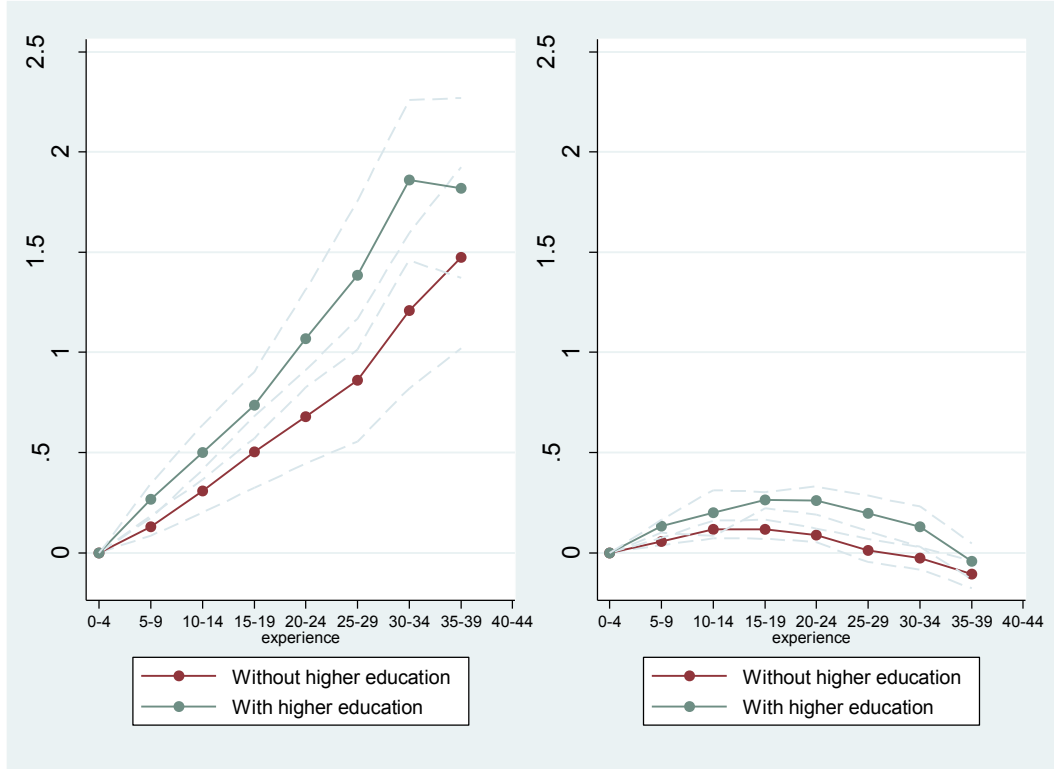
Separating the APC effects. Ideally, for calculating the effect of human capital accumulation with experience, we need to estimate the equation of the form (1):

$$\log w_{ict} = \alpha + \sum_{k=1}^K \theta_k \exp_{kict} + \sum_{l=1}^L \delta_l \text{educ}_{lict} + \gamma_t + \lambda_c + \varepsilon_{ict}, \quad (1)$$

where w_{ict} – the wage of individual i , from cohort c in period t ; \exp_{kict} – 5-year bins of labor market experience of individual i from cohort c in period t , $k=1 \dots K$; θ_k is the experience effect, $k=1 \dots K$; educ_{lict} – level of education of individual i from cohort c in period t , $l=1 \dots L$; γ_t – period t effect, $t=1 \dots T$; λ_c – cohort c effect, $c = 1, \dots, C$ cohorts; ε_{ict} – random error.

However, a straightforward estimation of all coefficients in equation (1) is impossible as the variables for age/experience (A), cohort/generation (C), and period/time (P) are perfectly collinear. This is known as the APC problem. If either time or cohort dummies are dropped, coefficients θ represent a mix of experience and cohort effects in the former, and a mix of experience and time effects in the latter (as in Figure 7 a,b). The estimates, if cohort dummies are not included, reproduce the shape as in the simple cross-section we have discussed above. If control for time is missing, wages tend to increase monotonically over an entire career. These two pictures tell us quite different stories but neither is correct.

Figure 7. Hourly wage growth with potential experience



Note. Left panel (a): The estimates from equation (1) without time dummies. Right panel (b): The estimates from the equation (1) without cohort dummies.

For estimating the equation (1), additional assumptions must be introduced. In doing this, we apply an idea grounded in human capital theory and suggested in Heckman et al. (1998). As discussed above, closer to retirement age, individuals lose incentives for investing in human capital because little time remains to recoup investment costs. This affects productivity and translates into zero wage growth because further experience does not amend human capital. Therefore, an observed wage growth for the cohort during the pre-retirement spell can be attributed to either time effect or due to human capital depreciation. Introducing plausible assumptions about the rate of depreciation d and the length of non-investment period y allows us to identify the time effect. Once it is done, two other effects can easily be calculated (Lagakos et al. 2018a).

Let us briefly discuss the estimation procedure that we are borrowing from Lagakos et al. (2018a). Consider the time trend of the average wage growth, g_M , over a period. It is equal to the sum of the time effect, g_γ , and to the change in total productivity due to change in the cohorts' composition of the labor force, g_λ :

$$g_M = g_\gamma + g_\lambda \quad (2)$$

Given that, the iterative estimation goes the following way. First, the wages get deflated by the estimated time trend of wage growth, g_M . Second, equation (3) is to be estimated:

$$\log w_{ict}^d = \alpha + \sum_{k=1}^K \theta_k \exp_{kict} + \sum_{l=1}^L \delta_l \text{educ}_{lict} + \gamma_t^* + \lambda_c + \varepsilon_{ict} \quad (3)$$

Where w_{ict}^d is the deflated wage of individual i , from cohort c in period t ; \exp_{kict} – 5-year groups of labor market experience of individual i from cohort c in period t , $k=1 \dots K$; θ_k is the experience effect, $k=1 \dots K$; educ_{lict} – level of education of individual i from cohort c in period t , $l=1 \dots L$; γ_t^* – transformed period t effects such that $\frac{1}{T} \sum_{t=0}^T \gamma_t^* = 0$, $t=1 \dots T$; λ_c – cohort c effect, $c = 1, \dots, C$ cohorts; ε_{ict} – random error.

Estimated coefficients θ give the average wage growth in the final y years of working life. Let us define it as g_y . According to the assumption borrowed from Heckman et al. (1998), the observed growth, g_y , comes from the time effect and depreciation. So, equation (4) should hold:

$$g_M = d + g_y + g_\lambda \quad (4)$$

The iterative procedure is repeated with the updated value of g_M until equation (4) holds.

As is evident from equation (4), the decomposition of wage growth is sensitive to the assumptions concerning d and y . The more the wage growth relates to depreciation, the less of that is left for the cohort effect. This condition has theoretical grounds. Skills can become obsolete over a career stage (associated with age) and due to a certain cohort affiliation. De Grip and Van Loo (2002) distinguish two types of such obsolescence: technical and economic. The technical – or internal – one affects the current stock of human capital due to consequences of the natural aging process, injuries, and illness, or due to unemployment and career interruptions. The economic – or external – skills obsolescence concerns the unit price of skills, and is incorporated in both experience and cohort effects. Assuming a higher depreciation caused by aging, less is left for the cohort effect.

Baseline results. We begin our estimations with $y=5$ and $y=10$ years, $d=0\%$ and $d=1\%$ per year, as in Lagakos et al. (2018a). The results are presented in Figure 8. If we assume a higher depreciation rate (of 1%) and a longer non-investment period (of 10 years), the estimated profile approaches the cross-sectional shape. Wages at the peak (15-19 years of experience) are higher by 15% than at the entry point (0-4 years of experience), but they fall below the starting level by 35-39 years of experience (see Table 3). In the case of zero depreciation and 5 years without investments, wages do not drop with experience at all and the profile takes a quite conventional shape with gradual growth throughout the whole career. The gain by the end of a career reaches 55% compared to the entry level. In the intermediate cases, the wages tend to stagnate and they fall slightly after a gradual rise during the first 20 years of working life. The group of low-income countries in Lagakos et al. (2018a) exhibit profiles of similar shape and steepness.

The cohort effect on wage growth goes in the opposite direction to the effect of experience. If experience brings wage gains, belonging to older cohorts tends to penalize. The estimated difference between the youngest cohort (birth years 1995-1999) and the oldest cohort (birth years 1940-1944) in our sample varies with depreciation and non-investment period assumptions. It is nearly 120% if no depreciation and a 5-year non-investment period is assumed, but it hardly exists under the assumption of massive depreciation at the end of a career.

For a transition economy, it is natural to assume that older cohorts fall behind the younger ones due to obsolescence of their human capital. Their human capital stock, in the form of education and values, has a Soviet origin and fits poorly to the market needs. The transition abruptly changed the demand for skills and thus made old skills obsolete. On top of that, it accelerated technological and organizational changes in the economy, which also required new skills. Still, the graphs presented in the figures show that the transition process alone is not able to account for the cohort effect. In particular, workers born in 1990-1994 gain the most, probably due to the favorable timing of their entry to the labor market.

The time effect, when disentangled from the confounding impacts of experience and cohorts, mirrors the aggregate productivity path. As Figure 1 suggests, given stable employment, the GDP growth rates should approximate aggregate productivity and real wage growth rates. The curve, based on our estimates for the time effect, largely follows the GDP path, but the scale of the effect depends also on the assumptions. The time effect can be decomposed into the trend and cyclical components. The time trend estimate is between 2.7% (under $y=5$ years and $d=0\%$) and 4.6% (under $y=10$ years and $d=1\%$). The cyclical component is the highest for 2008 and reaches 32.8%.

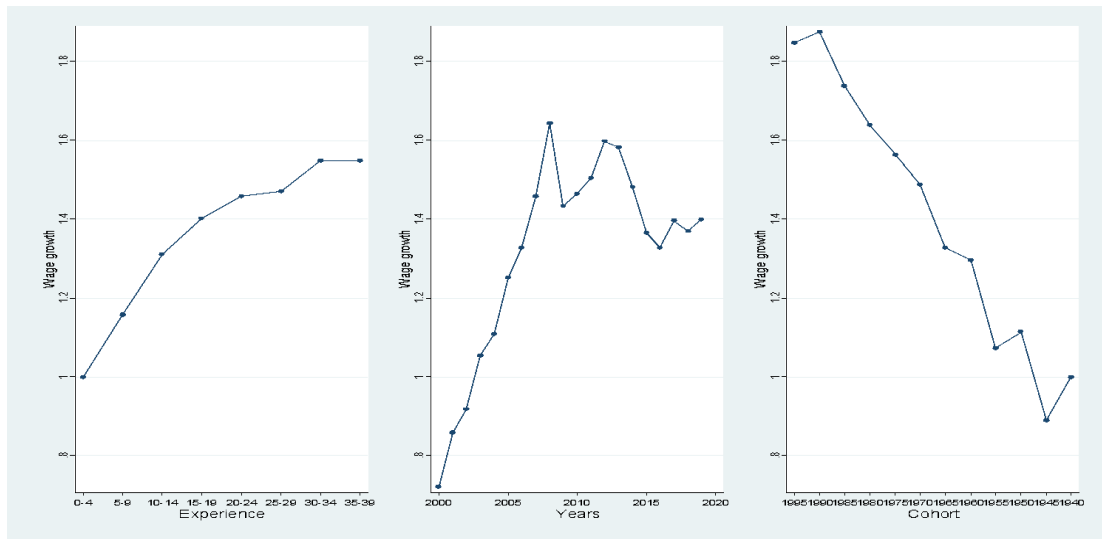
The sensitivity of our results to the depreciation and noninvestment assumptions raises the question: What could be a plausible depreciation rate? There is no consensus on this issue in the literature, and suggested values vary widely. In theoretical work, researchers often assume zero percent depreciation (e.g., Heckman et al. 1998; Manuelli and Seshadri 2014). This is motivated by the empirical fact that wages tend to rise over a life cycle (as discussed in Section 2). Because we do not observe a rising pattern in the Russian case, zero rate for depreciation would be a lower boundary value. Lagakos et al. (2018a) apply values up to 2% when they account for depreciation and check for robustness in their study.

Some authors estimate the rate of human capital depreciation empirically. Groot (1998) estimates rates of 11 to 17 percent per year in Great Britain and the Netherlands for all workers. Arrazola and Hevia (2004) use a more general model than that of Groot (1998), and they arrive at the rate of 1 to 1.5 percent. Both papers estimate the coefficient d that includes both internal and external human capital depreciation. Neuman and Weiss (1995) focus on human capital depreciation

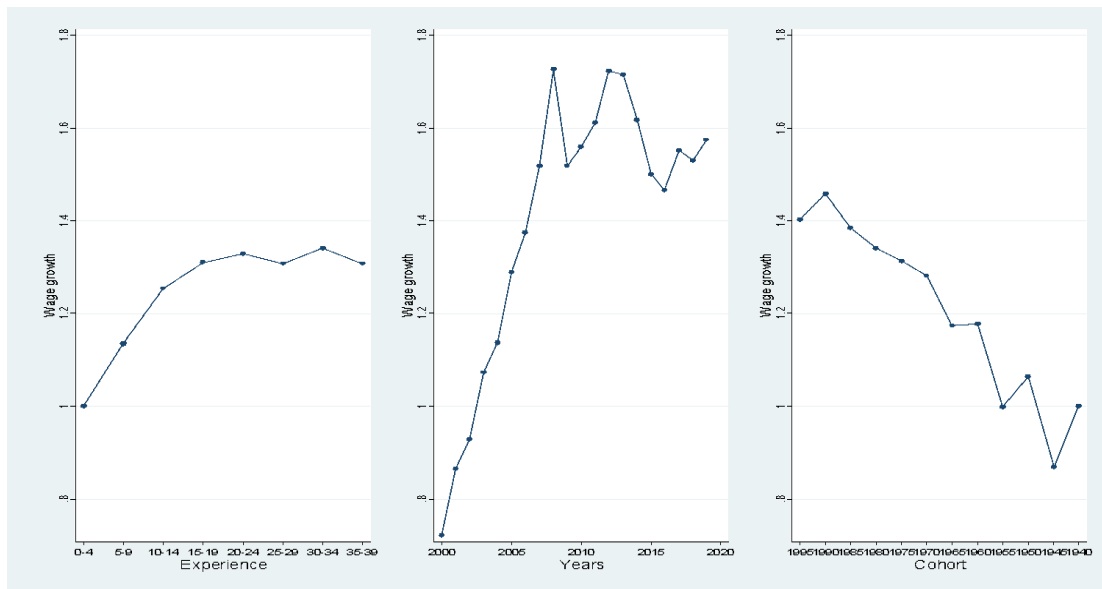
caused by economic (or external) obsolescence. Measuring how fast skills lose their value with experience, they arrive at the annual rate of 0.08 percent for each year of education in low-tech industries, and 0.12 in high-tech industries. In a study on Spain, Murillo (2011) finds the depreciation rates in the range of 0 and 2.7 percent, depending on industry and occupation. Lentini and Gimenez (2019) arrive at the rate of 6.3 percent for the 1980s and 2.3 percent per year for the 1990s for the group of OECD countries. In our study, depreciation due to obsolescence relates to the cohort effect. Our assumption attributes the remaining part of depreciation to the natural aging process, or internal depreciation.

Figure 8. Hourly wage growth due to experience, cohort, and year effects

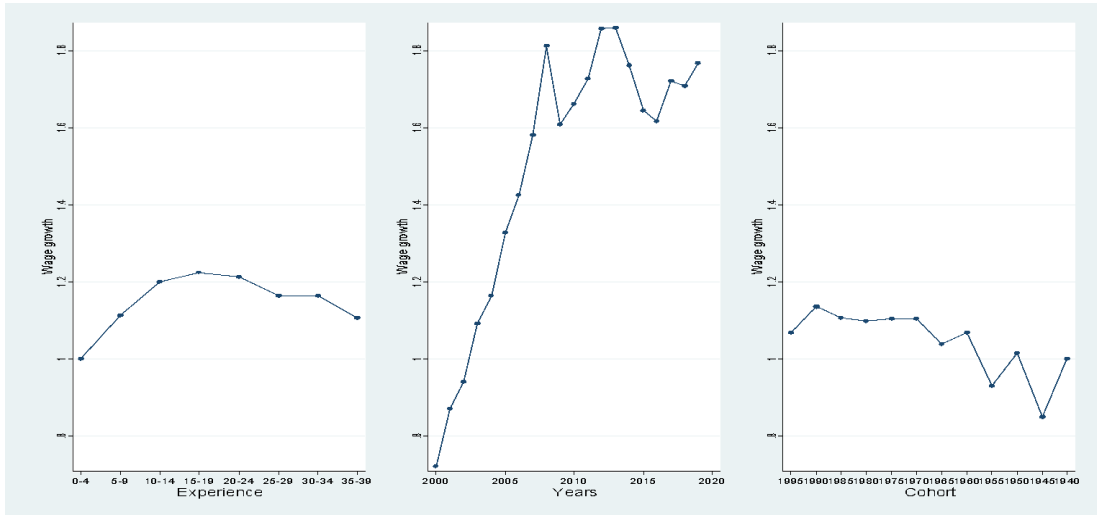
(A) $d = 0\%$, $y = 5$



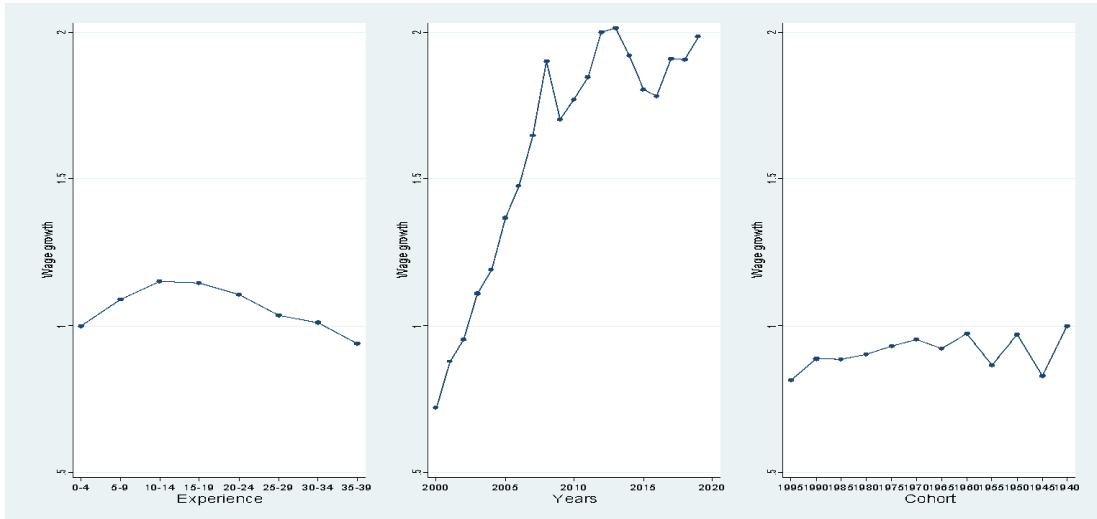
(B) $d = 0\%$, $y = 10$



(C) $d = 1\%$, $y = 5$



(D) $d = 1\%$, $y = 10$



Results by the level of education. As suggested by Figure 9, the effects are different for participants with higher education and participants without. Higher education is associated with steeper experience and cohort effects. This result is consistent with earlier observations (see, e.g., Brunello, Comi 2004). Even if a depreciation of 1% is assumed, the late career wage decline is less dramatic for those with a higher education.

A few studies provide some evidence that the depreciation can vary by level of education (Groot 1998; Murillo 2011). Workers whose jobs rely on cognitive skills are less exposed to depreciation of their human capital due to aging but are more exposed to economic obsolescence. Manual workers are more affected by aging due to deterioration in health, while the extent of economic obsolescence is less obvious. On the one hand, progress in technologies related to non-cognitive jobs is less rapid (compared to, for example, IT engineers). On the other hand, these jobs are more

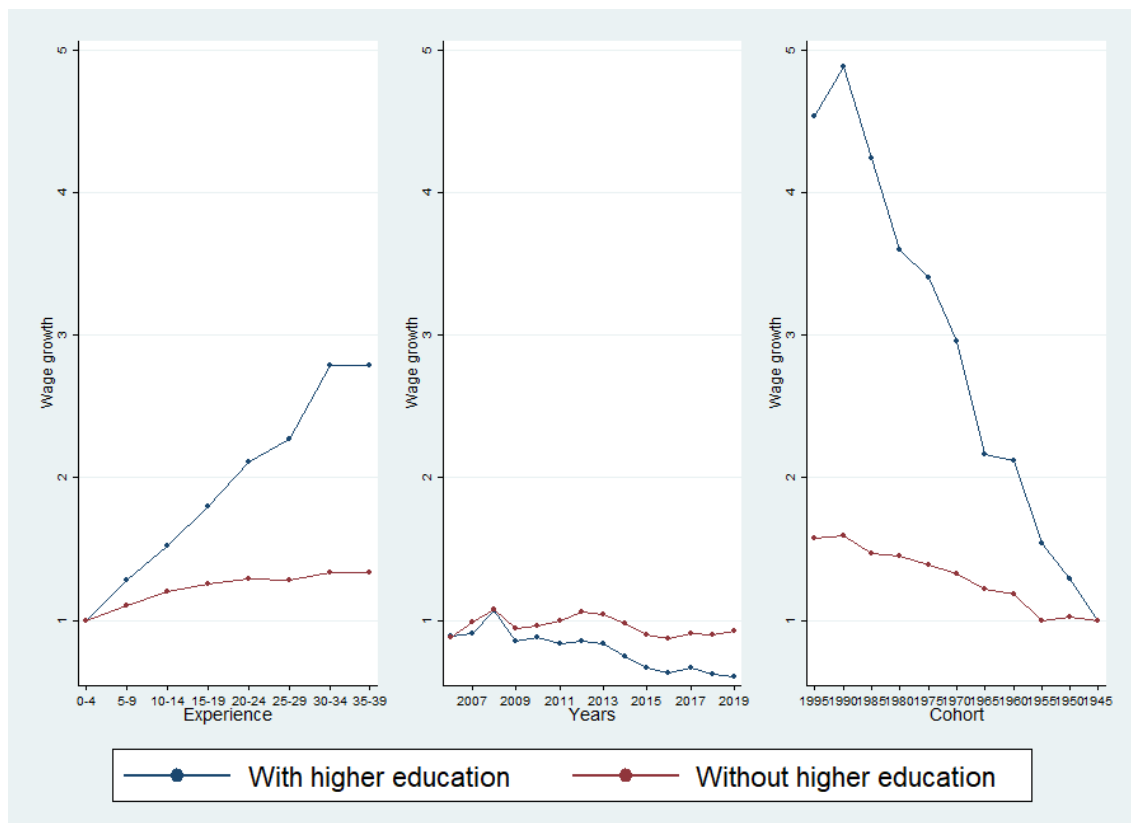
likely to be destroyed by automation. Nevertheless, the assumption that workers with higher education experience low depreciation and workers without experience higher depreciation seems very reasonable. This further emphasizes the difference between the profiles for individuals with and without higher education.

This finding suggests that families in which the children obtained higher education in the post-Soviet period can have higher intergenerational income mobility. Another conclusion that emerges is that the well-being of workers without higher education depends much more on the general macroeconomic trend in the country.

Table 3. Estimated parameters of experience–wage profile

	Peak experience (length from the start)	Peak height (steepness)	Height at 15-19 years	Height at 35-39 years
d=0%, y=5				
Whole population	35-39	1.55	1.4	1.55
With higher education	35-39	2.62	1.77	2.62
Without higher education	35-39	1.41	1.32	1.41
d=0%, y=10				
Whole population	30-34	1.34	1.31	1.31
With higher education	30-34	1.64	1.43	1.53
Without higher education	20-24	1.23	1.22	1.18
d=1%, y=5				
Whole population	15-19	1.22	1.22	1.11
With higher education	30-34	1.86	1.51	1.77
Without higher education	15-19	1.15	1.15	1.02
d=1%, y=10				
Whole population	15-19	1.15	1.15	0.94
With higher education	20-24	1.26	1.24	1.09
Without higher education	10-14	1.09	1.07	0.85

Figure 9. Hourly wage growth due to experience, cohort, and year effects by educational attainment



6. Robustness checks

We check whether the obtained results remain robust to various sample restrictions and changes in the key variables (see Table 4). For example, using potential schooling, instead of reported schooling, for calculating experience does not lead to any statistically significant differences. The same results hold when we exclude observations with non-typical working hours or include part-time workers. Women have less steep profiles, and so do the self-employed. Yet including these two groups in one sample does not affect the results in a statistically significant way.

Removing the lower age bound leads to slightly lower average wages in the 0-4 experience bin and thus to a slightly steeper trajectory of growth with experience. Incorporating the regression controls for region and settlement size only alters the results slightly.

Finally, using monthly instead of hourly wages results in a higher peak and a less flat downward slope of the profile in the latter years of a career.

Table 4. Robustness checks of the baseline result, $d = 0\%$, $y = 5$

	Peak experience (length from the start)	Peak height (steepness)	Height at 15- 19 years
Baseline results	35	1.55	1.40
Potential (instead of reported) schooling	35	1.50	1.44
Monthly (instead of hourly) wage	35	1.87*	1.55*
Monthly earnings from all jobs	35	1.78*	1.51*
Part-time workers included	35	1.54	1.40
Nontypical hours excluded	35	1.68	1.44
Entrepreneurs included	35	1.53	1.39
Women included	35	1.47	1.34
Controls for region and settlement size	35	1.57	1.39
No lower age limit	35	1.57	1.43

7. Conclusions

This paper explores the evolution of wages over a life cycle in Russia. The wage profile across the labor market experience reflects the accumulation and utilization of human capital, and in this capacity it is important for understanding the evolution of labor productivity and workers' well-being. The study presented here departs from the set of cross-sectional and panel-based evidence that Russian workers' wages change with experience in a unconventional way. There is a consensual view that wages tend to grow monotonically until late in a worker's career, and this fact has strong theoretical and empirical grounds. However, the Russian case looks completely different. Wages peak early and then decline steeply, and the trajectory of the whole profile remains much flatter compared to that documented for advanced economies. We seek explanations for this unconventional performance.

Interpreting the observed wage–experience profiles, scholars face the well-known problem of the perfect collinearity of experience, cohort, and time. Neither cross-sectional nor panel data allow a

straightforward separation of these effects. These three different effects cannot be disentangled by purely technical means, and their separation requires additional non-technical assumptions. In this study, we utilize an idea based on human capital theory that incentives to invest in workers' human capital in the pre-retirement period get weaker or disappear completely. As a result, the wage growth at this stage of career is a joint outcome of depreciation and time effect. With appropriate assumptions, the three effects can be identified.

Using the RLMS-HSE panel data set for 2000-2019, we decompose wage growth over a life cycle due to the effects of experience, cohort, and time. We do this under alternative scenarios for the non-investment period and for depreciation rates. As an outcome, we arrive at the conventional shape of wage growth with experience, when wages tend to rise until late in working life. This means that the labor market experience contributes to the accumulation of human capital as it is predicted by human capital theory, though the profile trajectory remains flatter than that observed in advanced economies. The contribution of the cohort effect goes in the opposite direction, thus offsetting earning gains from experience. Older cohorts are penalized for the skills they acquired at the start of their career (during Soviet times) and which could have become obsolete in the market economy and over time. Superposition of these two effects brings us to the initial unconventional profile that puzzled us and became a source of our research motivation. The time effect reflects the general path of the Russian economy over the first two decades of the century, which included both the economic boom and stagnation.

Exploring wage growth, we use alternative scenarios for noninvestment periods and depreciation. A longer non-investment spell is associated with an earlier peak and makes the wage–experience profile flatter. Introducing 1% depreciation leads to an earlier decline in wage. These changes in wage–experience profiles are reflected in wage–cohort profiles because these two are interlinked. Our results are robust to changes in measuring wages/earnings and experience. They also hold when we modify the sample composition by adding or excluding various groups (women, self-employed, part-timers, etc.).

This paper presents one of the first studies of the life cycle wage growth that decomposes APC effects for emerging economies transitioning from socialism. The cohort effect shows the price that older generations were forced to pay for the obsolete education and skills they had acquired. Whether future generations of workers are able to overcome this curse will depend on wage growth and new labor market opportunities.

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Appendix

Figure A-1 Wage–experience profiles with different wage variable definitions

