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The impact of changes on the labor market induced by structural change, the adoption of a new computer-based technology and economic slowdowns on family formation, family fertility outcomes and new careers

Tamara Thornquist

Doctoral Thesis in Economics at Stockholm University, Sweden 2020

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The impact of changes on the labor market induced by structural change, the adoption of a new computer-based technology and economic slowdowns on family formation, family fertility outcomes and new careers

Tamara Thornquist

Academic dissertation for the Degree of Doctor of Philosophy in Economics at Stockholm University to be publicly defended on Thursday 3 December 2020 at 10.00 in Nordenskiöldsalen, Geovetenskapens hus, Svante Arrhenius väg 12.

Abstract

Childlessness, Number of Children and The Labor Market at the Time of a New Technology, the US 1980-2018

The adoption of a new computer-based technology in the US in the late 1970s resulted in broad changes on the labor market that can be described by two major phenomena - job polarization and a shift in the relative returns to skill. A well established theoretical and empirical literature shows that commuting zones with a historically greater specialization in routine task intensive occupations adopted the new computer-based technology faster and subsequently saw greater changes on the local labor markets. In this paper, I build on the previous literature and analyze the relationship between the historical specialization of commuting zones in routine task intensive occupations and the change in family fertility outcomes in the US 1980-2018. The prediction is that commuting zones with a greater initial routine task specialization adopted the new technology faster and thereafter saw greater changes on the local labor markets, which further led to greater changes in the fertility outcomes. The estimation results suggest that among women in the age group 20-39 of any educational level, the shares of women with at least one child and at least two children decreased by more in commuting zones with a historically greater routine task employment. The result is driven by college educated women.

Marital economic homogamy and earnings polarization, the US 1970-2018

In this paper I analyze what impact the polarization of earnings had on a rise in the economic resemblance between marriage partners aged 27-36 in the US 1970-2018. An earnings polarization means that the relative earnings gap at the upper end of the earnings distribution has been widening, while the relative earnings gap at the lower end of the earnings distribution has been narrowing in the US since the 1950s-1960s. I employ a structural change driven explanation of labor market polarization and the instrumental variable technique to identify the causal effect of interest. The estimation results show that the marital economic resemblance increases on the widening relative earnings gap at the upper/lower part of the earnings distribution and decreases on the narrowing relative earnings gap at the upper/lower part of the earnings distribution. Keeping all else equal, the polarization of earnings would account for 19 to 25 percent of the rise in the coefficient of marital sorting in the US between 1970 and 2018.

New Careers, Labor Market Turmoil and Gender: Evidence from Russia 2000-2016

In this paper I study what was the effect of entering the labor market under adverse economic conditions on the career development of college educated men and women in Russia 2000-2016. The instrumental variable technique is used to identify the causal effect of interest. I find a negative immediate effect of graduating in a bad economy on the log hourly wage among all college graduates and among college graduate men. Although the negative effect gradually dissipates as the economy picks up, it remains present years after graduation. When it comes to college women, no immediate effect of graduating in a bad economy on the hourly wage is identified. The negative effect on the hourly wage among women first pops up three to five years after graduation. College men and women who graduated in a bad economy do, on average, have lower quality jobs which might explain negatively affected hourly wages.

Keywords: *Labor market, structural change, polarization of earnings, computer-based technology, economic slowdowns, family formation, family fertility outcomes, careers, college graduates.*

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Stockholm, Sweden

October 2020

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Introduction

The US and other advanced countries have seen a myriad of rapid changes in the structure and functioning of the economies and labor markets during the second half of the 19th and the beginning of the 20th century. The major forces behind these changes have been structural change (Kuznets (1957), Baumol (1967), Jorgenson & Timmer (2010), Herrendorf et al. (2013), Bárány & Siegel (2018) etc.), import competition and offshoring (Crino (2009), Kemeny & Rigby (2012), Autor et al. (2013), Becker et al. (2013), Autor et al. (2014), Acemoglu et al. (2016) etc.) and the adoption of a new computer-based technology (Autor et al. (2003), Autor et al. (2006), Goos & Manning (2007), Goos et al. (2009), Autor & Dorn (2013), Goos et al. (2014), Michaels et al. (2014) etc.). While researchers in economics and related disciplines have dedicated a great deal of time and effort to study the effect of these forces on industries, firms and labor markets, much less attention has been devoted to what has been the effect of changes on the labor markets induced by these forces further down the line on the outcomes of families and children. This doctoral thesis consists of three self-contained essays in economics. In the first two essays of this thesis I make an attempt to fill this gap in the literature.

In the first essay, *Childlessness, Number of Children and the Labor Market at the Time of a New Technology, the US 1980-2018,* I study the impact of changes on the labor market induced by the adoption of a new computer-based technology on the family fertility outcomes in the US in 1980-2018. More precisely, I am interested in what impact simultaneous changes in the labor market opportunities of both partners in a household induced by the adoption of computer-based technology in the late 1970s had on family fertility outcomes in the US in 1980-2018. Put differently, I am interested in the total effect of all labor market changes stemming from the new technology adoption on family fertility outcomes.

Computer-based technology was first introduced at American work places in the late 1970s. Shortly after that, in the 1980s, a large absolute decline in the price of computer power began. The computer adoption in the US resulted in broad changes on the labor market that can be described by two major phenomena. The first is job polarization, i.e. a faster growing employment in high-wage abstract tasks dominated occupations and low-wage manual tasks dominated occupations relative to middle-wage routine task dominated occupations (Autor et al. (2003), Autor & Dorn (2013)). The second is a shift in the relative demand for and the return to analytical and interpersonal skills (Bacolod & Blum (2010), Beaudry & Lewis (2014), Autor (2015), Deming (2017)).

Between 1980 and 2018, the share of childless women aged 20-39 increased from 0.40 to 0.54, while the share of women in the same age group with at least two children decreased from 0.41 to 0.29. Furthermore, the occurrence of postponed fertility - measured by the share of women aged 40 and 44 with a young child - occurred twice more often. The share of mature women with a child aged below 5 increased from 0.05 to 0.12 between 1980 and 2018.

To analyze the effect of interest I adopt the model of "routine-task" replacing technological change, where technological change takes the form of a declining price for computer power developed in Autor & Dorn (2013). Building on the predictions from the theories in the economics of fertility (Becker (1960), Becker (1965), Willis (1973), Hotz et al. (1997)), the theoretical predictions in Autor & Dorn (2013) and the empirical results in Autor & Dorn (2013), Bacolod & Blum (2010), Beaudry & Lewis (2014), Deming (2017) etc., I expect that commuting zones with a greater historical specialization in routine-task intensive occupations were characterized by a faster adoption of computer-based technology and subsequent larger changes in family fertility outcomes in the US in 1980-2018. My hypothesis is that commuting zones with a historically higher employment concentration in routine-task intensive occupations had adopted the new computer-based technology faster since the late 1970s and consequently saw greater changes on the local labor markets after 1980. Greater changes in the labor market outcomes further led to larger changes in family fertility outcomes.

I find that among women in the age group 20-39 of any level of education, the shares of women with at least one and at least two children decreased by more in commuting zones with an initially greater specialization in routine tasks intensive occupations. The result is economically and statistically highly significant and is driven by college educated women.

Concerning postponed fertility, the share of women aged 40-44 with a young child increased by more in commuting zones with a historically high routine-task employment share between 1980 and 2018, in other words, postponed fertility increased by more in routine task intensive commuting zones. The decrease in the shares of women aged 20-39 of any education with at least one child and with at least two children was larger in magnitude than the increase in the share of women aged 40-44 of any education with a young child.

In the second essay, *Marital Economic Homogamy and Earnings Polariza-*

tion, the US 1970-2018, I study what was the effect of changes on the labor market induced by structural change on family formation in the US in 1970-2018. In particular, I study how the polarization of earnings caused by structural change affected how similar marriage partners were with respect to earnings in the US in 1970-2018. The earnings polarization implies that the relative earnings gap at the upper end of the earnings distribution has been widening, while the relative earnings gap at the lower end of the earnings distribution has been narrowing in the US since the 1950s-1960s.

I define relative earnings gap measures over three broad industrial sectors and three broad occupational groups. In terms of broad industrial sectors, the constructed measures capture the development of the relative earnings gap between individuals employed in the high-skilled services sector and the manufacturing sector, and the relative earnings gap between individuals in the manufacturing sector and the low-skilled services sector in the US in 1960-2018. The constructed measures capture the development of the relative earnings gap in terms of broad occupational groups between individuals employed in abstract and routine occupational groups, and the relative earnings gap between individuals in routine and manual occupational groups in the US in 1960-2018.

Marital economic homogamy is described by a rank correlation coefficient over the wife's and the husband's earnings where a wife and a husband were 27-36 years old. Between 1960 and 2019, the coefficient of marital economic homogamy increased from 0.12 to 0.32.

I base my theoretical expectation on the predictions from the Fernandez et al. (2005) model. To identify the causal effect of interest, I employ a structural change driven explanation of labor market polarization developed in Bárány & Siegel's (2018) model.

My empirical findings support my theoretical expectations and show that commuting zones with greater relative earnings gaps both at the upper and lower ends of the earnings distribution are characterized by a greater earnings resemblance among married couples. In contrast, commuting zones with smaller relative earnings gaps both at the upper and lower ends of the earnings distribution are characterized by a smaller earnings resemblance among married couples. Additionally, changes in the relative earnings gap in the upper part of the earnings distribution have a greater effect on how similar marriage partners with respect to earnings are than the changes in the lower part of the earnings distribution.

Keeping all else equal, the polarization of earnings would account for 19 to

25 percent of the rise in the coefficient of marital sorting in the US between 1970 and 2018.

In the third and last essay, *New Careers, Labor Market Turmoil and Gender: Evidence from Russia 2000-2016,* I turn my attention to a different research question and country. In this paper, I study the effect of graduating from institutes of higher education in a bad economy in Russia in 2000-2016. In particular, I study the effect of starting a career under unfavorable economic conditions for the whole population of college graduates, the gender difference in the effect and the potential mechanisms behind the estimated effects.

The identification of the causal effect of graduating in a bad economy is a hard task as the timing of graduating might be correlated with the labor market conditions. To identify the causal effect of interest, I instrument an endogenous timing of graduation with an indicator for an exogenous timing of graduation (Kahn, 2010).

The results show that highly educated men who are unlucky to graduate in a recession have the negatively affected wages right after graduation. Although the initial negative effect gradually dissipates as the economy recovers, it still persists several years after graduation. Contrary to the effect on men, no immediate effect of graduating in a bad economy is identified on the hourly wage among women. The negative effect appears three to five year after graduation, though. However, in comparison to men, the negative effect on the hourly wage among women tends to increase over time.

An analysis of the potential mechanisms shows that men and women graduating in a bad economy on average had lower quality jobs which might explain the lower hourly wages right after graduation and over time. No gender difference in the effect of graduating in a bad economy on the job quality is identified. Additionally, women graduating in a recession tend to transit to parenthood faster.

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Chapter 1

Childlessness, Number of Children and The Labor Market at the Time of a New Technology, the US 1980-2018*

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1 Introduction

A vast economic literature shows that structural change (Kuznets (1957), Baumol (1967), Jorgenson & Timmer (2010), Herrendorf et al. (2013), Bárány & Siegel (2018) etc.), import competition and offshoring (Crino (2009), Kemeny & Rigby (2012), Autor et al. (2013b), Becker et al. (2013), Autor et al. (2014), Acemoglu et al. (2016) etc.) and the adoption of a new computer-based technology (Autor et al. (2003), Autor et al. (2006), Goos & Manning (2007), Goos et al. (2009), Autor & Dorn (2013), Goos et al. (2014), Michaels et al. (2014) etc.) have been the major forces shaping economies in the US and other advanced countries in the second half of the 19th and the beginning of the 20th centuries. While the effect of these forces on industries, firms and labor markets is well established, we still lack a comprehensive picture of what impact changes on the labor market induced by these forces has further down the line on the outcomes of families and children.

Computer-based technology was first introduced to American working places in the late 1970s. Shortly after that, in the 1980s, a large absolute decline in the price of computer power began. From then on, the price of computer power continued to fall by 60 to 75 percent annually (Nordhaus, 2007). The computer adoption in the US resulted in broad changes on the labor market that can be described by two major phenomena. The first is job polarization, i.e. faster growing employment in high-wage abstract tasks dominated occupations and low-wage manual tasks dominated occupations relative to middle wage routine task dominated occupations, as computers became substitutes for the routine-task intensive jobs in the middle of the wage distribution, complements to the abstract jobs in the upper part of the wage distribution and neither complements to nor substitutes for the service jobs at the lower end of the wage distribution (Autor et al. (2003), Autor & Dorn (2013)). The second is a shift in the relative demand for and the return to analytical and interpersonal skills. Although computers can easily substitute for motor skills and physical strength, machines are (for the time being) less potent when it comes to analytical skills and interpersonal skills (Bacolod & Blum (2010), Beaudry & Lewis (2014), Autor (2015), Deming (2017)).

At the same time, family fertility outcomes have undergone substantial changes. The share of childless women aged 20-39 increased from .40 to .54, while the share of women in the same age group with at least two children decreased from .41 to .29 between 1980 and 2018. Furthermore, postponed fertility - measured by the share of women aged 40-44 with a young child - occurs twice as often. The share of mature women with a child aged below

5 increased from .05 to .12 between 1980 and 2018.[2]

The literature on the economics of fertility has a long history of studying the association between parental labor market outcomes and the number of children in the family (Becker (1960), Becker (1965), Willis (1973), Hotz et al. (1997)). In a nutshell, under the assumption that fertility decisions are made by partners together, the theories suggest that the labor market opportunities of both a husband and a wife have an impact on a fertility decision and that this decision depends on the interplay between parental preferences for the quantity and quality of children.

In this paper, I am interested in the impact of simultaneous changes in the labor market opportunities of both partners in a household induced by the adoption of computer-based technology in the late 1970s on family fertility outcomes in the US 1980-2018. In other words, I am interested in the total effect of all labor market changes stemming from the new technology adoption on family fertility outcomes.

To analyze the effect of interest, I need a variable that captures simultaneous changes in the labor market opportunities of both household partners induced by the technology adoption. To this aim, I adopt Autor & Dorn's (2013) approach and exploit the cross local labor markets variation in the historical specialization in routine task intensive occupations and thus the intensity of the new computer-based technology adoption to capture changes on the local labor markets induced by the new technology.

Autor & Dorn (2013) develop and empirically test a model of "routine-task" replacing technological change where technological change takes the form of a declining price for computer power. Autor & Dorn's (2013) model predicts that commuting zones with a historically high employment share in the routine task intensive occupations will experience a differential adoption of computer-based technology, a faster reallocation of the labor force from the routine-intensive jobs and differential changes in employment and wages on the local labor market after 1980.

Following Autor & Dorn (2013), I use the historical employment share in occupations with a high routine-task content (RSH) as a right-hand side variable of the regression model. RSH is constructed for each commuting zone (722) at the beginning of three decades and an eight year period that together cover the period from 1980 to 2018. RSH is further instrumented with a 1950 industry mix measure to identify the causal effect of historical

[2]See Appendix Table 5. Own calculations from Ruggles et al. (2015).

differences in the industrial composition across commuting zones (Autor & Dorn, 2013). The left-hand side variables are constructed as decade and eight-year period changes in the shares of women with children among women with different socio-economic backgrounds.

Building on the predictions from the theories in the economics of fertility (Becker (1960), Becker (1965), Willis (1973), Hotz et al. (1997)), the theoretical predictions in Autor & Dorn (2013) and the empirical results in Autor & Dorn (2013), Bacolod & Blum (2010), Beaudry & Lewis (2014), Deming (2017) etc., I expect that commuting zones with a greater historical specialization in routine-task intensive occupations were characterized by a faster adoption of computer-based technology and subsequent larger changes in family fertility outcomes in the US 1980-2018. My hypothesis is that commuting zones with a historically higher employment concentration in routine-task intensive occupations have adopted the new computer-based technology faster since the late 1970s and consequently saw greater observed changes on the local labor markets after 1980. Greater changes in the labor market outcomes further led to larger changes in the family fertility outcomes.

The estimation results show support for my expectations. I find that among women in the age group 20-39 of any level of education, the shares of women with at least one and at least two children, respectively, decreased by more in commuting zones with an initially greater specialization in routine task intensive occupations. The result is economically and statistically highly significant and is driven by college educated women. When it comes to women in the age group 30-39 with college education, the shares of women with at least one child and at least two children decreased. In contrast, the shares of women with at least three and more than three children increased by more in historically routine task intensive labor markets between 1980 and 2018. This implies that college-educated women aged 30-39 who already had children had an additional child more often in commuting zones with a greater initial RSH. Concerning the share of women aged 40-44 with any education, the share of women with a young child increased by more in commuting zones with a historically high routine-task employment share between 1980 and 2018, in other words postponed fertility increased by more in routine task intensive commuting zones. The decrease in the shares of women aged 20-39 of any education with at least one child and with at least two children, respectively, was larger in magnitude than the increase in the share of women aged 40-44 of any education with a young child.

A number of studies investigate the impact of shocks to the labor market on family fertility outcomes. Autor et al. (2019) explore the effect of large scale, exogenous trade-induced shocks to local manufacturing employment for young men vs young women, stemming from rising import competition from China on marriage and fertility outcomes in the US between 1990 and 2014. Autor et al. (2019) find overall decreased fertility rates with an increased share of birth given by teen mothers and single mothers in response to the negative manufacturing employment shocks. Additionally, Autor et al. (2019) show that negative shocks to male-intensive employment result in decreased fertility, while the opposite applies to the shocks to female-intensive employment. Shenhav (2016) analyzes how a change in the relative female to male wage facilitated by a shift in the return to skill induced by the adoption of computer-based technology affected the family and labor market outcomes of women in the US between 1980 and 2010. Shenhav (2016) shows that an increased relative wage resulted in a rise in the probability of having children outside of wedlock.

Other studies in economics analyze how general labor market conditions affect the fertility outcomes. For example, Schaller (2016) studies how the overall labor market situation measured with unemployment rates is associated with fertility rates. Schaller (2016) finds that improved general labor market conditions result in a rise in the fertility rates for women of all levels of educational attainment, while improved labor market conditions for women are associated with a small, negative and only sometimes statistically different from zero effect. Further, several studies analyze how shocks to family total income and the husband's wage affect the fertility decisions (Lindo (2010), Amialchuk (2013), Black et al. (2013), Lovenheim & Mumford (2013), Dettling & Kearney (2014)). These studies find that negative income shocks reduce fertility, while, in contrast, positive income shocks increase fertility.

In this paper, I contribute to the literature in several ways. First, I provide new evidence for the total effect of the labor market changes induced by the adoption of computer-based technology on fertility outcomes. In comparison to Autor et al. (2019), I analyze the effect of another type of shock to the labor market. Regions susceptible to trade shocks, which are the focus of the analysis in Autor et al. (2019), experienced a net employment decline in manufacturing and among low skill workers, while regions susceptible to computerization, which are analyzed in this paper, were characterized by occupational polarization and a shift in skill return, but did not experience a net employment decline (Autor et al., 2015). Further, Autor et al. (2013a) show that the regional exposure to technological change was not correlated with the regional exposure to trade competition from China; additionally, the impact of the new technology was present throughout all American regions, while the impact of trade was more geographically concentrated.

In contrast to Shenhav (2016), who studies the effect of an improved relative female wage facilitated by the shift in the return to skill induced by technology adoption, I provide evidence for the total effect of the labor market changes - job polarization and a shift in the return to skill - associated with technology advancement that simultaneously affected the labor market opportunities of both household partners on household fertility outcomes.

Second, previous papers studying the impact of the shocks to the labor market on fertility outcomes mainly focus on fertility rates - the number of children born per thousand women of childbearing age (Schaller (2016) and Autor et al. (2019)).[3] The use of fertility rates does not allow us to differentiate the effect based on the order of birth, since the fertility rates treat both a woman giving birth to her first child and a woman giving birth to her third child identically. This is particularly unfortunate since the number of children born to women of different socioeconomic backgrounds might respond differently to labor market shocks. In this paper, I estimate the effect on the share of women with at least one child, the share of women with at least two, at least three children and more than three children in different education-age groups. This allows me to analyze where on the distribution of births and for women of different socioeconomic background the effect is concentrated.

Third, I study the effect on postponed fertility, namely the effect on the share of women aged 40 to 44 with a young child. This outcome has not previously been given much attention in this context either.

Apart from the literature in economics studying the impact of shocks to the labor market on the outcomes of families, this paper is also related to a large body of research in sociology and demography studying factors affecting the family fertility behavior (see Butler (2004), Sobotka (2004), Morgan & Taylor (2006), Mills et al. (2011) and Balbo et al. (2013) for comprehensive reviews).

The rest of the paper is organized as follows. Section 2 presents a theoretical and empirical background. Section 3 contains data and descriptive statis-

[3] Other outcomes studied in the previous literature include the probability of being a single mother (Autor et al. (2019), Shenhav (2016)) and the probability of being a teen mother (Autor et al., 2019).

tics. Section 4 presents the model and the identification strategy. Section 5 presents results and robustness tests. Section 6 concludes the paper.

2 Theoretical and Empirical Background

Adoption of a new computer-based technology and changes on the labor market

Computer-based technology was first introduced to American working places in the late 1970s. Shortly after that, in the 1980s, a large absolute decline in the price of computer power began. From then on, the price of computer power continued to fall by 60 to 75 percent annually (Nordhaus, 2007). The adoption of the computer-based technology resulted in broad changes on the labor market that can be described by two major phenomena: job polarization and a shift in the relative return to skills.

Job polarization is a hollowing out of the labor market as computers substitute for middle-skilled labor performing routine tasks and a complement to high-skilled labor performing abstract tasks (Autor et al. (2003), Autor et al. (2006), Autor & Dorn (2013), Goos et al. (2014)). In the model of "routine-task" replacing technological change, each occupation is classified by three tasks: routine, manual and abstract (Autor et al. (2003), Autor & Dorn (2013)). Routine tasks are repetitive, easily codifiable tasks prevalent in occupations in repetitive assembling, production, monitoring as well as bookkeeping and clerical work. Abstract reasoning tasks are such tasks as problem solving and coordination concentrated in managerial, professional and technicians' occupations. Finally, manual tasks are common in service occupations such as personal assistance and care, food preparation and service workers, security workers, gardeners, maids, child care workers, personal healthcare and beauty workers, personal trainers (Autor et al. (2003), Autor & Dorn (2013)).

While service occupations do not require any specific training and are located at the bottom of the occupational skill distribution, production and office occupations do require some training and are located in the middle of the occupational skill distribution. These two groups of occupations are usually occupied by non-college educated workers. Managerial and professional occupations requiring special training are located at the top of the occupational skill distribution and are mainly occupied by college educated workers. While computers are currently neither a strict substitute nor a complement to workers performing manual tasks, computers are a substitute for workers performing routine tasks that are easily codifiable and a complement to workers performing abstract tasks (Autor et al. (2003), Autor & Dorn (2013)).

As the price of computer power declined, the adoption of computer-based technology allowed us to rationalize and substitute for expensive human labor in occupations with a high routine-task content. As a result, there was a marked decline in the employment shares in the majority of occupations concentrated in production, assembling and office and clerical work. Released labor reallocated to service occupations and to a lesser extent to managerial and professional occupations. Computers became a complementary tool for workers mainly performing abstract tasks such as problem solving, analytical reasoning and coordination in managerial and professional occupations. As a result, the employment shares in the occupations at the bottom and at the top of the occupational skill distribution increased, while the employment shares in the middle of the occupational skill distribution decreased resulting in job polarization (Autor et al. (2003), Autor & Dorn (2013)).

In contrast to Autor et al. (2003) and Autor & Dorn (2013) that classify skills as being useful to produce routine versus nonroutine tasks, i.e. routine tasks versus abstract and manual tasks, Bacolod & Blum (2010) and Weinberger (2014) use an alternative classification of skills to capture different aspects of skills that are necessary to perform an occupation. Using alternative classifications of skills, Bacolod & Blum (2010) and Weinberger (2014) document a shift in the relative return to cognitive and interpersonal skills caused by technology advancement.

Deming (2017) focuses on nonroutine cognitive and nonroutine social skills. Deming (2017) shows that while the demand for and the wages in social skill intensive occupations grew rapidly between 1980 and 2012, employment and wage growth were particularly strong for occupations requiring a high level of both cognitive and social skills.[4] One possible explanation for this provided by technological change is that skills and tasks that cannot be substituted by computers are usually complemented by them, as are social interactions, which have to date been shown to be difficult to automate (Autor (2015), Deming (2017)).

Bacolod & Blum (2010) identify four groups of skills: motor,[5] cognitive,

[4]Weinberger (2014) also finds a complementarity between social and cognitive skills.

[5]In comparison to Autor et al. (2003), for example, Bacolod & Blum (2010) use the DOT variables fingdex (finger dexterity) and eye-hand (eye-hand-foot coordination)

people and physical strength. According to Bacolod & Blum's 2010 classification, occupations with a high level of motor and manual requirements are physicians and surgeons, veterinarians, machinists, draftsmen, technicians, toolmakers and setters, while occupations with a high level of cognitive skills are geologists and geophysicists, engineers, lawyers and judges. Occupations demanding a high level of people skills include clergymen, college professors, lawyers and judges, teachers, social and welfare workers. Finally, occupations requiring a high level of strength are plumbers and pip fitter, plasterers, charwomen and cleaners. Bacolod & Blum (2010) show that the demand for and the returns to cognitive and people skills increased, while the demand for and the return to motor skills decreased during the 1970s and 1980s. Additionally, interpersonal skills did not become more valuable in themselves but became more valuable by becoming more complementary to cognitive and motor skills (Bacolod & Blum, 2010).

The adoption of a computer-based technology benefited relatively better college educated workers as they were more represented in abstract task intensive occupations located at the upper tail of the occupational skill distribution. Changes on the labor market were unbalanced not only with respect to education level, but also with respect to gender. Women relative to men experienced a much sharper increase in employment in highly skilled abstract tasks occupations located in the upper part of the occupational skill distribution. Women relative to men have also experienced a sharper decline in employment in routine tasks dominated occupations located in the middle of the occupational skill distribution (Acemoglu & Autor (2010), Autor & Price (2013) and Autor & Wasserman (2013)).

A shift in the relative return to skill was present across genders and educational groups (Deming, 2017). However, women, who are naturally relatively more endowed in cognitive and interpersonal skills than in motor and physical strength skills, increased their representation in cognitive- and interpersonal intensive occupations by more than men and experienced a greater growth in return to skills relative to the their male counterparts (Beaudry & Lewis (2014), Bacolod & Blum (2010)).

Theoretical models in economics of fertility

In the economic literature, fertility behavior is viewed through the lenses of

to categorize the motor skills requirement, while Autor et al. (2003) use these DOT variables to categorize routine manual and nonroutine manual tasks, respectively.

the choice-theoretical framework of neoclassical economics.[6] In this model parents, viewed as consumers, choose the number of children that maximizes their utility function given their budget constraint and the price of children. The unit of time is parents' lifetime span. This model generates a demand for children function depending on the price of children and parental income which decreases on the latter and increases on the former. Standard income and substitution effects from consumer theory characterize the effect of the change in the "price of children" on completed fertility, and the standard income effect characterizes the effect of a change in parental income with respect to the "purchase" of children.

The correlation between income and fertility has, however, been shown to be negative both in time-series and cross-section.[7] This empirical puzzle contradicting the theory gave rise to several important extensions of this simple fertility model: the quality-quantity model and the model of female time allocation and the demand for children.

Becker (1960) developed a quality-quantity model stating that parents have stable preferences both for the number and the quality of children. In a newly formed family, partners are assumed to act as a single decision maker. Preferences are given by the utility function

$$U = U(n, q, s), \tag{1}$$

where n stands for the number of children, s for the parents' standards of living, and q for quality per child. The household's life time budget constraint is given by

$$I = p_c n q + p_s s, \tag{2}$$

where I stands for total family life time income, p_c for a price of goods and services devoted to children and p_s for a price index of goods and services consumed by adults.

An important implication of the model in equations 1 and 2 stressed by Becker (1960) is that income elasticities of demand for n, q and s must satisfy the following relationship

$$\beta(\varepsilon_n + \varepsilon_q) + (1 - \beta)\varepsilon_s = 1, \tag{3}$$

where β is the share of family income devoted to children and the εs stand for the income elasticities. Given that children are normal goods, i.e. the

[6]The discussion in this subsection draws on Hotz et al. (1997).

[7]For instance, Jones & Tertilt (2006) study the relationship between fertility and income for five-year birth cohorts of women between 1826-1960 in the US and show that it was negative for each cohort. See also Hotz et al. (1997).

demand for children and total expenditures on children increase as income increases, the sum of the income elasticities on the number and quality of children must be positive (i.e., $(\varepsilon_n + \varepsilon_q) > 0$). The income elasticity of demand for the number of children can be negative (i.e., $\varepsilon_n < 0$), if the income elasticity of quality is large enough.

Based on Becker's (1965) theory of allocation of time, Willis (1973) developed another model recognizing the importance of female time allocation between the labor market and household work on family fertility behavior. Willis's (1973) static model derives the effect of exogenous variations in the husband's income and the wife's wage rate on fertility and the wife's labor supply decisions. The model assumes that a married couple makes all decisions together and derives utility from adult standards of living and from the number and the quality of children as given in the equation 1. Adult standards of living and children cannot be directly purchased on the market. Instead, the household uses the non-market time of household members and buys goods as inputs into the household production process. The outputs, adult standards of living and children, enter the household's utility function. The model further assumes that the husband specializes in market work and his income, H, is taken as exogenous. The wife allocates her time between household production and market work, L, for the real wage rate, w. Total family income is, therefore, $I = H + wL$. Household's production occurs with the constant return to scale production functions, $s = f(t_s, x_s)$ and $c = f(t_c, x_c)$, where t_s and t_c are the wife's time inputs and x_s and x_c the purchased goods used for the production of adults' standards of living and children, respectively. The total time of the wife is given by $T = L + t_s + t_c$, and the household budget constraint is given by $I = H + wL = x_s + x_c$. Finally, the satisfaction from children is given by $c = nq$, where n and q are the number and the quality of children in the family, respectively.

Willis's (1973) model shows that an increase in the wife's market wage results in a greater total household income and greater opportunity costs of children. The overall effect of an increase in the female wage on child services, c, is not obvious as the negative substitution effect might be offset by the positive income effect. Even if the income effect dominates, i.e. $c = nq$ increases, fertility might either increase or decrease depending on the interrelation between parental preferences for the quality and quantity of children. An increase in the husband's income, H, will result in a greater total family income and a greater demand for children services. The effect on fertility will once more depend on the parental quantity-quality preferences.

Theories in the economics of fertility assume that fertility decisions are made by partners together and show that the labor market opportunities of both a husband and a wife have an impact on a fertility decision and that this decision depends on the interplay between parental preferences for the quantity and quality of children.

Assume that a shock to the labor market, for example, the adoption of the computer-based technology, simultaneously affects the labor market outcomes of both partners in the household. Then, a household fertility decision will potentially be affected by changes in the labor market opportunities of both household partners. In this case, the analysis of the impact of a change in one particular labor market outcome of only one partner in the household on the household fertility decision might reveal only part of the picture and miss the rest.

Therefore, when it comes to the analysis of the effect of labor market changes induced by a particular shock that simultaneously affected the labor market opportunities of both partners in the household, it might be motivated and important to analyze the total effect of all labor market changes on household fertility outcomes to obtain a complete picture. This is the aim of the empirical analysis in this paper.

3 Data and Descriptive Statistics

In this paper, I study the relationship between period changes in family fertility outcomes and the historical routine employment share in the US between 1980 and 2018. The hypothesis is that commuting zones with a historically greater routine employment share have adopted the new computer-based technology faster since the late 1970s and they have thereafter seen greater changes on the local labor market after 1980. Greater changes on the labor market further led to larger changes in the family fertility outcomes in commuting zones with a greater initial routine employment share between 1980 and 2018. I estimate an equation where on the right-hand side I have the routine employment share at the beginning of a period and on the left-hand side I have a period change in an outcome variable. In order to construct these variables, I use individual level data from the Integrated Public Use Microdata Series (IPUMS). IPUMS consists of surveys of the samples of the American population drawn from US federal censuses in 1980, 1990 and 2000 and the American Community Surveys (ACS) in 2010 and 2018 (Ruggles et al., 2015).

I construct the shares of women with children as fertility outcomes. The following outcomes are constructed:

- the share of women with at least one child,
- the share of women with at least two children,
- the share of women with at least three children, and
- the share of women with more than three children.

The outcome variables are constructed for women of three educational levels (any educational level, college educated and non-college educated[8]) and three age groups (20-39, 20-29, 30-39).

The geographical unit in my analysis is a commuting zone (722) (Autor & Dorn, 2013). Commuting zones are characterized by strong commuting ties within commuting zones and weak commuting ties across commuting zones. 722 commuting zones cover the mainland of the US and approximate the local labor markets (Autor & Dorn, 2013).

The way in which questions in the IPUMS are formulated causes several limitations to the construction of the outcome variables. The IPUMS variable used to construct the number of children in the household shows the number of own children (of any age or marital status) currently residing with each individual in a household. When a child moves out, she is no longer counted among the individual's children. Assuming that children tend to move out starting from the age around 16-18, data limitations imply that I cannot construct the number of children born to women roughly older than 39. This also implies that the number of outcomes might contain a measurement error. The shares of women in the age brackets 20-39 and 30-39 with at least one child, with at least two children, with at least three children and more than three children might be underestimated, and, therefore, regression estimates from the models with these outcomes should be interpreted with some caution. In section 5, I present results from a sensitivity test where I re-estimate the main regression models with fertility outcomes constructed for women in more narrow age brackets. The estimation results are not sensitive to the change in the age brackets.

The fact that it is not possible to construct the number of children born to women up to 44 years old is particularity unfortunate because changes on the labor market could affect the so-called postponed fertility. To capture the

[8] College is defined as either college or college plus, and non-college is defined as some college, high school and less than high school.

effect on fertility patterns of women aged above 40 and postponed fertility, I construct an additional fertility outcome - the share of women with a child aged below 5. For comparison and consistency this outcome is constructed for women aged 20-39, 20-29, 30-39 and 40-44 by three educational levels.

Construction of routine employment share, RSH

To construct the routine employment share, RSH, I use the occupational composition of employment (Autor et al. (2003), Autor & Dorn (2013)). I use 322 consistent occupations and the corresponding occupational routine, manual and abstract task inputs.[9] I combine task inputs into a measure of routine task-intensity for each occupation, RTI_o, according the the formula

$$RTI_o = ln(T_o^R) - ln(T_o^M) - ln(T_o^A), \tag{4}$$

where T_o^R, T_o^M and T_o^A are, respectively, routine, manual, and abstract task inputs in each occupation o (Autor et al. (2003), Autor & Dorn (2013)).[10] This measure increases in the importance of routine tasks and declines in the importance of manual and abstract tasks in each occupation. The RTI_o measure takes low values at the bottom and the top of the skill distribution, where manual and abstract tasks dominated occupations are located, and high values in the middle of the skill distribution where the routine task dominated occupations are located (Autor et al. (2003), Autor & Dorn (2013)). Further, I assign occupations into three terciles according to their values in RTI_o distribution. Occupations in the top tercile of the RTI_o are referred to as routine task-intensive occupations (Autor et al. (2003), Autor & Dorn (2013)).[11] I create a dummy variable set to unity if an occupation belongs to the routine task-intensive occupations, and zero otherwise.

Then, I assign a routine-task intensity dummy to all workers according to their occupation in IPUMS data files. Finally, I calculate the employment share in routine-task intensive occupations, RSH, in each commuting zone at the beginning of each decade during the period 1980-2018 (Autor & Dorn,

[9] The input data for occupational task originally comes from the *Dictionary of Occupational Titles* 1977 in the fourth edition of the US Department of Labor's *Dictionary of Occupational Titles* (Autor et al. (2003), Autor & Dorn (2013)). The data file is available at David Dorn's data page http://www.ddorn.net/data.htm

[10] The tasks are measured on a scale from 0 to 10.

[11] Included in the occupations with high routine-task intensity are, for example, bank teller, secretaries and stenographers, file clerks, typists. While included in occupations with low routine-task intensity are, for example, athletes, sport instructor, and officials, fire fighting, fire prevention, and fire inspection occupations, railroad conductors and yardmasters, recreation and fitness workers.

2013).[12] Routine employment, RSH, is, in other words, a measure of employment concentration or specialization in occupations with a high routine-task content in each commuting zone at the beginning of the decade. This measure takes greater values in the commuting zones with a larger employment concentration in occupations with a high-routine task intensity and lower values in the commuting zones with a lower employment concentration in occupations with a high-routine intensity content. Therefore, the variation in RSH is due to across time and space differences in employment concentration in occupations with a high routine-task intensity.

Descriptive statistics

Table 1 presents descriptive statistics for period changes in outcome variables. The majority of the outcome variables showed a negative change in each period between 1980 and 2018. Only the shares of women aged 30-39 and the shares of women aged 40-44 with a child aged below five make an exception. These shares showed a positive change during the period of the study.

Appendix Table 6 shows descriptive statistics for the routine employment share and the control variables in levels for 1980 and 2010. The development of the mean number of education years separately for men and women shows that since 1980, women have first caught up with and then outpaced men in the level of educational achievements. The share of black was stable at around .12 while the share of Hispanic increased from .065 to .164 between 1980 and 2010. The share of the foreign born population doubled and went up from .087 in 1980 to .137 in 2010.

The unemployment rates rose for men and women of both educational levels. For instance, the unemployment rate among non-college men increased from 7.5 percent in 1980 to 14.1 in 2010. At the same time, the share of unemployed college men increased from 1.9 percent in 1980 to 5.1 in 2010. The share in the labor force increased for women with both college and non-college education, while it decreased for men of any educational level (Appendix Table 6).

The share employed in the manufacturing sector declined for both men and women of any educational level, while the share employed in high-skilled services increased for both men and women of any educational level 1980-2010. The mean offshorability index of employment increased among college

[12]The sample used to construct RSH consists of workers between 16 and 64 years old.

educated men and women, decreased among non-college educated women and remained unchanged among non-college educated men between 1980 and 2010 (Appendix Table 6).

The share of employment in routine-task intensive occupations, RSH, decreased from .334 (se .034) in 1980 to .289 (se .019) in 2010 (Appendix Table 6).

4 Model and Identification Strategy

The relationship between period changes in a fertility outcome and the routine employment share at the start of a period is formulated by the below regression model:

$$\Delta Y_{pst} = \beta_0 + \beta_1\, RSH_{pst_0} + X'_{pst_0}\beta_2 + \delta_{t_0} + \gamma_s + u_{pst}, \tag{5}$$

where p defines the commuting zone (722) and s defines state (50). ΔY_{pst} is a change in one of the fertility outcomes over a period t_0 to t_1 in commuting zone p in state s. RSH_{pst_0} is the routine employment share in commuting zone p in state s at the start of a period t_0 to t_1. The equation 5 is composed of four stacked equations: three equations represent a decade each and one equation represents an eight-year period. The equation covers a period between 1980 and 2018. δ_{t_0} are start of a period fixed effects capturing time-specific shocks. γ_s are state fixed effects capturing state-specific time invariant characteristics. Standard errors are clustered at the state level to allow for overtime and within state error correlation. u_{pst} is an error term.

The vector of control variables, X'_{pst_0}, is defined at commuting zone p and the start of a period t_0 to t_1. To take into account secular trends in the educational composition of the population, I include two sets of control variables. The first set includes the average number of education years constructed by gender and age group (20-29, 30-39). The second set contains the shares with college education (at least a completed Bachelor degree) also by gender and age group. The shares of white, black and Hispanic (the share of other races is excluded and serves as base level and the share of foreign born are included to control for the racial and immigrant composition of commuting zones. Sex ratios constructed by age group are included to control for the sex composition of commuting zones.

Structural change - the reallocation of labor away from the broadly defined manufacturing sector and to high- and low-skilled services sectors[13] - has been observed in the US since 1950-1960 (Bárány & Siegel, 2018). To ensure that my estimates do not pick the effect of changes on the labor market caused by structural change, I include employment shares in the broadly defined manufacturing sector and the broadly defined highly-skilled services sector constructed by gender and educational level. The employment share in the low-skilled services sector is omitted and serves as a base level.

Globalization - accelerating import competition and offshoring[14] - is another important factor affecting the labor market between 1980 and 2010. To account for the potential offshoring of jobs, I follow the standard approach in the literature and use the offshoring index, measuring the offshoring potential of occupations, rather then the actual offshoring that takes place (Firpo et al. (2011), Autor & Dorn (2013) and Blinder & Krueger (2013)). The commuting zone offshorability index is constructed as the mean offshorability score of employment by gender and educational level.[15] Further, I include labor force participation rates and unemployment rates[16] by gender and educational level.

[13]The low-skilled service sector includes such industries as personal services, low-skilled transport, low-skilled business and repair services, retail and wholesale trade. The manufacturing sector contains such sectors as mining, construction and manufacturing. Finally, the high-skilled services sector includes such industries as professional and related services, finance, insurance and real estate, communications, high-skilled business services, utilities, highly-skilled transport and public administration (Bárány & Siegel, 2018).

[14]There is a belief that trade and technology are closely integrated forces and that occupational tasks that can be codified and automated are also easily offshorable. Blinder & Krueger (2013) use survey data to create several offshorability measures based on self-reporting as well as on judgements of professional coders. Blinder & Krueger (2013) show that the definitions of routinizability and offshorability are conceptionally different. They also show that jobs that can be routinized are as highly offshorable as non-routinizable jobs and that routinizability and offshorability are negatively correlated. Autor et al. (2013a) construct another measure of offshoring and import competition based on the realized trade shocks. Autor et al. (2013a) show that regional exposure to technological change was not correlated with regional exposure to trade competition from China; additionally, the impact of the new technology was present throughout all American regions, while the impact of trade was more geographically concentrated.

[15]The offshorability index is derived from the US Department of Labor's Occupational Informational Network database (O*NET) by Firpo et al. (2011). This index measures the extent to which occupations require face-to-face interactions, the proximity to and the presence on some specific work location or in-person care to others (Acemoglu & Autor, 2010). The index is increasing in offshorability.

[16]Unemployment rates also capture economic uncertainly more generally.

Identification strategy

In this paper, I investigate the relationship between decade changes in family fertility outcomes and the historical routine employment share in the US between 1980 and 2018. To this aim, I adopt Autor & Dorn's (2013) approach.

In Autor & Dorn's (2013) model of "routine-task" replacing technological change, technological progress takes the form of the falling price of computer power. The model hinges on several observations strongly supported by a large number of evidence. First, computers substitute for low skilled non-college workers performing *routine* tasks (bookkeeping, clerical work, and repetitive production and monitoring activities located in the middle of the occupational skill distribution). Second, computers are a complement to highly skilled college educated workers engaged in *abstract* reasoning tasks such as problem solving and coordination (professionals and managerial occupations located at the top of the occupational skill distribution). Then, computers do currently neither directly substitute for nor strongly complement low skilled non-college workers performing *manual* tasks (truck drivers, waiters, and janitors - service occupations[17] located at the bottom of the occupational skill distribution).

Autor & Dorn's (2013) model predicts that as the price of computer power declines, commuting zones with a historically greater routine employment share, RSH, will experience a faster adoption of computer-based technology. This will further result in greater changes on the local labor markets: a greater reallocation of workers from routine-task intensive occupations to manual-task intensive occupations as well as larger net inflows of highly skill workers, i.e. job polarization.

Further, the adoption of computer-based technology shifted the relative demand for and the return to cognitive and interpersonal skills (Bacolod & Blum (2010), Beaudry & Lewis (2014), Deming (2017) etc.). Skills that (for the time being) cannot be substituted by computer power, such as cognitive and interpersonal skills, are complemented by it (Autor (2015), Deming (2017)). Thus, commuting zones with greater initial routine employment and a faster technology advancement will experience a greater change in the relative wage of workers supplying cognitive and interpersonal skills.

Theories in the economics of fertility show, under the assumption that fertil-

[17]Service occupations also include such jobs as personal assistance and care, food preparation and service workers, security workers, gardeners, maids, child care workers, personal healthcare and beauty workers, personal trainers etc. (Autor & Dorn, 2013).

ity decisions are made by both partners, that the labor market opportunities of both a husband and a wife have an impact on the fertility decision and that this decision depends on the interplay between parental preferences for the quantity and quality of children (Becker (1960), Becker (1965), Willis (1973), Hotz et al. (1997)).

Building on predictions from the theories in family economics (Becker (1960), Becker (1965), Willis (1973), Hotz et al. (1997)), the theoretical predictions in Autor & Dorn (2013) and the empirical results in Autor & Dorn (2013), Bacolod & Blum (2010), Beaudry & Lewis (2014), Deming (2017), Autor (2015) etc., my expectation is that commuting zones with an initially higher routine task specialization adopted the new computer-based technology more quickly after computers had been introduced in the late 1970s and, as a consequence, saw larger changes in family fertility outcomes from 1980 onwards.

My hypothesis is that commuting zones with a greater initial specialization in routine-intensive occupations introduced the computer-based technology faster and thereafter saw greater changes on the local labor markets - growing job polarization and the change in returns to skills. Greater changes on the local labor markets further led to greater changes in family fertility outcomes between 1980 and 2018.

A positive estimate of the parameter β_1 in equation 5 implies that a commuting zone with greater routine employment RSH at the start of a period saw a greater increase in the fertility outcome by period between 1980 and 2018, while a negative estimate of the parameter β_1 implies that a commuting zone with greater routine employment RSH at the start of a period saw a greater decrease in the fertility outcome by period between 1980 and 2018.

Instrument

According to the theoretical model in Autor & Dorn (2013), the variance in historical routine employment is due to historical differences in the industrial composition across commuting zones. The routine employment share at the beginning of a period, RSH_{pt_0}, can therefore be presented as[18]

$$RSH_{pt_0} = RSH_p^* + \epsilon_{pt_0}, \tag{6}$$

where RSH_p^* is "the long-run, quasi-fixed component of industrial structure" and ϵ_{pt_0} is "any unobserved, time-varying" component (Autor & Dorn,

[18]The index for state is omitted for simplicity.

2013). The former (RSH^*_p) determines the routine task specialization in the commuting zones at the beginning of each period, while the latter (ϵ_{pt_0}) contains any other time varying factors. These unobserved time-varying factors might have both a direct impact on family fertility outcomes and an indirect impact through changes on the labor market.

For example, the "unobserved, time-varying" component ϵ_{pt_0} might contain the establishment and the expansion of public preschools. The establishment and expansion of public preschools might have a positive effect on the number of children in a family and thus have a direct effect on fertility outcomes.

At the same time, the establishment and expansion of public preschools increases the demand for low skilled service workers such as child care workers, food service and kitchen workers, cleaners etc. This leads to a faster reallocation of workers from routine task intensive occupations to service occupations. The routine employment share at the beginning of a period, RSH_{pt_0}, will therefore decline relative to "the long-run, quasi-fixed component of industrial structure" RSH^*_p. The establishment and expansion of public preschools will thus lead to a false relationship between RSH_{pt_0}, the adoption of the new technology and consequent changes on the labor market that are not caused by RSH^*_p. This will further result in a biased relationship between the routine employment share at the beginning of the period and period changes in fertility outcomes.

In addition, research shows that the establishment and expansion of public preschools have a positive effect on mothers' labor force participation (see Morrissey (2017) for literature overview) which might also influence the family fertility outcomes.

To solve the problem with the potential bias and isolate the effect running from historical differences in the industrial composition across commuting zones, I instrument for the routine employment share at the beginning of a decade with a predicted value for the routine employment share in 1950 (Autor & Dorn, 2013). This measure, called the 1950 industry mix, is constructed as a product of the local industry mix in 1950 and the national occupational structure of industries in 1950 as follows:

$$\overline{RSH}_p = \sum_{i=1}^{I} E_{i,p,1950} \times R_{i,\text{-}p,1950}, \tag{7}$$

where $\sum_{i=1}^{I} E_{i,p,1950}$ is the employment share of industry $i \in 1, ..., I$ in commuting zone p in 1950. $R_{i,\text{-}p,1950}$ is the routine employment share among workers in industry i in 1950 in all US states with the exception of the state that includes commuting zone p. Since $\overline{RSH}_p$ is determined several decades before 1980, $\overline{RSH}_p$ is expected to be strongly related to "the long-run component of routine occupation share," RSH_p^*, but unrelated to the time-specific factors influencing the routine employment share in each particular time period and reflected in ϵ_{pt_0} (Autor & Dorn, 2013).

The first-stage equation is thus:

$$RSH_{pst0} = \mu_0 + \mu_1 \overline{RSH}_{ps} + X'_{pst_0}\mu_2 + \kappa_{t_0} + \zeta_s + \theta_{pst0}, \tag{8}$$

where p defines commuting zone (722) and s defines state (50). RSH_{pst0} is the routine employment share in commuting zone p in state s at the beginning of the period t_0 to t_1, and $\overline{RSH}_{ps}$ is the 1950 industry mix in commuting zone p, state s. X'_{pst_0} is a set of controls. κ_{t_0} absorbs the beginning of the period time fixed effects and ζ_s captures state fixed effects. θ_{pst0} is an error term. Standard errors are clustered at the state level.

In all 2SLS regression models the instrument, the 1950 industry mix, is interacted with the beginning of the period dummies. The 1950 industry mix, $\overline{RSH}_p$, interacted with the start of the period dummies has a strong predictive power on the routine employment share RSH at the beginning of each period (Appendix Table 8 column 1). The 1950 industry mix is positively associated with RSH at the beginning of each period. The T-statistics are 12.5, 7, 3.5 and 1.5 in the decades starting with 1980, 1990, 2000 and an eight-year period starting with 2010, respectively (Appendix Table 8 column 1). The predictive power of the instrument decreases over time since the influence of the initial factors gradually diminishes.

Appendix Table 8 column 2 also presents estimation results of the regression model 8 where the routine employment share RSH is only regressed against the 1950 industry mix, i.e. without interactions with the start of a period dummies. The estimate is large, positive and highly significant (t-statistics is 6.6).

The main coefficient of interest β_1 in the regression model 5 estimated with 2SLS is identified by within state cross-commuting zone variation.

5 Results

In this paper, I analyze the relationship between changes in family fertility outcomes and the historical routine employment share in the US 1980-2018. In this section, I first present the estimation results. Then, I describe the potential mechanisms. At the end, I show several robustness checks.

5.1 Estimation Results

Table 2 presents estimation results for women in the age group 20-39. The top panel contains results for women of any educational level. The estimation results suggest that commuting zones with an initially higher routine task specialization were characterized by larger subsequent declines in the shares of women with at least one and at least two children, respectively, per decade between 1980 and 2018. When it comes to the share of women with at least one child, the OLS and the IV estimates are highly statistically significant, and the IV estimate is more than three times as large as the OLS estimate. As for the share of women with at least two children, the OLS estimate is negative, small and imprecisely estimated. The IV estimate is negative, large and statistically significant at any conventional significance level. Regarding the share of women with at least three children, the OLS and the IV estimates are small, positive and statistically not different from zero. Concerning the share of women with more than three children, the OLS and the IV estimate are small, positive and statistically significant at the 5 and 1 percent significance level, respectively. The IV estimate is more that twice as large as the OLS estimate. The estimation results thus suggest that the share of women with more than three children has increased by more per decade in routine task intensive labor markets since 1980. The estimate is economically small, however.

The Table 2 middle panel displays estimation results for college educated women in the age group 20-39. The estimation results suggest that the decrease in the shares of women with at least one and at least two children, respectively, in historically routine task intensive commuting zones was to a large extent driven by a decrease among college educated women with children. The IV estimates are highly significant and are of greater magnitude than the corresponding estimates for women of any educational level (Table 2 top panel). The estimation results suggest that a commuting zone at the 80th percentile of RSH in 1980 saw a 3.95 and a 4.08 percentage point larger decline in the share of college-educated women with at least one child and the share of college educated women with at least two children, respectively, per decade between 1980 and 2018 relative to a commuting zone at the 20th percentile.[19] When it comes to the shares of college-educated women with children of higher parities, OLS and IV estimates have mixed signs, which are small and statistically not different from zero.

The Table 2 bottom panel shows estimation results for non-college educated women in the age group 20-39. The estimation results suggest that among non-college educated women, the share of women with at least one child decreased by more in commuting zones with an initially high routine employment. The decline is of a smaller magnitude than that among college-educated women. A commuting zone at the 80th percentile of RSH in 1980 saw a 2.29 percentage point larger decline in the share of non-college educated women with at least one child per decade between 1980 and 2018 relative to a commuting zone at the 20th percentile. No association between the historical employment in routine task intensive occupations and the shares of non-college educated women with at least two and at least three children is identified, respectively. Further, among non-college educated women, the share of women with more than three children increased by more per decade in the commuting zone with a historical routine task specialization after 1980. An OLS estimate is positive, small and imprecisely estimated, while an IV estimate is positive and highly statistically significant. The estimate is economically small, however.

Further, I study whether there are any age-specific effects among college and non-college educated women in the age groups 20-29 and 30-39. Table 3 presents the estimation results. When it comes to younger women without college education, I find that the commuting zone with a historical specialization in routine tasks was characterized by a larger decline in the share of women with at least one child. No association between the routine employment and the shares of women with children of higher parities is identified. Nor is any relationship for college women in the age group 20-29 identified.

Among non-college educated women in the age group 30-39, the share of women with at least two children decreased by more per decade in commuting zones with an initially higher routine task specialization. An OLS estimate is imprecisely estimated, while an IV estimate is only marginally statistically significant at the 10 percent significance level. No association

[19] The difference between commuting zones at the 80th and 20th percentiles of the 1980 RSH distribution is 6.1 percentage points which is approximately equal to two standard deviations of the 1980 RSH distribution.

between the routine employment share and the share of women with at least one child or with children of higher parities is found.

Among college educated women in the age group 30-39, the shares of women with at least one and at least two children, respectively, decreased by more per decade in routine task intensive labor markets between 1980 and 2018. A commuting zone at the 80th percentile of RSH in 1980 saw a 4.19 and 1.92 percentage point larger decline in the share of college women aged 30-39 with at least one child and the share of college women aged 30-39 with at least two children, respectively, per decade between 1980 and 2018, relative to a commuting zone at the 20th percentile. In contrast, the shares of women with at least three and more than three children increased by more per decade in the labor markets with a historically greater routine task specialization 1980-2018. However, the effect on the share of women with at least three children is only marginally significant at the 10 percent significance level. When it comes to the share of women with more than three children, a commuting zone at the 80th percentile of RSH in 1980 saw a 1.70 percentage point larger increase in the share of college women aged 30-39 with more than three children per decade between 1980 and 2018 than did a commuting zone at the 20th percentile.

Finally, I estimate the relationship between the historical routine employment share and decade changes in the shares of women with a child aged below five. The relationship is estimated among women in four age groups - 20-39, 20-29, 30-39 and 40-44. Table 4 presents the estimation results.[20] I start with a description of the results for women in the age groups 20-39, 20-29 and 30-39. The 2SLS estimates suggest that, among women of any educational level in the age group 20-39, the share of women with a young child increased by more per decade in labor markets with an initially higher routine task specialization. The estimation results in the age groups 20-29 and 30-39 suggest that the effect is entirely driven by women in the age group 30-39. Estimates for the age group 20-29 are negative but statistically not different from zero, while estimates for the age group 30-39 are positive and statistically highly significant. This result might indicate that in commuting zones with a historically higher routine-task specialization, a larger share of women have a child later in life.

A similar relationship between the share of women with a young child and the routine employment share is found separately for college and non-college educated women (Table 4 middle and bottom panels). The shares of women

[20]In all models, I add control variables over the educational, sex and labor force composition of the population for the age group 40-44.

in the age group 20-39 with a young child increased by more per decade in the routine task intensive commuting zone between 1980 and 2018. The effect is entirely driven by women in the age group 30-39. The IV estimates are greater in magnitude than the corresponding OLS estimates are statistically highly significant.

When it comes to the effect on postponed fertility, I find that labor markets with a historically higher concentration in routine task intensive occupations were characterized by a larger increase in the share of mature women of any educational level with a young child. While an OLS estimate is imprecise, an IV estimate is statistically significant at the 5 percent significance level. The estimated effect is economically significant. A commuting zone at the 80th percentile of RSH in 1980 saw a 1.35 percentage point larger increase in the share of mature women of any educational level with a young child per decade between 1980 and 2018 than did a commuting zone at the 20th percentile. The association between the shares of mature women with a college and non-college education with a young child and routine employment is positive, but imprecisely estimated.

To summarize, the 2SLS estimates have a greater magnitude and are more precisely estimated than the corresponding OLS estimates, suggesting that the OLS estimates are biased downwards in absolute terms. Overall, the 2SLS estimates suggest that among women in the age group 20-39, the share of women with at least one child and with at least two children declined by more in commuting zones with a greater historical routine employment share. This implies that there was not only a decrease in the share of childless women, but those women who had one child also had another child less often in such commuting zones. The result is driven by women with a college degree. The effect is economically significant. The positive association between the shares of college women in the age group 30-39 with at least three and more than three children and the routine employment share suggests that college women in the age group 30-39, who already had several children, had an additional child more often in commuting zones with a greater historical routine employment share. Further, the postponed fertility among women of any education increased by more in commuting zones with a historically greater specialization in routine task intensive occupations. The decrease in the shares of women of any education with at least one child and with at least two children was, however, larger in magnitude than the increase in the share of mature women of any education with a young child.

5.2 Potential Mechanisms

The 2SLS estimation results described in the above subsection show that commuting zones with a greater initial employment concentration in routine-task intensive occupations did indeed experience differential changes in the shares of women with children between 1980 and 2018. As commuting zones characterized by a faster adoption of computer-based technology saw larger changes on the local labor markets driven by computer-based technology adoption (Autor & Dorn (2013), Bacolod & Blum (2010), Beaudry & Lewis (2014), Deming (2017), Autor (2015)), the estimation results in this paper thus suggest that commuting zones that experienced larger changes on the labor markets induced by the computer-based technology adoption also saw differential development patterns in the shares of women with children.

The chosen form of the analysis does not allow us to study the potential mechanisms, i.e. to analyze how changes in the particular labor market outcomes of each partner in a household impacted family fertility decisions. It might, however, be empirically difficult to disentangle the effects from different labor market outcomes of each household partner since i) the family fertility decision is taken given the labor market opportunities of both partners in a household and ii) the labor market opportunities of both partners in a household are simultaneously affected by technology advancement.

Below, I discuss how changes in the labor market opportunities of both partners in a household could affect the family fertility outcomes in the light of the model of female labor force participation and the opportunity costs of children (Willis, 1973) and the quality-quantity model of demand for children (Becker, 1960).

College workers benefited from the greater demand for college workers performing abstract tasks which was induced by technology adoption. Improved labor market opportunities for college educated women might increase the opportunity cost of children. As a consequence, some college women might decide to have fewer children, while other college-educated women might opt out from childbearing altogether which will lead to a decreased share of college-educated women with children. On the other hand, the growing income of college educated men might result in a greater demand for children, nq. However, this might be reflected in the greater quality of children, q, rather than the number of children, n. A greater quality of children might be interpreted as investment in children's education, as college tuition fees, or as the size of a bequest. All in all, changes in the labor opportunities for college workers combined with greater preferences for the quality of children might result in a lower number of children.

In general, non-college educated workers benefited less from computer technology adoption relative to college educated workers. Along with the advancement of the computer-based technology, the labor market opportunities of many non-college educated workers deteriorated. Worsening prospects on the labor market and lower wages among non-college workers might lead to a negative income effect on a number of children.

5.3 Robustness Check

There are several possible ways of constructing a measure of initial employment concentration in routine-task intensive occupations. The credibility of my estimation results is undermined if they depend on how this measure is constructed. To check this, I use two alternative measures of initial employment concentration in routine-task intensive occupations.

The first alternative measure is the mean routine intensity of employment. It is calculated as a mean of occupational routine task intensity, RTI_o, of all workers in each commuting zone in 1980, 1990, 2000 and 2010 (Autor & Dorn, 2013). The constructed measure, $meanRTI_{\text{-}1}$, has a mean of 1.132 and a standard deviation of .122 in 1980 and a mean of .967 and a standard deviation of .115 in 2010.

The second measure is constructed as an absolute share of workers employed in occupations with a high routine-task content, $absRSH_{\text{-}1}$. Absolute means that this measure does not take into account the actual number of hours supplied on the labor market. This measure has a mean of .309 and a standard deviation of .031 in 1980 and a mean of .288 and a standard deviation of .025 in 2010.

The estimation results with alternative measures are presented in Appendix Table 7. To save space, only 2SLS estimates are shown. Models estimated with the alternative measures of $RSH_{\text{-}1}$ are negative, highly significant and have a similar magnitude.[21] Overall, the estimation results are not sensitive when the alternative measures of employment concentration in routine-task intensive occupations are used.[22]

[21] The estimate with the alternative measure $absRSH_{\text{-}1}$ and the outcome variable share of non-college women with at least two children is negative though imprecise.

[22] I also tried other alternative measures such as the routine employment share constructed as the employment share in the top quartile and the top 40 percent instead of the top tercile of the RTI_o. I received similar results. The estimation results are available

The data limitations imply that the outcome variables constructed for the age groups 20-39 and 30-39 might underestimate the shares of women with children. To check if the estimation results are sensitive to the change in the age brackets, I re-estimate the main regression models with outcome variables constructed for women aged 20-34 and 30-34. Estimates from the estimated regression models are similar to the main estimates both in terms of magnitude and statistical significance.[23] I conclude that my estimation results are not sensitive to the change in the age brackets.

6 Conclusion

In this paper, I analyze the relationship between changes in family fertility outcomes and the historical routine employment share in the US 1980-2010. As commuting zones with a greater initial employment concentration in routine-task intensive occupations adopted computer-based technology faster and consequently experienced greater changes on the local labor markets driven by technology advancement (Autor & Dorn (2013), Bacolod & Blum (2010), Beaudry & Lewis (2014), Deming (2017), Autor (2015)), my hypothesis is that greater changes on the local labor markets further resulted in greater changes in family fertility outcomes. I follow the approach of Autor & Dorn (2013) and exploit cross local labor markets' variation in the routine employment share and thus, the intensity of the new computer-based technology adoption to capture changes on the local labor markets induced by the new technology. I use the routine employment share as a right-hand side variable for which I instrument with a 1950 industry mix measure.

The results from the empirical analysis suggest that commuting zones with a greater initial employment concentration in routine-task intensive occupations indeed experienced differential changes in the family fertility outcomes among women aged 20-39 between 1980 and 2018. I find that among women in the age group 20-39 of any level of education, the shares of women with at least one and at least two children decreased by more in commuting zones with an initially greater specialization in routine task intensive occupations. This implies that not only did the share of childless women increase, but also those women who had one child, had another child less often in such commuting zones. The result is economically and statistically highly signifi-

upon request.

[23] The estimation results are available upon request.

cant and is driven by a decline in the share of college educated women with children.

Further results suggest that the shares of college-educated women in the age group 30-39 with at least three and more than three children increased by more in commuting zones with a high routine employment share. The result suggests that college-educated women aged 30-39, who already had several children, had an additional child more often in commuting zones with a greater historical routine employment share. Concerning postponed fertility, a positive statistically and economically significant relationship is identified between the share of women aged 40-44 of any educational level with a young child and the historical routine employment share.

In this paper I improve our understanding of what effect shocks to the labor market have on family fertility outcomes. In comparison to Autor et al. (2019), analyzing, among other things, the effect of joblessness and reduced income caused by import competition from China, and in comparison to Shenhav (2016) studying the effect of improved relative female wage induced by technology adoption, I investigate the total effect of the changes on the labor market driven by technology adoption on family fertility outcomes. As opposed to previous studies, I use the shares of women with different socioeconomic backgrounds and with different number of children as outcome variables. This allows me to study the effect of labor market shocks on the order of birth for women with different socioeconomic backgrounds.

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7 Tables

Table 1: Descriptive statistics: changes in the shares of women with children

(1)	(2)	(3)		(4)		(5)		(6)	
	Shares of	*1980-1990*		*1990-2000*		*2000-2010*		*2010-2018*	
	women with	mean	sd	mean	sd	mean	sd	mean	sd
Any:									
20-39:	≥1 child	-0.023	0.025	-0.001	0.025	-0.057	0.030	-0.063	0.034
	≥2 children	-0.028	0.025	-0.000	0.025	-0.043	0.029	-0.043	0.031
	≥3 children	-0.024	0.017	0.005	0.016	-0.014	0.021	-0.014	0.024
	> 3 children	-0.016	0.010	0.005	0.009	-0.004	0.011	-0.003	0.013
	young child	-0.001	0.023	0.006	0.016	-0.013	0.026	-0.037	0.031
20-29:	≥1 child	-0.028	0.027	-0.011	0.028	-0.070	0.038	-0.078	0.048
	≥2 children	-0.015	0.022	-0.010	0.024	-0.041	0.031	-0.043	0.036
	≥3 children	0.002	0.013	-0.000	0.014	-0.013	0.018	-0.016	0.023
	> 3 children	0.001	0.006	0.002	0.006	-0.003	0.010	-0.005	0.012
	young child	-0.019	0.024	-0.009	0.025	-0.049	0.035	-0.070	0.043
30-39:	≥1 child	-0.070	0.022	-0.005	0.018	-0.013	0.031	-0.053	0.040
	≥2 children	-0.098	0.025	-0.003	0.024	-0.014	0.037	-0.048	0.044
	≥3 children	-0.082	0.026	0.005	0.021	-0.003	0.032	-0.014	0.039
	> 3 children	-0.046	0.018	0.006	0.012	0.001	0.020	-0.001	0.024
	young child	0.031	0.028	0.018	0.017	0.024	0.034	-0.005	0.041
40-44:	young child	0.011	0.017	0.026	0.016	0.022	0.025	0.008	0.035

Notes: The unit of observation is 722 commuting zones. The variables are changes in the shares of women with the number of children or a young child as specified in column (2). A young child is a child aged below five. The variables are weighted by the commuting zones' share of the national population at the beginning of a period.

Table 1: Descriptive statistics: changes in the shares of women with children, cont.

(1)	(2)	(3)		(4)		(5)		(6)	
	Shares of	*1980-1990*		*1990-2000*		*2000-2010*		*2010-2018*	
	women with	mean	sd	mean	sd	mean	sd	mean	sd
College:									
20-39:	≥1 child	0.005	0.042	0.010	0.036	-0.016	0.050	-0.031	0.056
	≥2 children	0.007	0.043	0.004	0.034	-0.011	0.048	-0.018	0.054
	≥3 children	0.005	0.022	0.004	0.021	-0.005	0.030	0.000	0.036
	> 3 children	-0.001	0.010	0.002	0.010	-0.001	0.015	0.003	0.020
	young child	0.012	0.034	0.022	0.031	-0.008	0.046	-0.026	0.051
20-29:	≥1 child	-0.024	0.048	0.009	0.048	-0.028	0.068	-0.039	0.076
	≥2 children	-0.006	0.031	0.000	0.031	-0.007	0.045	-0.013	0.054
	≥3 children	0.001	0.015	0.001	0.015	-0.001	0.022	-0.001	0.026
	> 3 children	0.000	0.006	0.000	0.006	0.000	0.009	-0.001	0.011
	young child	-0.021	0.047	0.002	0.046	-0.023	0.065	-0.036	0.072
30-39:	≥1 child	-0.051	0.039	0.012	0.035	0.010	0.054	-0.032	0.067
	≥2 children	-0.054	0.045	0.010	0.039	0.001	0.060	-0.027	0.071
	≥3 children	-0.018	0.031	0.008	0.029	-0.003	0.046	-0.001	0.053
	> 3 children	-0.008	0.016	0.004	0.015	-0.000	0.024	0.005	0.032
	young child	0.013	0.047	0.034	0.037	0.012	0.061	-0.023	0.069
40-44:	young child	0.034	0.036	0.038	0.032	0.029	0.061	-0.007	0.075

Notes: The unit of observation is 722 commuting zones. The variables are changes in the shares of women with the number of children or a young child as specified in column (2). A young child is a child aged below five. The variables are weighted by the commuting zones' share of the national population at the beginning of a period.

Table 1: Descriptive statistics: changes in the shares of women with children, cont.

(1)	(2)	(3)		(4)		(5)		(6)	
	Shares of	*1980-1990*		*1990-2000*		*2000-2010*		*2010-2018*	
	women with	mean	sd	mean	sd	mean	sd	mean	sd
Non-college:									
20-39:	≥1 child	-0.019	0.022	0.004	0.028	-0.063	0.032	-0.071	0.041
	≥2 children	-0.028	0.024	0.004	0.027	-0.046	0.033	-0.049	0.035
	≥3 children	-0.025	0.019	0.009	0.018	-0.012	0.024	-0.015	0.028
	> 3 children	-0.018	0.011	0.007	0.010	-0.003	0.014	-0.003	0.016
	young child	-0.003	0.025	0.002	0.018	-0.014	0.030	-0.044	0.038
20-29:	≥1 child	-0.022	0.026	-0.001	0.032	-0.073	0.042	-0.083	0.056
	≥2 children	-0.012	0.023	-0.003	0.027	-0.043	0.035	-0.048	0.043
	≥3 children	0.003	0.013	0.003	0.015	-0.013	0.022	-0.018	0.027
	> 3 children	0.001	0.007	0.003	0.007	-0.004	0.012	-0.005	0.015
	young child	-0.014	0.025	-0.001	0.027	-0.049	0.040	-0.076	0.050
30-39:	≥1 child	-0.065	0.021	-0.004	0.021	-0.009	0.036	-0.053	0.047
	≥2 children	-0.099	0.027	-0.001	0.027	-0.006	0.043	-0.047	0.051
	≥3 children	-0.089	0.030	0.010	0.025	0.010	0.038	-0.009	0.049
	> 3 children	-0.051	0.021	0.009	0.015	0.007	0.025	0.001	0.032
	young child	0.029	0.028	0.008	0.019	0.017	0.037	-0.004	0.048
40-44:	young child	0.002	0.015	0.021	0.015	0.014	0.026	0.009	0.039

Notes: The unit of observation is 722 commuting zones. The variables are changes in the shares of women with the number of children or a young child as specified in column (2). A young child is a child aged below five. The variables are weighted by the commuting zones' share of the national population at the beginning of a period.

Table 2: Changes in the shares of women with children and routine employment share, age group 20-39

	(1) $\geq$1 child	(2) $\geq$2 children	(3) $\geq$3 children	(4) > 3 children
Any:				
OLS: RSH_{-1}	-0.148***	-0.071	0.033	0.050**
	(0.054)	(0.069)	(0.046)	(0.023)
R^2	0.519	0.381	0.351	0.441
2SLS: RSH_{-1}	-0.545***	-0.346***	0.122	0.121***
	(0.117)	(0.126)	(0.095)	(0.047)
R^2	0.506	0.373	0.349	0.438
College:				
OLS: RSH_{-1}	-0.147*	-0.162*	0.039	0.036
	(0.081)	(0.093)	(0.050)	(0.029)
R^2	0.246	0.212	0.109	0.0735
2SLS: RSH_{-1}	-0.647***	-0.669***	-0.091	-0.031
	(0.180)	(0.185)	(0.093)	(0.049)
R^2	0.233	0.198	0.107	0.0709
Non-college:				
OLS: RSH_{-1}	-0.109	-0.028	0.007	0.043
	(0.071)	(0.079)	(0.053)	(0.029)
R^2	0.547	0.409	0.362	0.431
2SLS: RSH_{-1}	-0.376***	-0.186	0.158	0.141***
	(0.127)	(0.131)	(0.104)	(0.054)
R^2	0.542	0.407	0.358	0.427

Notes: The F statistics in 2SLS models is 39. The number of observations is 2 888 (722 commuting zones × four periods). The dependent variables are changes in the shares of women with the number of children specified in the column headings. The independent variable, RSH_{-t}, is routine employment at the start of a period. 2SLS specification instruments for RSH_{-t} with a 1950 industry mix interacted with start of a period dummies. The models cover a period 1980-2018. All models include the start of the period fixed effects, state fixed effects and a set of controls. The models are weighted by the start of the period commuting zone share of the national population. Standard errors clustered at the state level are presented in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

Table 3: Changes in the shares of women with children and the routine employment share, age groups 20-29 and 30-39

	(1)	(2)	(3)	(4)
		Non-college:		
VARIABLES	≥ 1 child	≥ 2 children	≥ 3 children	> 3 children
Age group 20-29:				
OLS: $RSH_{\text{-}t}$	-0.117	-0.059	0.057	0.010
	(0.102)	(0.060)	(0.036)	(0.017)
R^2	0.108	0.0440	0.0423	0.0320
2SLS: RSH_{-1}	-0.408**	-0.148	0.007	-0.034
	(0.200)	(0.127)	(0.067)	(0.035)
R^2	0.106	0.0434	0.0415	0.0285
Age group 30-39:				
OLS: RSH_{-1}	-0.029	-0.064	0.106	0.070
	(0.091)	(0.116)	(0.074)	(0.045)
R^2	0.273	0.217	0.102	0.0906
2SLS: RSH_{-1}	-0.229	-0.390*	0.081	0.023
	(0.216)	(0.235)	(0.135)	(0.072)
R^2	0.271	0.214	0.102	0.0901

Notes: The F statistics in 2SLS models is 39. The number of observations is 2 888 (722 commuting zones $\times$ four periods). The dependent variables are changes in the shares of women with the number of children specified in the column headings. The independent variable, $RSH_{\text{-}t}$, is routine employment at the start of a period. The 2SLS specification instruments for $RSH_{\text{-}t}$ with a 1950 industry mix interacted with the start of a period dummies. The models cover a period 1980-2018. All models include the start of the period fixed effects, state fixed effects and a set of controls. The models are weighted by the start of the period commuting zone share of the national population. Standard errors clustered at the state level are presented in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

Table 3: Changes in the shares of women with children and the routine employment share, age groups 20-29 and 30-39, cont.

	(1)	(2)	(3)	(4)
			College:	
VARIABLES	$\geq$ 1 child	$\geq$ 2 children	$\geq$ 3 children	$>$ 3 children
Age group 20-29:				
OLS: $RSH_{\text{-}t}$	-0.098	-0.016	0.045	0.030
	(0.081)	(0.040)	(0.023)	
R^2	0.467	0.311	0.246	0.147
2SLS: RSH_{-1}	-0.179	-0.061	0.127	0.066
	(0.173)	(0.140)	(0.090)	(0.051)
R^2	0.467	0.311	0.244	0.146
Age group 30-39:				
OLS: RSH_{-1}	-0.236***	-0.108	-0.045	0.074
	(0.077)	(0.099)	(0.070)	(0.048)
R^2	0.457	0.573	0.636	0.599
2SLS: RSH_{-1}	-0.687***	-0.315**	0.256*	0.278***
	(0.155)	(0.159)	(0.134)	(0.092)
R^2	0.444	0.572	0.633	0.595

Notes: The F statistics in 2SLS models is 39. The number of observations is 2 888 (722 commuting zones $\times$ four periods). The dependent variables are changes in the shares of women with the number of children specified in the column headings. The independent variable, $RSH_{\text{-}t}$, is routine employment at the start of a period. The 2SLS specification instruments for $RSH_{\text{-}t}$ with a 1950 industry mix interacted with the start of a period dummies. The models cover a period 1980-2018. All models include the start of the period fixed effects, state fixed effects and a set of controls. The models are weighted by the start of the period commuting zone share of the national population. Standard errors clustered at the state level are presented in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

Table 4: Changes in the shares of women with a young child and the routine employment share

	(1)	(2)	(3)	(4)
		Age group:		
VARIABLES	*20-39*	*20-29*	*30-39*	*40-44*
Any:				
OLS: RSH_{-1}	0.094	-0.029	0.118	0.052
	(0.058)	(0.071)	(0.073)	(0.036)
R^2	0.427	0.407	0.312	0.244
2SLS: $RSH_{\text{-}t}$	0.460***	-0.187	0.670***	0.221**
	(0.111)	(0.144)	(0.117)	(0.096)
R^2	0.409	0.406	0.281	0.239
College:				
OLS: $RSH_{\text{-}t}$	0.137*	-0.008	0.253**	0.068
	(0.079)	(0.092)	(0.113)	(0.110)
R^2	0.221	0.0843	0.175	0.155
2SLS: $RSH_{\text{-}t}$	0.420***	-0.258	0.907***	0.306
	(0.148)	(0.184)	(0.205)	(0.213)
R^2	0.217	0.0822	0.160	0.153
Non-college:				
OLS: $RSH_{\text{-}t}$	0.084	0.007	0.076	0.052
	(0.073)	(0.087)	(0.085)	(0.052)
R^2	0.401	0.442	0.244	0.176
2SLS: $RSH_{\text{-}t}$	0.513***	-0.009	0.671***	0.150
	(0.128)	(0.169)	(0.126)	(0.097)
R^2	0.382	0.442	0.213	0.174

Notes: The F statistics in 2SLS models is 39. The number of observations is 2 888 (722 commuting zones × four periods). The dependent variables are changes in the shares of women with a young child in the age groups specified in the column headings. Young child is a child aged below five. The independent variable, $RSH_{\text{-}t}$, is routine employment at the start of a period. The 2SLS specification instruments for $RSH_{\text{-}t}$ with a 1950 industry mix interacted with the start of a period dummies. The models cover a period 1980-2018. All models include the start of a period fixed effects, state fixed effects and a set of controls. The models are weighted by the start of the period commuting zone share of the national population. Standard errors clustered at the state level are presented in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

8 Appendix

Table 5: Descriptive statistics: shares of women with children, 1980 and 2018

(1)	(2)	(3)		(4)	
Age group	Shares of women with	*1980* mean	sd	*2018* mean	sd
Any:					
20-39:	≥1 child	0.60	0.06	0.46	0.07
	≥2 children	0.41	0.05	0.29	0.06
	≥3 children	0.17	0.03	0.12	0.04
	>3 children	0.06	0.02	0.04	0.02
	young child	0.31	0.04	0.27	0.04
20-29:	≥1 child	0.45	0.08	0.26	0.08
	≥2 children	0.24	0.06	0.13	0.05
	≥3 children	0.07	0.02	0.04	0.02
	>3 children	0.02	0.01	0.01	0.01
	young child	0.35	0.07	0.21	0.07
30-39:	≥1 child	0.80	0.05	0.66	0.07
	≥2 children	0.63	0.06	0.46	0.08
	≥3 children	0.30	0.05	0.20	0.06
	>3 children	0.11	0.03	0.07	0.03
	young child	0.26	0.03	0.33	0.04
40-44:	young child	0.05	0.01	0.12	0.04

Notes: The unit of observation is 722 commuting zones. The variables are the shares of women with the number of children or a young child as specified in column (2). Young child is a child aged below five. The variables are weighted by the commuting zones' share of the national population in the corresponding year.

Table 5: Descriptive statistics: shares of women with children, 1980 and 2018, cont.

(1) Age group	(2) Shares of women with	(3) *1980* mean	sd	(4) *2018* mean	sd
College:					
20-39:	≥1 child	0.46	0.07	0.42	0.09
	≥2 children	0.28	0.05	0.26	0.08
	≥3 children	0.08	0.03	0.09	0.04
	>3 children	0.02	0.01	0.02	0.02
	young child	0.28	0.05	0.28	0.06
20-29:	≥1 child	0.24	0.07	0.15	0.08
	≥2 children	0.08	0.04	0.06	0.05
	≥3 children	0.01	0.01	0.01	0.02
	>3 children	0.00	0.00	0.00	0.01
	young child	0.21	0.07	0.13	0.08
30-39:	≥1 child	0.68	0.08	0.61	0.10
	≥2 children	0.48	0.08	0.40	0.10
	≥3 children	0.16	0.05	0.14	0.07
	>3 children	0.04	0.03	0.04	0.03
	young child	0.35	0.05	0.38	0.06
40-44:	young child	0.06	0.03	0.15	0.06

Notes: The unit of observation is 722 commuting zones. The variables are the shares of women with the number of children or a young child as specified in column (2). Young child is a child aged below five. The variables are weighted by the commuting zones' share of the national population in the corresponding year.

Table 5: Descriptive statistics: shares of women with children, 1980 and 2018, cont.

(1)	(2)	(3)		(4)	
Age	Shares of	*1980*		*2018*	
group	women with	mean	sd	mean	sd
Non-college:					
20-39:	≥1 child	0.63	0.06	0.48	0.06
	≥2 children	0.43	0.05	0.31	0.05
	≥3 children	0.19	0.03	0.14	0.03
	>3 children	0.07	0.02	0.05	0.02
	young child	0.32	0.04	0.26	0.04
20-29:	≥1 child	0.48	0.08	0.30	0.08
	≥2 children	0.26	0.05	0.16	0.05
	≥3 children	0.08	0.02	0.06	0.03
	>3 children	0.02	0.01	0.02	0.01
	young child	0.38	0.06	0.24	0.07
30-39:	≥1 child	0.83	0.04	0.70	0.05
	≥2 children	0.66	0.05	0.51	0.06
	≥3 children	0.33	0.05	0.25	0.05
	>3 children	0.13	0.03	0.09	0.03
	young child	0.24	0.03	0.29	0.04
40-44:	young child	0.05	0.01	0.10	0.04

Notes: The unit of observation is 722 commuting zones. The variables are the shares of women with the number of children or a young child as specified in column (2). Young child is a child aged below five. The variables are weighted by the commuting zones' share of the national population in the corresponding year.

Table 6: Descriptive statistics: the routine employment share and the control variables at the beginning of a period

	1980		1990		2000		2010	
	mean	sd	mean	sd	mean	sd	mean	sd
Rout. empl. sh., *RSH*	0.334	0.034	0.323	0.024	0.300	0.020	0.289	0.019
Sh. black	0.118	0.099	0.120	0.098	0.122	0.100	0.126	0.100
Sh. Hispanic	0.065	0.097	0.088	0.120	0.125	0.140	0.164	0.155
Sh. other race	0.023	0.047	0.037	0.054	0.064	0.065	0.077	0.068
Sh. foreign born	0.067	0.061	0.087	0.085	0.117	0.100	0.137	0.103
Mean educ. years:								
Men age 20-29	12.708	0.386	12.642	0.369	12.584	0.378	12.882	0.391
Wom. age 20-29	12.693	0.349	12.833	0.361	12.944	0.380	13.388	0.402
Men age 30-39	13.058	0.555	13.101	0.450	12.969	0.477	13.327	0.515
Wom. age 30-39	12.605	0.450	13.091	0.399	13.168	0.432	13.766	0.487
Men age 40-44	12.450	0.631	13.339	0.518	13.010	0.460	13.340	0.522
Wom. age 40-44	12.082	0.462	13.046	0.430	13.126	0.401	13.610	0.460
Sh. college:								
Men age 20-29	0.157	0.045	0.157	0.057	0.168	0.066	0.179	0.071
Wom. age 20-29	0.145	0.040	0.171	0.062	0.213	0.075	0.248	0.085
Men age 30-39	0.274	0.068	0.255	0.074	0.256	0.084	0.286	0.094
Wom. age 30-39	0.182	0.050	0.234	0.065	0.270	0.079	0.344	0.096
Men age 40-44	0.223	0.068	0.314	0.076	0.255	0.079	0.289	0.094
Wom. age 40-44	0.133	0.041	0.239	0.061	0.254	0.069	0.324	0.087
Sex ratio:								
Age 20-29	1.023	0.068	0.989	0.071	0.976	0.065	0.975	0.064
Age 30-39	1.036	0.050	1.014	0.047	1.005	0.051	1.007	0.066
Age 40-44	1.048	0.062	1.026	0.057	1.016	0.052	1.017	0.091

Notes: The unit of observation is 722 commuting zones. The variables are weighted by the commuting zones' share of the national population in the corresponding year. College corresponds to at least a completed Bachelor degree.

Table 6: Descriptive statistics: the routine employment share and the control variables at the beginning of a period, cont.

	1980		1990		2000		2010	
	mean	sd	mean	sd	mean	sd	mean	sd
Labor force part.:								
Non-coll. men	0.808	0.034	0.806	0.035	0.753	0.043	0.740	0.043
Non-coll. wom.	0.558	0.049	0.647	0.049	0.647	0.052	0.655	0.045
Coll. men	0.939	0.022	0.932	0.019	0.906	0.025	0.905	0.032
Coll. wom.	0.745	0.028	0.818	0.022	0.802	0.027	0.813	0.029
Unempl. rate:								
Non-coll. men	0.075	0.026	0.076	0.020	0.070	0.018	0.141	0.031
Nnon-coll. wom.	0.073	0.021	0.073	0.020	0.072	0.020	0.124	0.028
Coll. men	0.019	0.007	0.022	0.007	0.021	0.006	0.051	0.019
Coll. wom.	0.027	0.009	0.024	0.007	0.021	0.007	0.051	0.018
Sh. empl. manuf. sect.:								
Non-coll. men	0.438	0.093	0.398	0.084	0.394	0.087	0.334	0.075
Coll. men	0.247	0.075	0.227	0.065	0.206	0.064	0.181	0.057
Non-coll. wom.	0.232	0.088	0.184	0.071	0.157	0.060	0.102	0.038
Coll. wom.	0.078	0.031	0.089	0.034	0.084	0.031	0.069	0.028
Sh. empl. high-sk. serv sect.:								
Non-coll. men	0.243	0.059	0.244	0.054	0.247	0.053	0.261	0.045
Non-coll. wom.	0.426	0.069	0.434	0.064	0.446	0.055	0.422	0.042
Coll. men	0.570	0.071	0.571	0.064	0.600	0.064	0.600	0.065
Coll. wom.	0.760	0.052	0.713	0.052	0.725	0.045	0.700	0.050
Empl. offsh. ind.:								
Non-coll. men	-0.169	0.095	-0.164	0.088	-0.164	0.088	-0.162	0.095
Non-coll. wom.	0.441	0.077	0.384	0.068	0.358	0.069	0.252	0.087
Coll. men	-0.026	0.180	0.038	0.191	0.069	0.214	0.067	0.217
Coll. wom.	-0.331	0.170	-0.229	0.198	-0.213	0.186	-0.213	0.176

Notes: The unit of observation is 722 commuting zones. The variables are weighted by the commuting zones' share of the national population in the corresponding year. College corresponds to at least a completed Bachelor degree.

Table 7: Robustness check: Changes in the shares of women with children and the alternative measures of routine employment share, age group 20-39

	(1) $\geq$1 child	(2) $\geq$2 children	(3) $\geq$3 children	(4) $>$ 3 children
Any:				
2SLS: $meanRSH_{\text{-}t}$	-0.196***	-0.141***	0.011	0.029**
	(0.038)	(0.039)	(0.024)	(0.013)
R^2	0.491	0.355	0.351	0.439
2SLS: $absRSH_{\text{-}t}$	-0.503***	-0.288**	0.167*	0.141***
	(0.120)	(0.131)	(0.096)	(0.043)
R^2	0.509	0.376	0.349	0.439
College:				
2SLS: $meanRSH_{\text{-}t}$	-0.223***	-0.246***	-0.064**	-0.017
	(0.054)	(0.058)	(0.025)	(0.012)
R^2	0.234	0.188	0.105	0.0708
2SLS: $absRSH_{\text{-}t}$	-0.611***	-0.612***	-0.062	-0.027
	(0.176)	(0.186)	(0.089)	(0.048)
R^2	0.234	0.201	0.108	0.0711
Non-college:				
2SLS: $meanRSH_{\text{-}t}$	-0.166***	-0.107***	0.017	0.032**
	(0.039)	(0.039)	(0.026)	(0.015)
R^2	0.528	0.393	0.362	0.430
2SLS: $absRSH_{\text{-}t}$	-0.336***	-0.130	0.206**	0.166***
	(0.129)	(0.137)	(0.105)	(0.051)
R^2	0.543	0.408	0.358	0.428

Notes: The F statistics in 2SLS models is 39. The number of observations is 2 888 (722 commuting zones $\times$ four periods). The dependent variables are changes in the shares of women with the number of children specified in the column headings. The independent variables $meanRSH_{\text{-}t}$ and $absRSH_{\text{-}t}$ are mean routine intensity of employment and absolute number of workers employed in occupations with a high routine task intensity at the start of a period, respectively. 2SLS specification instruments for $RSH_{\text{-}t}$ with the 1950 industry mix interacted with the start of a period dummies. The models cover the period 1980-2018. All models include the start of a period year fixed effects, state fixed effects and a set of controls. The models are weighted by the start of the period commuting zone share of the national population. Standard errors clustered at the state level are presented in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

Table 8: First stage: The routine employment share and the 1950 industry mix

VARIABLES	(1)	(2)
$\overline{RSH}_p \times 1980$	0.575***	
	(0.046)	
$\overline{RSH}_p \times 1990$	0.330***	
	(0.047)	
$\overline{RSH}_p \times 2000$	0.166***	
	(0.047)	
$\overline{RSH}_p \times 2010$	0.101	
	(0.065)	
$\overline{RSH}_p$		0.286***
		(0.044)
R-squared	0.895	0.883

Notes: The number of observations is 2 888 (722 commuting zones × four periods). The dependent variable is the routine employment share, RSH. In column 1, the independent variable is the 1950 industry mix interacted with the start of a period dummies. In column 2, the independent variable is 1950 industry. The models cover a period 1980-2018. All models include the start of a period fixed effects, state fixed effects and a set of controls. The models are weighted by the start of the period commuting zone share of the national population. Standard errors clustered at the state level are presented in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

Chapter 2

Marital Economic Homogamy and Earnings Polarization, the US 1970-2018*

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1 Introduction

The American family has undergone tremendous changes since the 1960s. The prevalence of marriage has declined and the cohabitation rate has risen. There has been a rapid increase in marital instability (Ruggles, 2016). Additionally, marriage partners have become more economically similar (Schwartz & Mare (2005), Schwartz (2010), Gonalons-Pons & Schwartz (2017)). The coefficient of marital economic homogamy constructed as a rank correlation coefficient over the wife's and the husband's earnings increased from .12 in 1960 to .32 in 2018 (figure 1). At the same time, the phenomenon of an earnings polarization has been observed in the US since the 1950s-1960s (Bárány & Siegel, 2018).[2] Earnings polarization means that the relative earnings gap at the upper end of the earnings distribution has been widening, while the relative earnings gap at the lower end of the earnings distribution has been narrowing.

In this paper, I study an association between the change in the structure of the American family and the earnings polarization between 1970 and 2018. In particular, I analyze if a rise in marital economic homogamy is associated with an earnings polarization driven by the structural change in the US between 1970 and 2018.

Spousal homogamy and, in particular, spousal economic homogamy, plays an important role in determining socio-economic outcomes and their intergenerational transmission (Schwartz & Mare, 2005). A greater economic resemblance of marriage partners might lead to an increase in household income inequality (Schwartz (2010), Eika et al. (2014), Greenwood et al. (2015a), Greenwood et al. (2016)). As household income and household human capital are closely related, an increase in household income inequality will also result in a widened gap in household human capital. It is a well documented fact that human capital, earnings and wealth are highly persistent across generations (Solon (1992), Björklund & Jäntti (1997), Mazumder (2005), Chetty et al. (2014) etc.). Thus, an increase in spousal homogamy in the current generation might significantly affect the level of human capital, earnings and wealth of the next generations. In other words, an increase in marital economic homogamy might contribute to the long-run income and

[2]Contrary to the consensus in the literature (Autor et al. (2006), Autor et al. (2008), Autor & Dorn (2013)), Bárány & Siegel (2018) show that the labor market polarization in the US has been observed from the 1950s-1960s. For more details see section 2.1 Labor Market Polarization in the US, 1960-2018 and section 4 Empirical Model and Identification Strategy.

human capital inequality (Fernandez et al. (2005), Corak (2013), Greenwood et al. (2016)).

A large body of research investigates what factors can explain the rise in economic homogamy during the last fifty years. A majority of the studies focuses on the role of marriage partners' characteristics. A growing assortative matching of individuals has been one of the most prominent explanations. The idea is that individuals increasingly sort into marriages along education and other socio-economic traits which, in turn, results in greater economic resemblances (Kremer (1997), Fernandez & Rogerson (2001), Schwartz & Mare (2005), Richard Breen (2011), Breen & Andersen (2012), Eika et al. (2014), Greenwood et al. (2015b)). Another important explanation is a shift from a single earner household to a dual-earner household. A large increase in the female labor force participation since the middle of the 20th century implies that women spend more time on the labor market both before and after marriage and that wives' earnings are more similar to their husbands' earnings during longer periods of marriage (Hyslop (2001), Pestel (2014), Greenwood et al. (2016), Hryshko et al. (2017), Gonalons-Pons & Schwartz (2017)).

Unlike previous studies that analyze how the economic resemblance of marriage partners can be explained by marriage partners' characteristics, the analysis in this research focuses on an external factor that potentially affects the individual choice of a marriage partner. In particular, I study what role the polarization of earnings played in the rise in economic similarity between marriage partners.

My theoretical expectation based on the predictions from the Fernandez et al.'s (2005) model is that the greater relative earnings gap at the upper/lower end of the earnings distribution is associated with greater marital sorting, while the smaller relative earnings gap at the upper/lower end of the earnings distribution is associated with weaker marital sorting.

Empirical findings support my theoretical expectations and show that commuting zones with a larger earnings gap at the upper/lower tail of the earnings distribution are characterized by a greater marital economic resemblance, while commuting zones with a smaller relative earnings gap at the upper/lower end of the earnings distribution are characterized by a weaker economic resemblance in marriage unions where a wife and a husband were aged between 27 and 36 in the US in 1970-2018. An increase/a decrease in the relative earnings gap at the upper part of the earnings distribution has a greater impact on marital homogamy in absolute terms relative to an increase/a decrease in the relative earnings gap at the lower part of the earnings distribution.

The quantification of the estimation results shows that the earnings polarization defined over broad industrial sectors would account for 19.2 percent of the rise in the coefficient of marital sorting in the absence of other factors in the US between 1970 and 2018. The earnings polarization defined over broad occupational groups would constitute 25 percent of the rise in the coefficient of marital economic resemblance in the absence of other factors in the US in 1970-2018.

Empirically, I regress the coefficient of marital economic resemblance on two sets of relative earnings gap measures constructed for commuting zones (728) in each year starting in a decade between 1970 and 2010 and in 2018. The first (second) set of relative earnings gap measures is defined over three broad industrial sectors (broad occupational groups). As relative earnings gap measures I use relative earnings premiums in broad industrial sectors (broad occupational groups) (Bárány & Siegel, 2018). Relative earnings premiums are constructed as exponents of the coefficient on sector (occupational group) dummies that come from the regressions of log hourly earnings controlling for gender, race and foreign dummies and the polynomial in potential experience. The relative earnings gap at the upper tail of the earnings distribution is constructed as an exponent on the high-skilled services sector dummy estimated relative to the manufacturing sector dummy (the abstract occupational group dummy relative to the routine occupational group dummy), while the relative earnings gap at the lower end of the earnings distribution is constructed as the manufacturing sector dummy estimated relative to the low-skilled services sector dummy (the routine occupational group dummy relative to the manual occupational group dummy). In order to identify a causal association between marital economic homogamy and earnings polarization, I employ a structural choice driven explanation of the labor market polarization developed in Bárány & Siegel (2018).

Bárány & Siegel (2018) explicitly model labor supply in three broad industrial sectors: the low-skilled services sector, the manufacturing sector and the high-skilled services sector. Bárány & Siegel's (2018) model shows that as the productivity in the technologically progressive sector - the manufacturing sector - increases, labor from the technologically progressive sector has to reallocate to technologically marginal sectors - low- and high-skilled services sectors - which leads to structural change. In order to attract workers to technologically constant sectors, wages in these sectors have to increase relative to wages in the technologically progressive sector. Since wages in the technologically marginal sectors - low- and high-skilled services sectors - are located in the lower and upper parts of the earnings distribution, while wages in the technologically progressive sector - the manufacturing sector - are located in the middle part of the earnings distribution, structural change leads to employment and wage polarization.

Structural change resulted in a contraction of employment in the sector with the fastest growing productivity. Routine-task intensive occupations which are concentrated in this sector hence also saw declining employment and a relative earnings premium. Thus, when employment in manufacturing started to contract after 1950, this led to a polarization over broad occupational groups, since routine occupations were located in the middle of the wage and earnings distribution (Bárány & Siegel, 2018).

Employment and wage polarization over the broad industrial sectors have been observed in the data from the 1960s (figure 3). By 1960, such economic and technological conditions were created - by some form of mechanization combined with some specific features of preferences - that productivity in the technologically progressive sector - the manufacturing sector - started to grow dramatically. Then, the sector premium in 1960 should contain a quasi-fixed component reflecting the relative economic and technological conditions in 1960 that created a necessary environment for structural change to start. This quasi-fixed component is then naturally correlated with sector premiums decades later and it can be used to predict the development of the sector premiums over time. I use the relative sector premium in 1960 to instrument for the relative sector premium in each commuting zone and year at the beginning of a decade between 1970 and 2010 and in 2018. By analogy, the relative premium in broad occupational groups in 1960 is used to instrument for the relative premium in broad occupational groups at the beginning of a decade between 1970 and 2010 and in 2018 (figure 4).

This paper is related to several broad strands of literature. The first strand of literature studies trends and causes of spousal homogamy and its contribution to household income inequality (Kalmijn (1998), Schwartz & Mare (2005), Schwartz (2013), Mare (1991), Mare (2016)). Gonalons-Pons & Schwartz (2017) study the development of the correlation coefficient between the earnings of marriage partners in the US between 1970 and 2013. Gonalons-Pons & Schwartz (2017) decompose the correlation coefficient and show that the greater labor force participation of wives accounts for more than fifty percent of the rise in the correlation coefficient, while a rise in the earnings resemblance between partners accounts for only eleven percent of the rise in the earnings correlation coefficient among prevailing marriages.

The results in Eika et al. (2014) indicate that, in general, educational assortative matching accounts for a considerable part of the earnings inequality across households. However, the change in the educational assortative matching between 1980 and 2007 did not generate a rise in households' earnings inequality. Greenwood et al. (2015a), Greenwood et al. (2015b) and Hryshko et al. (2017) come to the same conclusion using different methodologies and alternative datasets. Schwartz (2010) finds that a rise in earnings homogamy explains 17-51 percent of the increase in inequality across married couples 1968-2006. Greenwood et al. (2016) develop a unified framework that allows us to study the role of educational attainment, married female labor-force participation, and the marital structure on the development of households' income inequality. Two underlying driving forces are considered: technological progress in the household sector and the shift in the wage structure. The results of the simulation exercise suggest that the change in the wage structure contributed to a rise in assortative matching between 1960 and 2005.

The second strand of literature studies the impact of changes on the labor market on family formation, the outcomes of women and families with children. Autor et al. (2019) explore the effect of large scale, exogenous trade-induced shocks to local manufacturing employment, stemming from a rising import competition from China on the marriage and family outcomes in the US between 1990 and 2007. When it comes to marriage outcomes, Autor et al. (2019) find that import shocks negatively affecting male employment result in a decline in marriage. Shenhav (2016) analyzes the relationship between the change in the relative female to male wage on family and labor market outcomes of women in the US between 1980 and 2010. Shenhav (2016) shows that "improvements in the relative wage have facilitated women's independence by reducing the monetary incentives for marriage." An increased relative wage resulted in a decline in the probability of marriage for those women who were at the margin of their first marriage with the effect concentrated among less desirable matches.

In addition to the above mentioned studies, this paper relates to the literature studying marriage market and family formation originated by Becker (1973) and further developed by, among others, Becker (1991) and Grossbard-Shechtman (1993).

This paper contributes to the existing literature in several ways. First, in comparison to previous studies that investigate how the economic resemblance of marriage partners can be explained by marriage partners' characteristics, this study focuses on the external factors that might affect the individual choice of a marriage partner (Fernandez et al. (2005), Greenwood et al. (2016), Gonalons-Pons & Schwartz (2017)). In particular, I study what impact polarization of earnings had on the increase in the earnings similarity between marriage partners.

Second, this paper investigates what impact changes on the labor market have on the selection into marriage along particular matching traits, in general, and along earnings, in particular. Previous studies mainly focus on the probability of marriage (Shenhav (2016), Autor et al. (2019)) while, to the best of my knowledge, sorting into marriage and sorting along earnings have not received much attention in this context before.

Third, this paper is the first one out to study the impact of an earnings polarization induced by structural change on the earnings resemblance in marriage. The earnings polarization measures are defined over broad industrial sectors and broad occupational groups. This allows us to analyze the effect of interest from different angles and obtain a complete picture of the effect of the earnings polarization on marital economic homogamy.

The rest of the paper is organized as follows. Section 2 describes the phenomenon of labor market polarization, the development of marital sorting with respect to earnings and theoretical predictions. Section 3 presents data and descriptive statistics. Section 4 formulates the empirical model and the identification strategy. Section 5 contains results and sensitivity checks. And, finally, Section 6 concludes the paper.

2 Background

This section starts with a description of the labor market polarization across broadly defined industrial sectors and occupational groups in the US, 1960-2018 (Bárány & Siegel, 2018). Then, it discusses how marital sorting with respect to earnings evolved in the US between 1960 and 2018. Finally, it makes predictions about the impact of earnings polarization on marital sorting based on the theoretical model developed in Fernandez et al. (2005).

2.1 Labor Market Polarization in the US, 1960-2018

In contrast to the consensus in the literature that the polarization of the labor market started in the 1980s with the adoption of information and computer technology (ICT) (Autor et al. (2003), Autor & Dorn (2013), Goos et al. (2014) etc.), Bárány & Siegel (2018) show that the polarization of the labor market started as early as in the 1950-1960s. The authors document that polarization defined over broad occupational groups both in terms of employment and earnings has been present in the US since the 1950s, and that the same pattern in terms of three broad industrial sectors has been observed in the US since the 1960s.

Bárány & Siegel (2018) delineate three broad industrial sectors: the low-skilled services sector, the manufacturing sector and the high-skilled services sector. The low-skilled services sector includes such industries as personal services, low-skilled transport, low-skilled business and repair services, retail and wholesale trade. The manufacturing sector contains such industries as mining, construction and manufacturing. Finally, the high-skilled services sector covers such industries as professional and related services, finance, insurance and real estate, communications, high-skilled business services, utilities, highly-skilled transport and public administration (Bárány & Siegel, 2018).

Three broad occupational groups are defined by the dominant task in each occupation (Autor et al. (2003), Autor & Dorn (2013), Bárány & Siegel (2018)). These groups are manual, routine and abstract. The manual occupational group consists of occupations with a high content of manual tasks such as low-skilled service jobs (personal services, care of others, recreation, waiters and waitresses, restaurant workers, housemaids, janitors and gardeners). The routine occupational group gathers occupations with a high routine-task content such as occupations in repetitive assembling and production, clerical and office jobs. Lastly, the abstract occupational group accounts for occupations with a high abstract-task content such as managerial and professional occupations (Autor et al. (2003), Autor & Dorn (2013), Bárány & Siegel (2018)).

Although the adoption of ICT and offshoring certainly were important factors contributing to the labor market polarization since the 1980s, Bárány & Siegel (2018) suggest a new structural change driven explanation of the labor market polarization over sectors since the 1960s.

Bárány & Siegel (2018) explicitly model labor supply in three broad industrial sectors, i.e. low-skilled services, manufacturing and high-skilled services sectors. Bárány & Siegel's 2018 model shows that as productivity in the technologically progressive sector - the manufacturing sector - increases, labor from the technologically progressive sector has to reallocate to technologically marginal sectors - low- and high-skilled services sectors - which causes structural change. In order to attract workers to technologically constant sectors, wages in these sectors must increase relative to wages in the technologically progressive sector. Since wages in the technologically marginal sectors - low- and high-skilled services sectors - are located in the lower and upper parts of the wage and earnings distribution, respectively, while wages in the technologically progressive sector - the manufacturing sector - are located in the middle part of the wage and earnings distribution, structural change leads to employment and wage polarization.

Structural change resulted in a contraction of employment in the sector with the fastest growing productivity. Routine-task intensive occupations which are concentrated in this sector did, hence, also see a declining employment and a relative earnings premium. Thus, when employment in manufacturing started to contract after 1950, this led to a polarization over broad occupational groups, since routine occupations were located in the middle of the wage and earnings distribution (Bárány & Siegel, 2018).

Figure 3 shows the polarization of the labor market defined over three broad industrial sectors from 1950 to 2018 (Bárány & Siegel, 2018). The panel a of figure 3 shows employment polarization. The employment share[3] in the manufacturing sector reached its top point, .43 percent, in 1960 and then shrank dramatically down to around .20 percent by 2010. It then rebounded to around 27 percent between 2010 and 2018. At the same time, the employment share in the high-skilled sector grew steadily from around .28 to .46 percent between 1960 and up to 2010. Then, it decreased slightly down to about 43 percent between 2010 and 2018. Finally, the share of employed in the low-skilled sector showed a decline between 1950 and 1960, a modest growth in the next two decades and a steady growth after that up to 2010. It further remained stable between 2010 and 2018. Overall, the share of employed in the low-skilled sector increased from .27 in 1960 to .34 in 2018.

The panel b of figure 3 shows the earnings polarization in terms of a broad industrial sector. I construct relative sector premiums as measures describing the relative earnings gaps at the lower and upper ends of the earnings distribution.[4] More precisely, I construct a sector premium in manufacturing

[3]Employment shares are computed as the share of total hours worked in the economy.

[4]Sector premiums are constructed as the exponents of the coefficient on sector dummies that come from the regressions of log hourly earnings controlling for gender, race, foreign dummies and the polynomial in potential experience (Bárány & Siegel, 2018). The occupational groups premium is constructed in the same way. The earnings are computed as logarithm hourly earnings for all workers aged 16-64 with non-negative

relative to low-skilled services to describe the relative earnings gap at the lower end of the earnings distribution and a premium in high-skilled services relative to manufacturing to describe the relative earnings gap at the upper end of the earnings distribution.[5]

The sector premium in manufacturing decreased from 1960 to 1980 and then remained unchanged between 1980 and 1990. After that, it decreased between 1990 and 2000 and rebounded from 2000 to 2018. The sector premium in high-skilled services increased slightly between 1960 and 1980 and then grew steadily between 1980 and 2000. It further leveled off between 2000 and 2010 and decreased slightly between 2010 and 2018 (panel b of figure 3).

Figure 4 shows the polarization of the labor market defined over three broad occupational groups since 1950. The panel a of figure 4 shows employment polarization. The share employed in the routine occupational group decreased, while the share of employed in the abstract occupational group did, in contrast, increase between 1950 and 2018. The employment share in the manual occupational group showed a slight decline from 1950 and 1960, a constant growth from 1960 to 2010 and a slight decrease between 2010 and 2018.

The panel b of figure 4 presents an earnings polarization in terms of broad occupational groups. The occupational group premium in routine relative to manual occupational groups reflects the relative earnings gap at the lower end of the earnings distribution, while the occupational group premium in abstract relative to routine occupational groups captures the development at the upper end of the earnings distribution.[6] After an increase between 1950 and 1960, the earnings premium in the routine occupational group has exhibited a strong downward trend since 1960 and up to 2010. Between 2010 and 2018, the earnings premium in the routine occupational group rebounded slightly. The occupational group premium in the abstract occupational group showed an increase between 1950 and 1960. The occupational group premium in the abstract occupational group was then roughly constant between 1960 and 1970. It decreased slightly between 1970 and 1980 and rose steadily after that.

earnings and hours worked. For a more detailed description of earnings data, see Section 3 Data and Descriptive Statistics.

[5]Appendix Figure 5 panel a displays industrial sector premiums in low-skilled and high-skilled services sectors relative to the manufacturing sector.

[6]The panel b of Appendix Figure 5 displays occupational group premiums in manual and abstract relative to routine occupational groups.

Overall, the relative earnings gap measures defined both in terms of broad industrial sectors and broad occupational groups show that the relative earnings gap at the upper end of the earnings distribution widened, while the relative earnings gap at the lower end of the earnings distribution narrowed in the US 1960-2018. In other words, the earnings of individuals located at the upper end of the earnings distribution relative to the earnings of individuals located in the middle of the earnings distribution become more diverted, while the earnings of individuals located in the middle of the earnings distribution relative to the earnings of individuals located at the lower end of the earnings distribution become more similar. In terms of broad industrial sectors and occupational groups, this implies the following. The relative earnings gap between individuals employed in the high-skilled services sector and the manufacturing sector increased, while the relative earnings gap between individuals in the manufacturing sector and the low-skilled services sector decreased in the US in 1960-2018. Analogously, the relative earnings gap between individuals employed in abstract and routine occupational groups rose, while the relative earnings gap between individuals in routine and manual occupational groups declined in the US in 1960-2018.

2.2 Marital Economic Homogamy in the US, 1960-2018

Marital economic homogamy, measured by the coefficient of marital sorting, increased in the US between 1960 and 2018 (figure 1). Aside from a slight decrease in 1970, the coefficient of marital sorting among marriage unions where a husband and a wife were between 27 and 36 years old rose from .12 in 1960 to .32 in 2018. An increase in the coefficient of marital sorting implies that marriage partners were more similar in terms of earnings in 2018 than in 1960. Note that the coefficient of marital sorting is a summary index showing sorting into marriage among partners located in the whole span of the earnings distribution. I.e. it does not show how sorting among individuals located at the different parts of the earnings distribution evolved.

Figure 2 presents descriptive evidence for what marital sorting among individuals located at different parts of the earnings distribution looked like in 1960 and 2018. Figure 2 shows stacked bar plots over the shares of wives according to earnings quintile married to husbands of a particular earnings quintile in 1960 and 2018, respectively.[7] The horizontal axis shows wives'

[7]The coefficient of marital sorting presented in figure 1 is constructed over the earnings deciles. The quintiles in figure 2 are used for simplicity. Analogous plots in figure 2

earnings quintile, while the vertical axis shows the shares of wives matched to husbands in each earnings quintile. Very dark grey bars located just above the horizontal axis show the shares of wives married to husbands in the first earnings quintile. The husband's earnings quintile increases with each next stacked bar plots which also take a lighter color. Very light grey bars thus show the shares of wives matched to husbands in the fifth earnings quintile.

Several observations from figure 2 stand out. First, already in 1960, there was a clear sorting after earnings quintile which is also manifested in the coefficient of marital sorting. Moreover, the sorting was stronger at the ends of the earnings distribution. Put differently, sorting into marriage with respect to earnings exhibited some polarization in 1960. For example, nearly 52 percent of the women in the first earnings quintile and 49 percent of the women in the second earnings quintile were married to men in either the first or the second earnings quintiles. Regarding women at the upper end of the distribution, almost 55 percent of the women in the fifth earnings quintile and almost 45 percent of the women in the fourth earnings quintile were married to men in either the fourth or fifth earnings quintiles.

Second, by 2018, the marital sorting tightened even further. The tightening was especially pronounced at the upper end of the earnings distribution. The share of women in the highest earnings quintile, whose husbands were in the top two earnings quintiles, increased by eleven percentage points between 1960 and 2018 and reached 66 percent in 2018. At the same time, the analogous share of women in the next highest earnings quintile increased by five percentage points and rose to 50 percent. Concerning women in the lower earnings quintiles, the share of women in the first earnings quintile matched to husbands in the two lowest earnings quintiles rose by almost nine percentage points and reached 61 percent by 2018. The analogous share for women in the second earnings quintile rose by almost two percentage points and went up to 51 percent.

Third, marital sorting grew the most among individuals in the absolutely lowest and highest earnings quntiles. The growth rate in the share of women in the first earnings quintile matched to men in the same earnings quintile was 20 percent between 1960 and 2018. An analogous rate for women in the fifth earnings quintile was 39 percent.

Fourth, the share of women in the three lowest earnings quintiles matched to men in the highest earnings quintile shrank dramatically between 1960

constructed for earnings deciles show a similar picture.

and 2018. Further, the share of women in the two highest earnings quintiles matched to men in the three lowest earnings quintiles decreased substantially. Fifth, women in the third earnings quintile were more often matched to men in the same earnings quintile or in the second earnings quintile in 2018 than in 1960.

Overall, this development implies that individuals located in the relatively higher earnings quintiles were less often matched with individuals in the relatively lower earnings quintiles in 2018 in comparison to 1960. This relationship is intensified the higher in the earnings distribution individuals are located. Additionally, marital sorting with respect to earnings became even more polarized in 2018 in comparison to 1960. And it became especially pronounced at the upper tail of the earnings distribution.

Clustering of the individuals at the tails of the earnings distribution implies that the marriage market is segmented and that there is some kind of (potentially endogenous) threshold in terms of how far down (or up) along the distribution of earnings individuals match. Clustering at the ends of the earnings distribution suggests that the matching threshold goes approximately through the middle of the earnings distribution.

2.3 Theoretical Predictions and Expectations

Fernandez et al.'s (2005) model of marital sorting

The theoretical predictions in this paper draw on the results from the theoretical model developed in Fernandez et al. (2005). The model of Fernandez et al. (2005) describes how household formation, income inequality, and per capita output may interact in an economy.

The agents in Fernandez et al.'s (2005) model are either of the skilled or the unskilled type, a number of skilled men equals a number of skilled women and a number of unskilled men equals a number of unskilled women. The agent of each skill type earns her skill type wage, where a skilled type wage is strictly larger than an unskilled type wage. The wages of agents only depend on their skill types and the share of skilled agents in the population. Further, men and women of the same skill type earn identical wages.

Agents match into couples and derive a couple indirect utility function which is a sum of the couple total income and a term representing the quality of the match q called "love". The matching of agents into couples happens in two rounds. In the first round, agents are matched randomly and draw a random match-specific quality term q representing the "love" of agents for each other. If the match is accepted by both agents, it leads to a marriage, otherwise agents move to the second round where they are matched with agents of the same skill type and draw a new random match quality (Fernandez et al., 2005).

When a skilled agent meets an unskilled agent and draws a high quality q, "love", in the first round, she will face a trade-off between forming a lower-income household with a high quality match or waiting for a next round to be matched and form a high income household with another skilled agent but with some expected quality of the match μ. This is where the agent encounters a trade-off between love and money (Fernandez et al., 2005). The expected difference in the quality of the matches (between the high quality match with unskilled agent, q, in the first round and the expected quality match with skilled agent, μ, in the second round) must be high enough to compensate for the income and utility loss from forming a household with a low skilled agent. Since agents maximize their utility, since the quality of the match, "love", is randomly drawn in each round, and since in the second round each agent meets another agent of the same education type, skilled agents will have matching preferences for skilled agents (Fernandez et al., 2005).

The main theoretical prediction from the model of Fernandez et al. (2005) is that an exogenous increase in the wage of unskilled agents decreases sorting, while an exogenous increase in the wage of skilled agents, in contrast, increases sorting. As the wage of unskilled agents increases, the utility and income loss from forming a marriage partnership for skilled agents, when matched with unskilled agents with a high quality match q, "love", will be lower, and, therefore, more matches between skilled and unskilled agents will be accepted and the share of couples with similar skill levels in the economy will decrease. When, in contrast, the wage of skilled agents increases, the utility and income loss from a marriage union for skilled agents with unskilled agents will increase, and a skilled agent maximizing her life-long utility will not accept a match with an unskilled agent and will rather wait until the next round to be matched with a skilled agent. Then, the share of couples with the same skill level in the economy will increase.

Application of Fernandez et al.'s (2005) model of marital sorting

Fernandez et al.'s (2005) model only considers two types of agents, skilled and unskilled with skilled and unskilled wage, respectively. More generally, Fernandez et al.'s (2005) model can be applied to agents of n different skill and earnings levels. Then, the earnings in each skill level $n + 1$ is strictly larger than the earnings in skill level n. The earnings of men and women of the same skill level are identical. The number of men and women in each skill and earnings level is equal.

As in the main model, individuals match into couples in two rounds and derive a couple indirect utility function consisting of the couple total income and the quality of the match q, "love". In the first round, individuals are matched randomly and draw a random match-specific quality term q "love" of individuals for each other. If the match is accepted by both individuals, it leads to a marriage, otherwise individuals move to the second round, where they are matched with individuals of the same skill and earnings level and draw a new random match quality (Fernandez et al., 2005).

When an individual with a relatively higher skill and earnings level (with relatively higher earnings) meets an individual with a relatively lower skill and earnings level (with relatively lower earnings) and draws a high quality q, "love", in the first round, she will encounter a trade-off between forming a lower-income household with a high quality match or waiting for a second round to be matched and to form a high income household with an individual with the same skill and earnings level but with some expected quality of the match μ. The expected difference in the quality of the matches (between a high quality match with the relatively lower skill and earnings level individual, q, in the first round and the expected quality match with an individual of the same skill and earnings level, μ, in the last round) must be high enough to compensate for the income and utility loss from forming a household with a relatively lower skill and earnings level individual (Fernandez et al., 2005).

Then, the general prediction of Fernandez et al.'s (2005) model can be formulated as follows. An exogenous increase in the earnings of individuals of a relatively lower skill and earnings level decreases sorting, while an exogenous increase in the earnings of individuals of a relatively higher skill and earnings level, in contrast, increases sorting. As the earnings of individuals of a relatively lower skill and earnings level increase, the utility and income loss from forming a marriage for an individual with a relatively higher skill and earnings level, when matched with an individual with a relatively lower skill and earnings level with a high quality match q, "love", will be lower, and, therefore, more matches between individuals with a relatively higher skill and earnings level and individuals with a relatively lower skill and earnings level will be accepted and the share of couples with a similar skill and earnings level in the economy will decrease. When, in contrast, the earnings of individuals with a relatively higher skill and earnings level increases, the utility and income loss from a marriage union for an individual with a relatively higher skill and earnings level with an individual with a relatively lower skill and earnings level will increase, and a relatively higher skill and earnings individual maximizing her life-long utility will not accept a match with a relatively lower skill and earnings level individual and will rather wait to a second round to be matched with an individual with the same skill and earnings level. Then, the share of couples of the same skill and earnings level in the economy will increase.

As shown above, the marriage market is segmented in a sense that individuals tend to cluster at the ends of the earnings distribution with respect to their own and their partners' earnings deciles. This implies that there is some threshold in terms of how far up (or down) along the earnings distributions individuals match and that this matching threshold goes approximately through the middle of the earnings distribution. It was also shown above that the relative earnings gap at the upper part of the earnings distribution has been widening, while the relative earnings gap at the lower end of the earnings distribution has been narrowing in the US since 1960. Then, the relative earnings gaps measures might be used to capture the relative changes at the upper and lower ends of the earnings distribution or above and below the matching threshold.

Thus, it is reasonable to assume that (i) changes in the relative earnings below the middle of the earnings distribution to a greater extent affect the matching between individuals that are located below the matching threshold with respect to their earnings decile, (ii) and that changes in the relative earnings above the middle of the earnings distribution to a greater extent affect the matching between individuals that are located above the matching threshold with respect to their earnings decile.

Taking into account the segmentation of the marriage market and the earnings polarization, I have the following theoretical expectations.

As the relative earnings gap widens at the upper end of the earnings distribution, the growing relative earnings of individuals located in the upper deciles of the earnings distribution (with relatively higher earnings) will make them less willing to form households with individuals located in the relatively lower earnings deciles near the middle of the earnings distribution (with relatively lower earnings) as the total household income and, consequently, the household utility will be lower. This will lead to greater marital sorting.

In contrast, narrowing the relative earnings gap at the upper tail of the earnings distribution will make the utility and income loss from forming a partnership for individuals located in the upper deciles of the earnings distribution with individuals located in the relatively lower earnings deciles near the middle of the earnings distribution, given the high quality match "love", lower. Therefore, matches between individuals located in the upper deciles of the earnings distribution (with relatively higher earnings) and individuals located in the relatively lower earnings deciles near the middle of the earnings distribution (with relatively lower earnings) will be accepted more often and marital sorting will decrease.

In the same fashion, as the relative earnings gap at the lower end of the distribution widens, growing relative earnings of individuals located in the earnings deciles near the middle of the earnings distribution (with relatively higher earnings) will make them less willing to form a household with individuals located in the lower deciles of the earnings distribution (with relatively lower earnings), as the total utility and income loss from forming a household with individuals located in the relatively lower earnings decile will be greater. This will lead to greater marital sorting.

When, in contrast, the relative earnings gap at the lower end of the distribution narrows, individuals located in the earnings deciles closer to the middle of the earnings distribution (with relatively higher earnings), when coupled with individuals located in the lower deciles of the earnings distribution (with relatively lower earnings) with a high quality match, "love", will have lower incentives to search for a partner in a higher earnings decile due to the smaller decline in total household income and household utility. If these individuals get married, the share of couples in the economy with different earnings levels will increase and thus marital sorting with respect to earnings will decrease.

The higher the earnings decile in which an individual is located, the larger is the utility loss if matched with an individual located in a relatively lower earnings decile. The utility loss from forming a marriage union with an individual located in the relatively lower income deciles (with relatively lower earnings) is especially large for individuals located in the upper earnings deciles (with the highest earnings). Therefore, I expect a change in the relative earnings gap at the upper end of the earnings distribution to have a greater effect on the coefficient of marital sorting in absolute terms than a change in the relative earnings gap at the lower end of the earnings distribution.

3 Data and Descriptive Statistics

All variables in the analysis are constructed using Integrated Public Use Microdata Series USA (IPUMS). IPUMS consists of samples of the American population drawn from US federal censuses in 1960, 1970, 1980, 1990 and 2000 and the American Community Surveys (ACS) in 2010 and 2018 (Ruggles et al., 2020). The geographical unit in my analysis is commuting zone (Autor & Dorn, 2013). Commuting zones are characterized by strong commuting ties within commuting zones and weak commuting ties across commuting zones. 728 commuting zones cover the mainland of the US and approximate local labor markets (Autor & Dorn, 2013).

In this paper, I analyze the association between marital economic homogamy and the earnings polarization induced by structural change in the US between 1970 and 2018. To analyze this association, I need an outcome variable that captures economic resemblance between marriage partners and a set of measures that describes earnings polarization.

Coefficient of marital sorting

To construct a measure of marital economic resemblance, I follow previous literature that implicitly models sorting into marriage (Fernandez et al. (2005), Greenwood et al. (2016)). Individuals sort into marriage for both economic and non-economic reasons. The non-economic reason is love (or marital bliss) and companionship, while the economic reason is couple total income. Individuals sort into couples and derive a couple indirect utility function which is the sum of couple total income and a term representing love (or marital bliss) (Fernandez et al. (2005), Greenwood et al. (2016)). I assume that individuals sort into marriages with respect to the perceived potential earnings of a marriage partner (Oppenheimer (1988), Sweeney (2002), Xie et al. (2003)). Since the potential earnings are not observable to an individual, the evaluation of the economic potential of the marriage partner is subject to uncertainty (Oppenheimer, 1988). I use the partners' current earnings as a proxy for the potential earnings. Current earnings, thought, might be a poor proxy for the potential earnings of marriage partners. In section 5, I present results from a sensitivity test where I investigate if my main estimation results are sensitive to the use of alternative coefficients of marital homogamy based on the potential earnings of marriage partners (Oppenheimer (1988), Hyslop (2001), Xie et al. (2003), Hryshko et al. (2017), Gonalons-Pons & Schwartz (2017)).

The exact year of marriage is not available. To restrict the sample to presumably recently married couples, I keep only those couples where a husband and a wife are between 27 and 36 years old. The lower age bound guarantees that individuals and, especially, college graduates, who usually graduate and start their careers at the age of 22, have labor market experience, while the upper bound limits the pool of marriage partners to hopefully recently married couples. Additionally, the restriction of the age of marriage partners to 27-36 years allows us to study the marital economic resemblance in non-overlapping cohorts over time.

As a quantitative measure of marital sorting, I construct a Pearson correlation coefficient between the ranked earnings[8] of a husband and a wife. The rank scale ranges from 1 to 10, where 1 corresponds to the lowest earnings and 10 to the highest earnings. The greater is the coefficient of marital sorting, the more similar marriage partners are in terms of their earnings ranks. The increasing coefficient of marital sorting implies that marriage partners became more similar with respect to earnings over time.

Sector (occupational group) premiums as relative earnings gap measures

The relative earnings gap measures describing the earnings polarization are constructed for the whole employment since these measures need to capture the situation on the whole labor market rather than the labor market situation of workers in a particular demographic group.

I use two sets of the relative earnings gap measures. The first set of measures is defined over three broad industrial sectors, while the second set of measures is defined over three broad occupational groups. In particular, I use the relative earnings premiums in the broad industrial sectors and broad occupational groups. The relative earnings premiums are constructed as the exponents of the coefficient on sector and occupational group dummies that come from the regressions of log hourly earnings[9] controlling for gender,

[8] Earnings are computed as a logarithm of hourly earnings for workers with non-negative earnings and hours worked. For a more detailed description of earnings data, see the next footnote.

[9] All workers with non-negative earnings and hours worked aged 16-64 are included. I use personal weights provided in IPUMS 1960, 1970, 1980, 1990 and 2000 US census and 2010 and 2018 ACS and the labor supply weight constructed as a product of usual weekly hours worked divided by 35 and the number of weeks worked last year divided by 50 to account for the labor market hours supplied by each worker (Autor & Dorn, 2013). Top coded earnings are multiplied by 1.5. I set hourly wages below the first percentile of the national hourly wage distribution equal to the value of the first percentile (Autor & Dorn, 2013). While the censuses 1960, 1970, 1980, 1990 and

race and foreign dummies and the polynomial in potential experience. I use relative earnings premiums rather than relative earnings, since it allows me to account for the potential effects of the demographic composition of employment in each sector and their potentially diverse development patterns across sectors (Bárány & Siegel, 2018).

More precisely, to construct the relative earnings premium over broad industrial sectors (broad occupational groups) I run two sets of regressions. In the first set of regressions, the log hourly earnings are regressed against the high-skilled services and manufacturing sector (abstract and routine occupational groups) dummies, while the low-skilled services sector (manual occupational group) dummy is omitted and serves as a baseline. The exponent of the coefficient on the manufacturing sector (routine occupational group) dummy estimated relative to the low-skilled services sector (the manual occupational group) dummy captures the relative earnings premium in the manufacturing sector (routine occupational group) and is used as the measure of the earnings gap at the lower end of the earnings distribution.

In the second set of regressions, the log hourly earnings are regressed against the high-skilled services sector and the low-skilled services sector (abstract and manual occupational groups) dummies, while the manufacturing sector (routine occupational group) dummy serves as a baseline. The exponent of the coefficient on the high-skilled services sector (abstract occupational groups) dummy estimated relative to the manufacturing sector (routine occupational groups) dummy captures the relative earnings premium in the high-skilled services sector (abstract occupational groups) and is used as the measure of the earnings gap at the upper end of the earnings distribution.

Ideally, I would like to know when the choice of a marriage partner is made and what the situation on the labor market was at that point. The timing of the choice of a marriage partner is naturally not observed. The actual marriage date is not available in IPUMS either. Since the current situation on the labor market is strongly correlated with the situation on the labor market several years back, the current measures of the relative earnings gap might be a good proxy for the situation on the labor market some time ago when the choice of marriage partner was made.

2000 collected information on income received during the previous calendar year, for the 2010 and 2018 ACS the reference period was the past 12 months. In order to make hourly wages comparable across wages, nominal hourly wages are adjusted for inflation to the year 2009 using the Personal Consumption Expenditure Index from Ruggles et al. (2020).

Descriptive statistics

Table 1 presents descriptive statistics for all variables in 1970 and 2018. The coefficient of marital sorting increased from .08 in 1970 to .32 in 2018 (Panel A). When it comes to the relative earnings gap measures defined over broad industrial sectors, the relative earnings gap at the lower end of the earnings distribution (the manufacturing sector premium) decreased from 1.30 to 1.25 between 1970 and 2018, while the relative earnings gap at the upper end of the earnings distribution (the high-skilled services sector premium) increased from 1.10 to 1.20. Regarding the relative earnings gap defined over broad occupational groups, the relative earnings gap at the lower end of the distribution (the routine occupational group premium) declined from 1.52 to 1.22 between 1970 and 2018, while the relative earnings gap at the upper end of the earnings distribution (the abstract occupational group premium) increased from 1.38 to 1.62 (Panels B and C).

When it comes to the instruments, the manufacturing sector premium in 1960 and the high-skilled services sector premium in 1960 were 1.38 and 1.06, respectively. The routine occupational group premium in 1960 and the abstract occupational group premium in 1960 were 1.66 and 1.36, respectively.

Panel D presents descriptive statistics for control variables. The unemployment rate among college educated men increased from .01 in 1970 to .03 in 2018, while the unemployment rate among college educated women went up from .02 in 1970 to .03 in 2018. The unemployment rates among non-college educated men increased from .04 to .06, while the employment rate among non-college educated women remained stable at .06 between 1970 and 2018. The labor force participation increased markedly among women with and without a college degree, from .64 and .46 in 1970 to .82 and .65 in 2018, respectively. At the same time, the labor force participation among college educated men and non-college educated men decreased from .94 and .83 in 1970 to .91 and .74 in 2018, respectively. The shares of the population with a college education and the average number of education years rose among both men and women. The share of women with a college degree in 2018 was, however, larger than that of men and, on average, women had more education years in 2018. The shares of foreign born, black, Hispanics and other races increased during the study period.

4 Empirical Model and Identification Strategy

In this paper, I study what effect the polarization of earnings induced by structural change had on the development of the marital sorting coefficient in the US between 1970 and 2018. The association between the development of the marital sorting coefficient and the relative earnings gap measures describing earnings polarization is presented by the below regression specification:[10]

$$\begin{aligned} Marital\,Sorting_{pst} = \beta_0 &+ \beta_1\, Rel.\, Earnings\, Gap\, Lower\, End_{pst} \\ &+ \beta_2\, Rel.\, Earnings\, Gap\, Upper\, End_{pst} \\ &+ X'_{pst} + \gamma_s + \gamma_t + u_{pst}, \quad (1) \end{aligned}$$

where p stands for commuting zone (728) in state s (50) and t for year (1970, 1980, 1990, 2000, 2010 and 2018). Marital sorting, $Marital\,Sorting_{pst}$, is a rank correlation coefficient constructed as a rank correlation over the wife's and the husband's earnings where a husband and a wife were 27-36 years old in commuting zone p state s and year t.

I estimate the model with two sets of relative earnings gap measures. Each set contains measures which describe the relative earnings gap at the lower and upper ends of the earnings distribution in commuting zone p state s and year t, $Rel.\, Earnings\, Gap\, Lower\, End_{pst}$ and

$Rel.\, Earnings\, Gap\, Upper\, End_{pst}$. The first set contains relative earnings measures defined over broad industrial sectors: the relative sector premium in the manufacturing sector (the relative earnings gap at the lower end) and the relative sector premium in high-skilled services sector (the relative earnings gap at the upper end). The second set of relative earnings gap measures contains measures defined over broad occupational groups: the relative occupational group premium in the routine occupational group (the relative earnings gap at the lower end) and the relative occupational group premium in the abstract occupational group (the relative earnings gap at the upper end).

I add a set of controls, X_{pst}, in order to account for potential confounding factors. To capture secular trends in the educational composition of the pop-

[10] An alternative specification of the regression model, where the outcome variable is specified in long-term differences, i.e. decade differences, is discussed in detail in Appendix 2.

ulation, I include the average number of education years and the share with a college education[11] by gender. To account for the growing participation of women on the labor market, I add the labor force participation rate and the share of unemployed in the labor force by gender and education level. Other standard demographics controls include the share of black, Hispanic and other races, the share foreign born and the sex ratio for 27-36 years old. Demographic, educational and labor force composition controls also absorb possible labor supply shocks to commuting zones.

Time fixed effects, γ_t, are included to absorb changes in the laws and regulations (Lawrence et al., 2012) passed at the national level as well as other factors that affect all states unanimously. State fixed effects, γ_s, capture state specific time invariant characteristics. All models are weighted with the commuting zone share of the national population. Standard errors are clustered as the state level.

A positive (negative) estimate of the population parameter β_1 implies that commuting zones with a greater relative earnings gap at the upper end of the earnings distribution are characterized by a greater (lower) marital economic homogamy. A positive (negative) parameter estimate of the population parameter β_2 implies that commuting zones with a greater relative earnings gap at the lower end of the earnings distribution are characterized by a greater (lower) marital economic homogamy.

Identification strategy

The identification strategy is based on the theoretical model presented in Bárány & Siegel (2018). Bárány & Siegel (2018) suggest a new structural change driven explanation of the labor market polarization since 1950-1960s. The model is based on several facts. Productivity in some industrial sectors is technologically progressive. This technological progressivism combined with "innovation, capital accumulation and economies of large scale" leads to an increase in the output per hour worked (Baumol, 1967). Productivity in other sectors - technologically relatively constant sectors - is by nature low and might be increased only occasionally and marginally (Baumol, 1967).

Bárány & Siegel (2018) model labor supply in three broad industrial sectors: the manufacturing sector, the low-skilled services sector and the high-skilled services sector. While productivity in the former sector is technologically

[11] Two educational levels are defined: college (at least completed Bachelor degree) and non-college (at most some college).

progressive, productivity in the two latter sectors is technologically constant. Further, these three broad industrial sectors produce three consumption goods - manufacturing goods, low-skill services and high-skill services - which are complements to each other (Bárány & Siegel, 2018). For example, dry-cleaning and home aid refer to low-skill services, while banking and consulting services belong to high-skill services (Bárány & Siegel, 2018).

Bárány & Siegel (2018) use the model to show how employment and wages behave as the productivity levels increase across sectors. By 1960, such economic and technological conditions had been created - by some form of mechanization combined with some specific features of preferences - that productivity in the technologically progressive sector - the manufacturing sector - started to grow dramatically. Since goods and services produced by different sectors are complements, labor from the technologically progressive sector - manufacturing - had to reallocate to technologically marginal sectors - low-skilled services and high-skilled services sectors, which led to structural change (Bárány & Siegel, 2018). To attract workers in technologically marginal sectors, the wages had to improve relative to the technologically progressive sector. Since wages in the manufacturing sector are located in the middle of the wage distribution, while wages in the low- and high-skilled services sectors, respectively, are located in the lower- and upper-parts of the wage distribution, this resulted in employment and wage polarization (Bárány & Siegel, 2018).

Structural change resulted in a contraction of employment in the sector with the fastest growing productivity. Routine-task intensive occupations which are concentrated in this sector hence also saw a declining employment and relative earnings premium. Thus, when employment in manufacturing started to contract after 1950, this led to a polarization over broad occupational groups, since routine occupations were located in the middle of the wage and earnings distribution (Bárány & Siegel, 2018).

Bárány & Siegel (2018) quantify their model and show that it predicts a substantial share of the relative earnings growth in the low- and high-skilled services sector relative to the manufacturing sector and the change in the employment shares across broad industrial sectors in the US from 1960 to 2007.

The year 1960 is a starting point of employment and earnings polarization over broad industrial sectors (figure 3). The sector premiums in 1960 come from the regressions which control for the demographic composition of the employment. Hence, the sector premiums in 1960 potentially only reflect the relative technological and economic component in the broad industrial sectors in each commuting zone. Then, the sector premiums in 1960 should contain a quasi-fixed component reflecting the relative economic and technological conditions in 1960 that created a necessary environment for structural change to start. This quasi-fixed component is then naturally correlated with sector premiums decades later and it might be used to predict the development of the sector premiums over time.

I use the sector premium in 1960 to instrument for sector premiums in 1970-2018. By analogy, the occupational group premiums in 1960 are used to instrument for occupational group premiums 1970-2018 (figure 4). Since there are two endogenous variables, the first-stage equations are:

$$\begin{aligned} &Rel.\,Earnings\,Gap\,Lower\,End_{pst} = \\ &\qquad \mu_0 + \mu_1\,Rel.\,Earnings\,Gap\,Lower\,End_{ps1960} \\ &\qquad + \mu_2\,Rel.\,Earnings\,Gap\,Upper\,End_{ps1960} \\ &\qquad\qquad + X'_{pst} + \delta_s + \delta_t + \epsilon_{pst}, \end{aligned} \tag{2}$$

and

$$\begin{aligned} &Rel.\,Earnings\,Gap\,Upper\,End_{pst} = \\ &\qquad \mu'_0 + \mu'_1\,Rel.\,Earnings\,Gap\,Lower\,End_{ps1960} \\ &\qquad + \mu'_2\,Rel.\,Earnings\,Gap\,Upper\,End_{ps1960} \\ &\qquad\qquad + X''_{pst} + \delta'_s + \delta'_t + \epsilon'_{pst}, \end{aligned} \tag{3}$$

where p stands for commuting zone (728) in state s (50) and t for the year (1970, 1980, 1990, 2000, 2010 and 2018). The endogenous variables are the relative earnings gap at the lower and upper ends of the earnings distribution in commuting zone p state s and year t, $Rel.\,Earnings\,Gap\,Lower\,End_{pst}$ and $Rel.\,Earnings\,Gap\,Upper\,End_{pst}$. The instruments are the relative earnings gap at the lower and upper ends of the earnings distribution in commuting zone p state s and year 1960, $Rel.\,Earnings\,Gap\,Lower\,End_{ps1960}$ and $Rel.\,Earnings\,Gap\,Upper\,End_{ps1960}$. In all 2SLS regression models, the instruments are interacted with the time dummies.

The set of controls (X'_{pst} and X''_{pst}), the state fixed effects (δ_s and δ'_s) and the time fixed effects (δ_t and δ'_s) are as in model 1. ϵ_{pst} and ϵ'_{pst} are error terms.

Appendix Tables 3 (4) contain estimation results from equations 2 and 3 for earnings polarization measures defined over broad industrial sectors (occupational groups). The instrumental variables have a strong predicting power over the corresponding endogenous variables. The predictive power of sector (occupational group) premiums in 1960 over corresponding sector (occupational group) premiums in the following years decreases over time. A decrease in the magnitude of the coefficients and t-values is expected as the influence of the conditions in 1960 weakens over time.

Concerning first-stage estimation results for premiums defined over broad industrial sectors, commuting zones with a greater relative earnings premium in the high-skilled services (manufacturing) sector in 1960 had a greater relative earnings premium in the high-skilled services (manufacturing) sector in 1970-2018. Additionally, commuting zones with a greater relative earnings premium in the manufacturing sector in 1960 had a lower relative earnings premium in the high-skilled services sector in 1970-2018 (Appendix Tables 3).

When it comes to the first-stage estimation results for premiums defined over broad occupational groups, commuting zones with a greater relative earnings premium in the abstract (routine) occupational group in 1960 had a greater relative earnings premium in the abstract (routine) occupational group in 1970-2018. In addition, commuting zones with a greater relative earnings premium in the abstract occupational group in 1960 had a lower relative earnings premium in the routine occupational group in 1970-2018 (Appendix Table 4).

Appendix Table 5 also presents estimation results of the first-stage models 2 and 3 where the endogenous variables are only regressed against the instrument, i.e. without interaction with time dummies. The instrumental variables have strong predictive power over corresponding endogenous variables. Greater sector (occupational group) premiums in 1960 are associated with greater sector (occupational group) premiums in 1970-2010.

Further, I study a change in the sector (occupational group) premiums between 1970 and 2018 in relation to sector (occupational group) premiums in 1960. Appendix Figure 7 plots changes in the sector premiums between 1970 and 2018 against sector premiums in 1960, while Appendix Figure 8 plots changes in the occupational group premiums between 1970 and 2018 against occupational group premiums in 1960. Plots on Appendix Figures 7 and 8 suggest that commuting zones with greater sector (occupational group) premiums in 1960 saw smaller changes in sector (occupational group) premiums between 1970 and 2018. At the same time, commuting zones with lower sector (occupational group) premiums in 1960 saw larger changes in sector (occupational group) premiums between 1970 and 2018. This implies that commuting zones that were more (less) polarized in terms of earnings in 1960 had less (more) room for an earnings polarization thereafter.

The last row in Table 2 contains F-statistics from the first stage of the 2SLS regression models. The F-statistics are (20 22) for relative earnings gaps measures defined over broad industrial sectors. The F-statistics are (18 8) for the relative earnings gaps measures defined over broad occupational groups. The F-statistics are greater than what is conventionally accepted (Angrist & Pischke, 2009). The only exception is the F-statistic on the relative abstract occupational group premium which is slightly lower than what is normally accepted.

The year 1960 is not included in the regression models to avoid a mechanical correlation between instrumental and instrumented variables. The identification variation comes from the differences in economic and technological conditions within states across commuting zones in 1960.

5 Results

Estimation results

Table 2 panel A contains estimation results with the first set of relative earnings gap measures defined over broad industrial sectors: the relative earnings premium in high-skilled services and manufacturing sectors. Column 1 presents estimation results from the regression where the coefficient of marital sorting is regressed against the relative earnings gap measures, state and year fixed effects. The estimation results show that commuting zones with greater relative earnings gaps at the lower and upper ends of the earnings distribution are characterized by a greater coefficient of marital sorting. The estimates are highly significant at any conventional significance level. Column 2 adds a set of controls over labor force participation and unemployment rates by gender and education level, the educational composition of the labor force and the demographic composition of the population. The parameter estimates of the relative earnings gap measures decline in the magnitude but remain statistically highly significant. This indicates that, among other things, growing labor force participation and greater educational achievements among women contributed to the growing economic resemblance of marriage partners.

The third column presents 2SLS estimates controlling for the set of control variables, state and year fixed effects. The 2SLS estimates on the relative earnings gap measures at the lower and upper ends of the earnings distribution are positive and statistically highly significant at the 1 percent significance level.[12] The 2SLS estimates suggest that commuting zones with greater relative earnings gaps at the lower (upper) end of the earnings distribution measured by sector premiums in manufacturing (high-skilled) services are characterized by a greater coefficient of marital sorting. Alternatively, commuting zones with smaller relative earnings gaps at the lower (upper) end of the earnings distribution measured by sector premiums in manufacturing (high-skilled) services are characterized by the lower coefficient of marital sorting.

The relative earnings gap at the lower end of the earnings distribution measured by the earnings premium in the manufacturing sector narrowed between 1970 and 2018 (figure 3). Then, the estimation results suggest that, holding all else constant, the narrowing earnings gap at the lower end of the earnings distribution contributed to a decrease in the coefficient of marital sorting in the US in 1970-2018.

The earnings gap at the upper end of the earnings distribution measured by the earnings premium in the high-skilled services sector widened between 1970 and 2018 (figure 3). Then, the estimation results suggest that, holding all else constant, the widening of the earnings gap at the upper tail of the earnings distribution contributed to an increase in the coefficient of marital sorting among American couples in the age group 27-36 in 1970-2018.

Table 2 panel B contains analogous estimation results with the second set of relative earnings gap measures defined over broad occupational groups: the relative earnings premium in abstract and routine occupational groups. The estimation results for the second set of the relative earnings gap measures follow the same pattern as the results for the first set of earnings polarization measures. The 2SLS estimates suggest that commuting zones with greater relative earnings gaps at the lower (upper) end of the earnings distribution measured by the occupational groups premium in the routine (abstract) occupational group are characterized by a greater coefficient of marital sorting.[13] Or, commuting zones with smaller relative earnings gaps at the lower (upper) end of the earnings distribution measured by the occupational groups premium in routine (abstract) occupational group are characterized by a lower coefficient of marital sorting.

The earnings gap at the upper (lower) end of the earnings distribution mea-

[12] The F-statistics are equal to 20 and 22.

[13] The F-statistics are equal to 18 and 8.

sured by the earnings premium in the abstract (routine) occupational group widened (narrowed) between 1970 and 2018 (4). Then, the estimation results suggest that, holding all else constant, the widening (narrowing) of the earnings gap at the upper (lower) tail of the earnings distribution contributed to an increase (a decrease) in the coefficient of marital sorting among couples in the age group 27-36 in the US in 1970-2018.

The estimates of the terms describing relative earnings gaps at the upper end of the earnings distribution have a greater magnitude in absolute terms than the estimates on the terms describing relative earnings gaps at the lower end of the earnings distribution. This is true for both sets of earnings polarization measures. This implies that an increase/a decrease in the relative earnings gap at the upper end of the earnings distribution has a greater effect on marital sorting relative to an increase/a decrease in the relative earnings gap at the lower end of the earnings distribution.

How much did a growing earnings polarization contribute to a rise in marital sorting in the US between 1970 and 2018? I start with a quantification of the estimated results for the model estimated with the first set of relative earnings gaps measures defined over broad industrial sectors. The increase in the relative earnings gap in manufacturing and high-skilled services sectors was -.05 and .1, respectively, between 1970 and 2018 (Table 1). The multiplication with the 2SLS estimates on the corresponding relative earnings terms equal to .474 and .698 (Table 2 column 3) gives -.024 and .070, respectively. The narrowing gap at the lower part of the earnings distribution resulted in a .024 lower coefficient of marital sorting, while the widening earnings gap at the upper part of the earnings distribution resulted in a .070 greater coefficient of marital sorting constructed for marriage partners aged 27-36 in 1970-2018. The quantified effects partially offset each other and the overall effect is equal to .046. Thus, all else equal, the earnings polarization defined over broad industrial sectors contributed to a rise in the economic resemblance between marriage partners in the US between 1970 and 2018. The coefficient of marital sorting increased from .08 in 1970 to .32 in 2018 (Figure 1). The earnings polarization defined over broad industrial sectors would account for $.046/.24 = .192$, i.e. 19.2 percent of the rise in the coefficient of marital sorting in the absence of other factors in the US in 1970-2018.

The quantification of the estimation results from the models estimated with the second set of the relative earnings gaps measures gives a similar result. The increase in the relative earnings in the routine and abstract occupational groups sectors was -.30 and .24, respectively, between 1970 and 2018 (Table 1). A multiplication with the 2SLS estimates on the corresponding relative earnings terms equal to .226 and .533 (Table 2 column 6) gives -.068 and .128, respectively. The narrowing earnings gap at the lower part of the earnings distribution resulted in a -.068 lower coefficient of marital sorting, while the widening earnings gap at the upper part of the earnings distribution contributed to a .128 greater coefficient of marital sorting constructed for marriage partners aged 27-36 in 1970-2018. The quantified effects partially cancel out each other and the total effect is equal to .060. All in all, all else equal, the growing earnings polarization defined over broad occupational groups contributed to a rise in the economic resemblance between marriage partners in US in 1970-2018. The earnings polarization defined over occupational groups would account for .06/.24 = .25, i.e. 25 percent of the rise in the coefficient of marital sorting in the absence of other factors in the US in 1970-2018.

Even though the polarization of earnings did contribute to the rise in the marital economic homogamy in the US between 1970 and 2018, it only accounts for a small share of the total rise in the spousal economic resemblance in the absence of other factors.

Sensitivity tests

The coefficient of marital economic homogamy is constructed using current earnings as a proxy for potential earnings according to which individuals are sorted. However, current earnings might be a poor measure of potential earnings. For instance, current earnings might underestimate potential earnings since individuals in the age group 27-36, although they have already completed higher education, might still be at the beginning of their working careers and, thus, have relatively low earnings. Some individuals might be working part-time which would also underestimate their potential earnings. Additionally, individuals might sort on ambition level and career plans which might affect future earnings but might not yet be reflected in the current earnings. In this subsection, I analyze if my results are sensitive to the change in the measure of earnings used to compute the coefficient of economic homogamy. For this purpose, I construct two alternative coefficients of marital sorting based on the full-time full-year potential earnings of marriage partners (Xie et al. (2003), Gonalons-Pons & Schwartz (2017)).

To construct full-time full-year potential earnings on marriage partners, I first restrict the sample to married men and women aged 27-36 who work a full-year (at least 50 weeks) and full-time (at least 35 hours per week). Then, I construct potential earnings as a function of educational level (at least completed college degree), polynomial in experience, white dummy and five occupational group dummies (managerial and professional; technical, sales, and administrative; service; precision production, craft, and repairers; operatives and laborers). Regression models are run for each year, commuting zone and gender. Then I merge full-time full-year potential earnings for married men and women with non-negative earnings and for married men and women with any earnings.[14] Further, I assign rank from 1 to 10 over potential full-time full-year earnings and construct two alternative rank correlation coefficients: one for married partners with non-negative earnings and one for married partners with any earnings.

The alternative coefficients of marital sorting are presented in Appendix figure 6. Along with the main coefficient of marital sorting, the alternative coefficients exhibit an upward move between 1960 and 2018. The alternative coefficients started from a higher level in 1960, however. They rose between 1960 and 2000 and then declined slightly between 2000 and 2018.

Appendix Table 7 presents estimation results from the sensitivity test regressions with alternative coefficients of marital sorting as the outcome variables. Overall, the estimation results from the sensitivity test regressions are in line with the main estimation results. Only parameter estimates on routine occupational group premiums are not precisely estimated (columns 2 and 4). I conclude that my main estimation results are not sensitive to the change in the measure of earnings used to construct the coefficient of marital economic homogamy.

I also check if my estimation results are sensitive to the choice of age brackets in the construction of the marital sorting coefficient. I construct an alternative coefficient of marital sorting only for couples aged 32-36 since individuals in this age group are more likely to have stable earnings. The coefficient is plotted on Appendix figure 6. As expected, the alternative coefficient follows the original coefficient. Appendix table 8 contains estimation results of model 1 with the alternative coefficient of marital sorting. The estimation results are similar to the main estimation results. Thus, my main estimation results are not sensitive to the change in the age brackets.

[14]For individuals with a missing occupational code, I assign the potential earnings constructed as a function of educational level, polynomial in experience and a dummy for whether a person is white.

6 Conclusion

The earnings polarization over broad industrial sectors and broad occupational groups has been observed in the US since the 1950s-1960s. At the same time, the earnings similarity between marriage partners in the age group 27-36 increased significantly. In this paper, I study what effect the polarization of earnings driven by structural change had on the spousal economic resemblance in the US in 1970-2018. In order to identify a causal association between marital economic homogamy and earnings polarization, I employ a structural choice driven explanation of the labor market polarization developed in Bárány & Siegel (2018). The theoretical expectations are based on the model developed in Fernandez et al. (2005).

The empirical findings support my theoretical expectations and show that the rise in marital economic resemblance is indeed associated with the earnings polarization driven by structural change in the US in 1970-2018. The marital economic resemblance is greater in commuting zones with a greater earnings gap at the upper/lower part of the earnings distribution and lower in commuting zones with a smaller relative earnings gap at the upper/lower part of the earnings distribution. An increase/a decrease in the relative earnings gap at the upper part of the earnings distribution has a greater impact on marital homogamy in absolute terms relative to an increase/a decrease in the relative earnings gap at the lower part of the earnings distribution. This result is in line with the findings in Chiappori et al. (2017) which show that the preferences for a partner of the same education in the US has increased significantly and particularly at the top of the education distribution.

In the absence of other factors, the polarization of earnings would account for 19-25 percent of the rise in the coefficient of marital sorting in the US between 1970 and 2018.

The results in this paper improve our understanding of how changes on the labor market affect family formation outcomes. While Autor et al. (2019) study the effect of deteriorated employment on the probability of marriage, and while Shenhav (2016) studies the effect of an improved relative female to male wage on the probability of marriage, this paper investigates the effect of an earnings polarization on marital economic resemblance. The findings in these papers complement each other and provide a more complete picture of the effect of changing labor market conditions on the structure of the American family during the last few decades.

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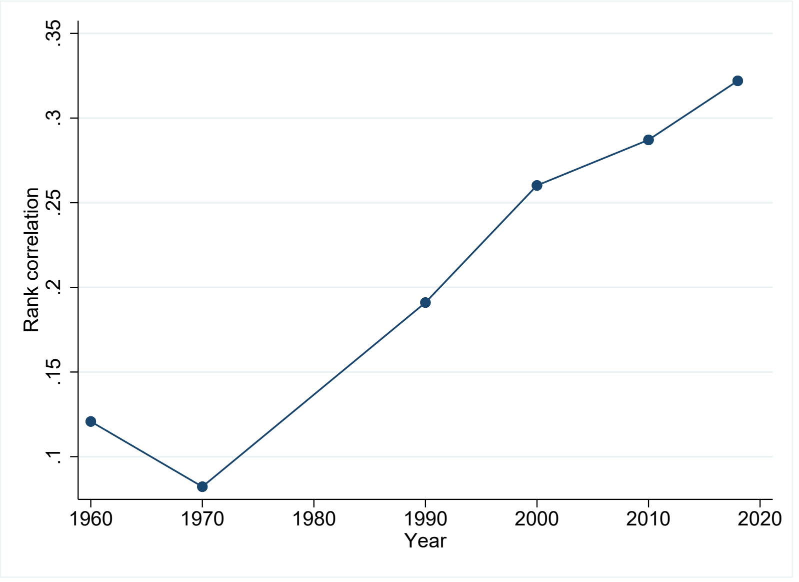
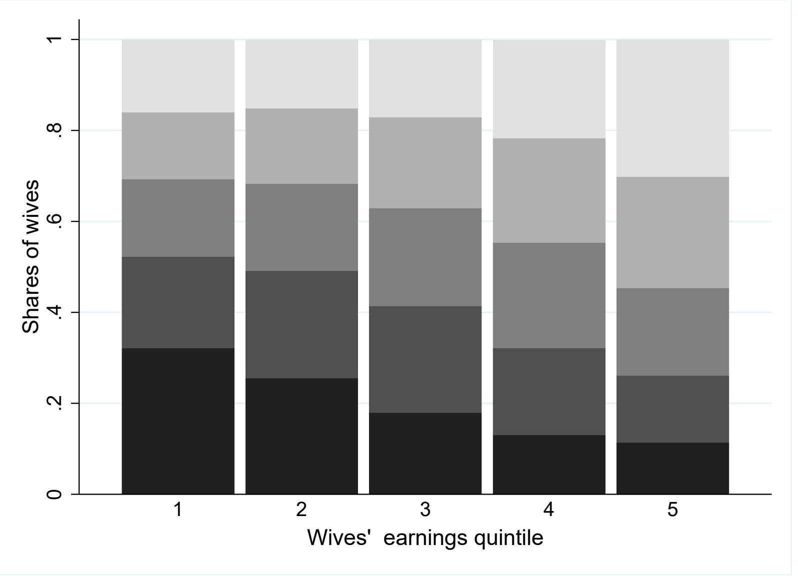
7 Figures

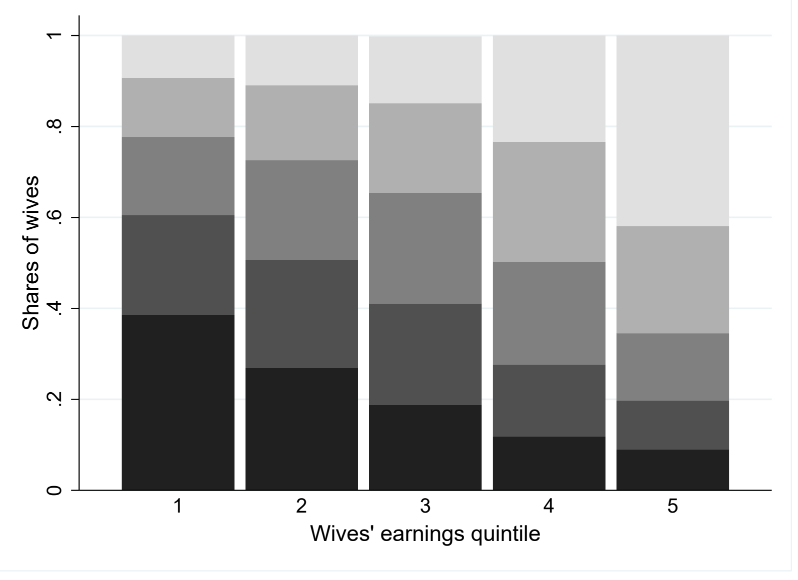
Figure 1: Coefficient of marital sorting, US 1960-2018



Notes: The coefficient of marital sorting is constructed as a rank correlation coefficient between the ranked earnings of a wife and a husband where a wife and a husband have non-negative earnings. Marriage partners are in the age group 26-37.



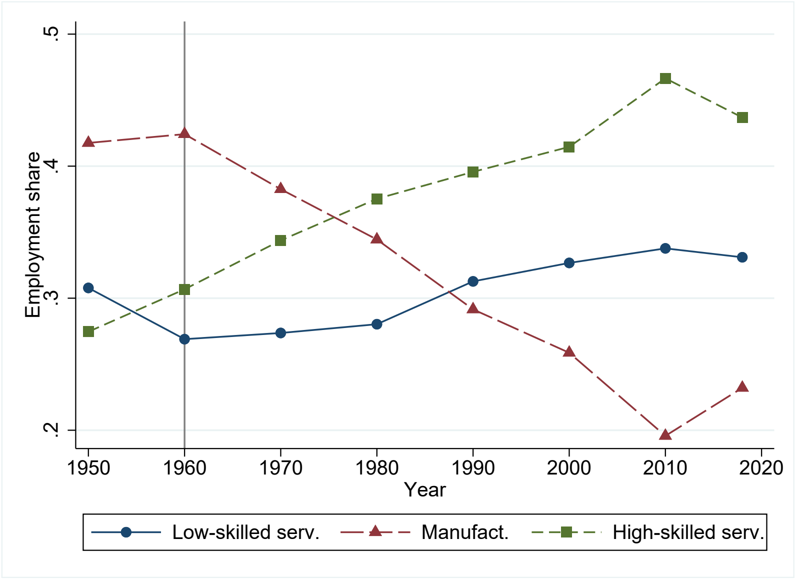
(a) Year 1960



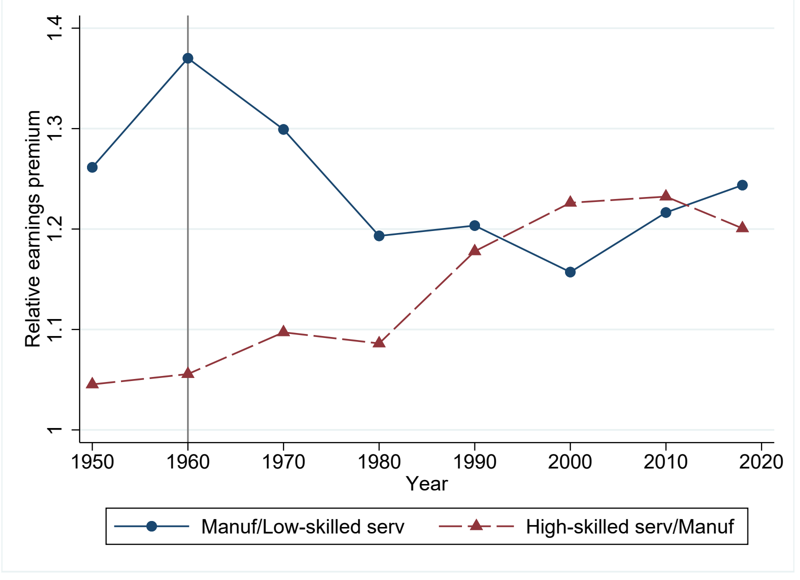
(b) Year 2018

Figure 2: Shares of wives with husbands according to earnings quintile, 1960 and 2018

Notes: The horizontal axis shows wives' earnings quintile. The vertical axis shows the shares of wives married to husbands of a particular earnings quintile. Very dark grey bars show the share of wives married to husbands in the first earnings quintile, dark grey bars show the share of wives married to husbands in the second earnings quintile, grey bars show the share of wives married to husbands in the third earnings quintile, light grey bars show the share of wives married to husbands in the fourth earnings quintile, while very light grey bars show the share of wives married to husbands in the fifth earnings quintile.



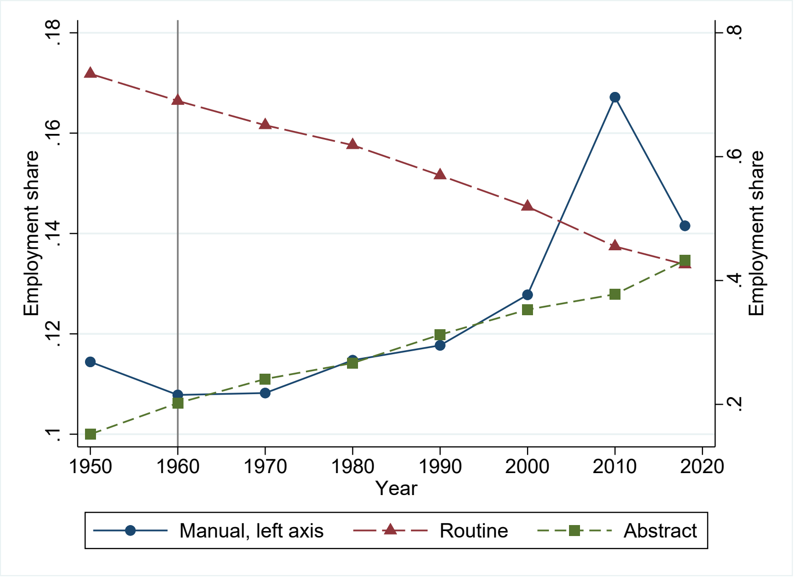
(a) Employment shares



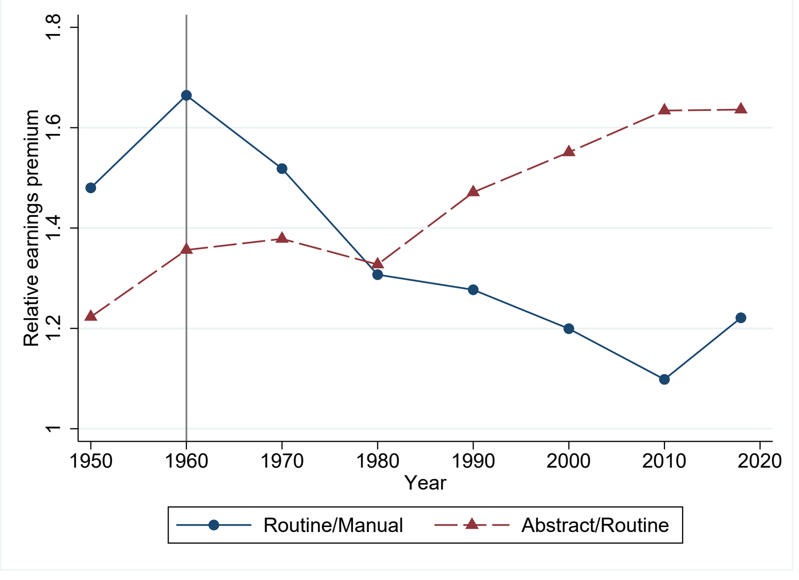
(b) Earnings

Figure 3: Labor market polarization over broad industrial sectors, US 1950-201

Notes: Sector premiums are constructed as the exponents of the coefficients on sector dummies that come from the regressions of log hourly earnings controlling for gender, race and foreign dummies and the polynomial in potential experience.



(a) Employment shares



(b) Earnings

Figure 4: Labor market polarization over broad occupational groups, US 1950-2018

Notes: Occupational groups premiums are constructed as the exponents of the coefficients on occupational groups dummies that come from the regressions of log hourly earnings controlling for gender, race and foreign dummies and the polynomial in potential experience.

8 Tables

Table 1: Descriptive statistics, 1970 and 2018

	1970		*2018*	
	mean	sd	mean	sd
Panel A: Outcome variable				
Coefficient of marital sorting	0.08	0.11	0.32	0.10
Panel B: Relative earnings gap measures, industrial sectors				
Lower end of the earnings distribution:				
Manufacturing premium	1.30	0.08	1.25	0.09
Upper end of the earnings distribution:				
High-skilled services premium	1.10	0.07	1.20	0.08
Instruments:				
Manufacturing premium 1960	1.38	0.09		
High-skilled services premium 1960	1.06	0.09		
Panel C: Relative earnings gap measures, occupational groups				
Lower end of the earnings distribution:				
Routine premium	1.52	0.22	1.22	0.06
Upper end of the earnings distribution:				
Abstract premium	1.38	0.08	1.62	0.10
Instruments:				
Routine premium 1960	1.66	0.13		
Abstract premium 1960	1.36	0.10		

Notes: The unit of observation is commuting zone×year. The descriptive statistics are weighted by the commuting zone share of the national population.

Table 1: Descriptive statistics, 1970 and 2018, cont.

	1970		*2018*	
	mean	sd	mean	sd
Panel D: Control variables				
Mean education years, men	11.40	0.54	13.24	0.46
Mean education years, women	11.33	0.43	13.58	0.42
Share college, men	0.12	0.04	0.27	0.08
Share college, women	0.08	0.02	0.31	0.08
Share black	0.11	0.09	0.13	0.10
Share Hispanic	0.04	0.07	0.18	0.16
Share other race	0.01	0.04	0.09	0.07
Share foreign	0.05	0.05	0.15	0.10
Sex ratio, age group 26-37	1.06	0.06	0.99	0.07
Unemployment rate, non college men	0.04	0.02	0.06	0.02
Unemployment rate, non college women	0.06	0.02	0.06	0.02
Unemployment rate, college men	0.01	0.01	0.03	0.01
Unemployment rate, college women	0.02	0.01	0.03	0.01
Labor force participation rate, non college men	0.83	0.03	0.74	0.04
Labor force participation rate, non college women	0.46	0.05	0.65	0.04
Labor force participation rate, college men	0.94	0.03	0.91	0.03
Labor force participation rate, college women	0.64	0.05	0.82	0.03

Notes: The unit of observation is commuting zone×year. The descriptive statistics are weighted by the commuting zone share of the national population.

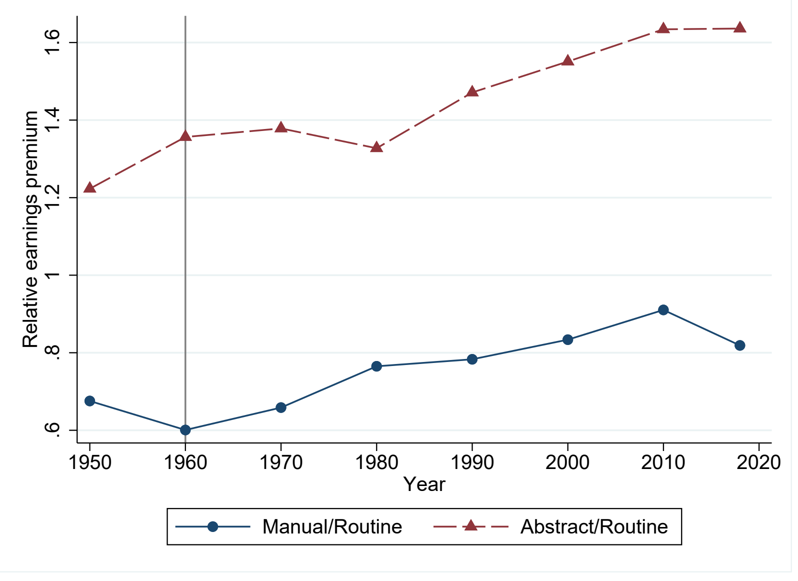
Table 2: Marital sorting and earnings polarization over broad industrial sectors and broad occupational groups, US 1970-2018

VARIABLES	(1) OLS	(2) OLS	(3) 2SLS	(4) OLS	(5) OLS	(6) 2SLS
Panel A: Relative earnings gap measures, industrial sectors						
Lower end of the earnings distribution						
Manufacturing premium	0.265***	0.098**	0.474***			
	(0.035)	(0.038)	(0.112)			
Upper end of the earnings distribution						
High-skilled services premium	0.447***	0.187***	0.698***			
	(0.049)	(0.038)	(0.125)			
Panel B: Relative earnings gap measures, occupational groups						
Lower end of the earnings distribution						
Routine premium				0.080**	-0.019	0.226**
				(0.035)	(0.038)	(0.099)
Upper end of the earnings distribution						
Abstract premium				0.410***	0.150***	0.533***
				(0.040)	(0.032)	(0.112)
R-squared	0.637	0.701	0.670	0.649	0.701	0.673
Controls	No	Yes	Yes	No	Yes	Yes
Fstat			20 22			18 8

Notes: The number of observations is 4 368 (728 commuting zones $\times$ 6 periods.) In Column 3, the 2SLS specification instruments for the sector premium in manufacturing relative to low-skilled services (high-skilled services relative to manufacturing) with the sector premium in manufacturing relative to low-skilled services (high-skilled services relative to manufacturing) in 1960 interacted with time dummies. In Column 6, the 2SLS specification instruments for the occupational group premium in routine relative to manual (abstract relative to routine) with the occupational group premium in routine relative to manual (abstract relative to routine) in 1960 interacted with time dummies. The models cover the period 1970-2018. The set of controls, the state and year fixed effects are included in all models. The models are weighted by the commuting zone share of the national population. State level clustered standard errors in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

9 Appendix 1

(a) Industrial sectors



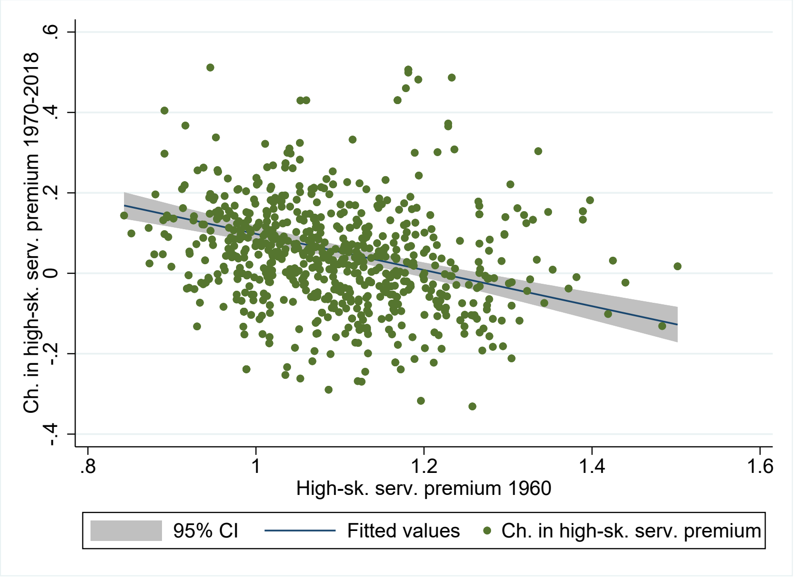
(b) Occupational groups

Figure 5: The earnings polarization over broad industrial sectors and broad occupational groups, US 1950-2018

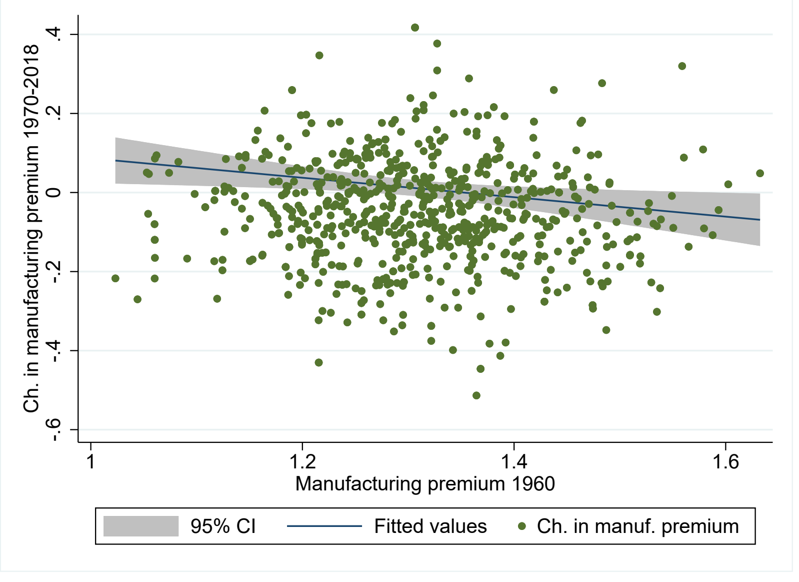
Notes: The sector (occupational group) premiums are constructed as the exponents of the coefficients on sector (occupational group) dummies that come from the regressions of log hourly earnings controlling for gender, race and foreign dummies and the polynomial in potential experience.

Figure 6: Alternative coefficients of marital sorting, US 1960-2018

Notes: The coefficients of marital sorting are constructed as a rank correlation coefficient between ranked potential full-time full-year earnings of a wife and a husband where a wife and a husband have non-negative (any) earnings and for couples in the age group 32-36.



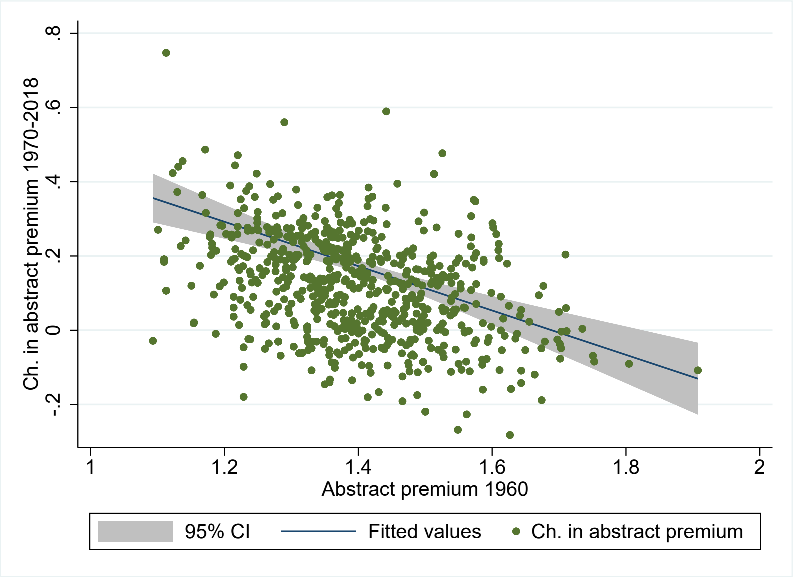
(a) High-skilled services premium



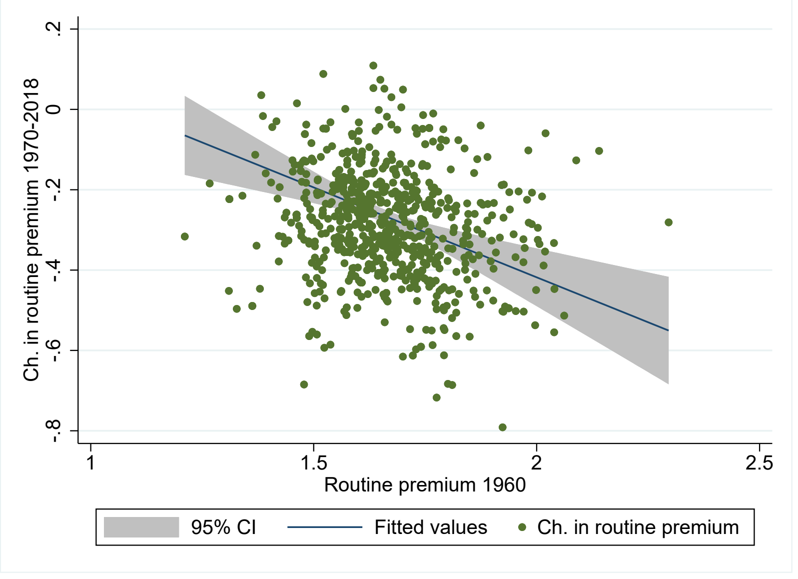
(b) Manufacturing premium

Figure 7: The change in sector premiums 1970-2018 relative to sector premiums in 1960

Notes: Sector premiums are constructed as the exponents of the coefficients on sector dummies that come from the regressions of log hourly earnings controlling for gender, race and foreign dummies and the polynomial in potential experience. Each dot corresponds to a commuting zone.



(a) Abstract premium



(b) Routine premium

Figure 8: The change in occupational group premiums 1970-2018 relative to occupational group premiums in 1960

Notes: Occupational group premiums are constructed as the exponents of the coefficients on occupational group dummies that come from the regressions of log hourly earnings controlling for gender, race and foreign dummies and the polynomial in potential experience. Each dot corresponds to a commuting zone.

Table 3: First stage: The relative earnings premium in broad industrial sectors by year 1970-2018 and in 1960

	(1)	(2)
	Premium in	
VARIABLES	High-skilled services	Manufacturing
Premium in manufacturing 1960		
× 1970	0.033	0.427***
	(0.055)	(0.059)
× 1980	-0.218***	0.412***
	(0.062)	(0.058)
× 1990	-0.203***	0.473***
	(0.054)	(0.065)
× 2000	-0.276***	0.385***
	(0.072)	(0.060)
× 2010	-0.126	0.280***
	(0.084)	(0.063)
× 2018	-0.138*	0.304***
	(0.075)	(0.086)
Premium in high-skilled services 1960		
× 1970	0.465***	0.057
	(0.071)	(0.083)
× 1980	0.281***	-0.106*
	(0.062)	(0.058)
× 1990	0.196***	-0.015
	(0.054)	(0.057)
× 2000	0.079	-0.023
	(0.062)	(0.058)
× 2010	0.158**	-0.126**
	(0.078)	(0.053)
× 2018	-0.017	0.018
	(0.076)	(0.097)
R-squared	0.658	0.620

Notes: The number of observations is 4 368 (728 commuting zones × 6 periods). In column 1 (2), the left-hand side variable is the sector premium in high-skilled services relative to manufacturing (manufacturing relative to low-skilled services). The right-hand side variables in both columns are sector premiums in high-skilled services relative to manufacturing and in manufacturing relative to low-skilled services in 1960 interacted with time dummies. The set of controls, the state and year fixed effects are included in all models. The models are weighted by the commuting zone share of the national population. The state level clustered standard errors in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

Table 4: First stage: The relative earnings premium in broad occupational groups by year 1970-2018 and in 1960

	(1)	(2)
	Premium in	
VARIABLES	Abstract group	Routine group
Premium in routine group 1960		
× 1970	-0.029	0.345***
	(0.031)	(0.068)
× 1980	-0.099***	0.147***
	(0.026)	(0.037)
× 1990	0.096***	0.095***
	(0.028)	(0.031)
× 2000	0.032	-0.008
	(0.026)	(0.022)
× 2010	0.055*	0.026
	(0.028)	(0.045)
× 2018	-0.049	0.014
	(0.037)	(0.035)
Premium in abstract group 1960		
× 1970	0.404***	-0.010
	(0.051)	(0.053)
× 1980	0.355***	-0.283***
	(0.046)	(0.032)
× 1990	0.192***	-0.206***
	(0.048)	(0.029)
× 2000	0.123***	-0.096***
	(0.039)	(0.027)
× 2010	-0.073*	0.031
	(0.039)	(0.037)
× 2018	-0.093*	0.012
	(0.048)	(0.038)
R-squared	0.862	0.850

Notes: The number of observations is 4 368 (728 commuting zones × 6 periods). In column 1 (2), the left-hand side variable is the sector premium in high-skilled services relative to manufacturing (manufacturing relative to low-skilled services). The right-hand side variables in both columns are sector premiums in high-skilled services relative to manufacturing and in manufacturing relative to low-skilled services in 1960 interacted with time dummies. The set of controls, the state and year fixed effects are included in all models. The models are weighted by the commuting zone share of the national population. State level clustered standard errors in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

Table 5: First stage: The relative earnings premium in broad industrial sectors and broad occupational groups in 1970-2018 and in 1960

	(1)	(2)	(3)	(4)
VARIABLES	*Indust. sect., prem. in*		*Occup. gr., prem. in*	
	High-sk. serv.	Manuf.	Abst.	Rout.
Panel A: Indust. sect.				
Manuf. prem. 1960	-0.152***	0.382***		
	(0.049)	(0.045)		
High-sk. serv. prem. 1960	0.179***	-0.032		
	(0.053)	(0.048)		
Panel B: Occup. gr.				
Rout. prem. 1960			0.005	0.110***
			(0.017)	(0.023)
Abst. prem. 1960			0.121***	-0.095***
			(0.029)	(0.022)
R-squared	0.639	0.614	0.843	0.832
Controls	Yes	Yes	Yes	Yes

Notes: The number of observations is 4 368 (728 commuting zones × 6 periods). In column 1 (2), the left-hand side variable is sector premiums in high-skilled services relative to manufacturing (manufacturing relative to low-skilled services). The right-hand side variables in columns 1 and 2 are sector premiums in high-skilled services relative to manufacturing and in manufacturing relative to low-skilled services in 1960. In columns 3 (4), the left-hand side variable is the occupational group premium in abstract relative to routine (routine relative to manual). The right-hand side variables are occupational group premiums in abstract relative to routine and routine relative to manual in 1960. The models cover the period 1970-2018. The set of controls, the state and year fixed effects are included in all models. The models are weighted by the commuting zone share of the national population. State level clustered standard errors in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

Table 6: Reduced form: The coefficient of marital sorting and the relative earnings premium in broad industrial groups and broad occupational groups in 1960, 1970-2018

VARIABLES	(1)	(2)
Panel A: Industrial sectors		
Manufacturing premium 1960	-0.021	
	(0.029)	
High-skilled services premium 1960	-0.021	
	(0.037)	
Panel B: Occupational groups		
Routine group premium 1960		-0.016
		(0.023)
Abstract group premium 1960		0.004
		(0.032)
R-squared	0.697	0.697
Controls	Yes	Yes

Notes: The number of observations is 4 368 (728 commuting zones × 6 periods.) The left-hand side variable is the coefficient of marital sorting. In column 1, the right-hand side variables are sector premiums in the high-skilled services relative to manufacturing and manufacturing relative to the low-skilled services in 1960. In column 2, the right-hand side variables are occupational group premiums in abstract relative to routine and routine relative to manual in 1960. The models cover the period 1970-2018. The set of controls, the state and year fixed effects are included in all models. The models are weighted by the commuting zone share of the national population. State level clustered standard errors in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

Table 7: Sensitivity test: Coefficient of marital sorting constructed over the wife's and husband's potential full-time full-year earnings

VARIABLES	(1) Couples with non-negative earnings	(2) Couples with non-negative earnings	(3) Couples with any earnings	(4) Couples with any earnings
Panel A: Relative earnings gap measures, industrial sectors				
Lower end of the earnings distribution				
Manufacturing premium	0.524***		0.396***	
	(0.202)		(0.145)	
Upper end of the earnings distribution				
High-skilled services premium	0.744***		0.645***	
	(0.247)		(0.185)	
Panel B: Relative earnings gap measures, occupational groups				
Lower end of the earnings distribution				
Routine premium		0.105		0.003
		(0.152)		(0.118)
Upper end of the earnings distribution				
Abstract premium		0.709***		0.663***
		(0.132)		(0.112)
R-squared	0.447	0.477	0.591	0.596
Controls	Yes	Yes	Yes	Yes
Fstat	20 22	18 8	20 22	18 8

Notes: The number of observations is 4 368 (728 commuting zones $\times$ 6 periods.) The outcome variable in columns 1 and 2 (3 and 4) is a coefficient of marital sorting constructed as a rank correlation coefficient between the ranked potential full-time full-year earnings of a wife and a husband where a wife and a husband have non-negative (any) earnings. In Columns 1 and 3, the 2SLS specification instruments for the sector premium in manufacturing relative to low-skilled services (high-skilled services relative to manufacturing) with the sector premium in manufacturing relative to low-skilled services (high-skilled services relative to manufacturing) in 1960 interacted with time dummies. In Columns 2 and 4, the 2SLS specification instruments for the occupational group premium in routine relative to manual (abstract relative to routine) with the sector premium in routine relative to manual (abstract relative to routine) in 1960 interacted with time dummies. The models cover the period 1970-2018. The set of controls, the state and year fixed effects are included in all models. The models are weighted by the commuting zone share of the national population. State level clustered standard errors in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

Table 8: Sensitivity test: The coefficient of marital sorting constructed over the wife's and the husband's ranked earnings, age group 32-36

	(1)	(2)
VARIABLES	2SLS	2SLS
Panel A: Relative earnings gap measures, industrial sectors		
Lower end of the earnings distribution		
Manufacturing premium	0.568***	
	(0.198)	
Upper end of the earnings distribution		
High-skilled services premium	0.912***	
	(0.254)	
Panel B: Relative earnings gap measures, occupational groups		
Lower end of the earnings distribution		
Routine premium		0.053
		(0.203)
Upper end of the earnings distribution		
Abstract premium		0.500**
		(0.214)
R-squared	0.466	0.491
Controls	Yes	Yes
Fstat	20 22	18 8

Notes: The number of observations is 4 368 (728 commuting zones × 6 periods.) The outcome variable is a coefficient of marital sorting constructed as a rank correlation coefficient between the ranked earnings of a wife and a husband where a wife and a husband are in the age group 32-36. In Column 1, the 2SLS specification instruments for the sector premium in manufacturing relative to low-skilled services (high-skilled services relative to manufacturing) with the sector premium in manufacturing relative to low-skilled services (high-skilled services relative to manufacturing) in 1960 interacted with time dummies. In Column 2, the 2SLS specification instruments for the occupational group premium in routine relative to manual (abstract relative to routine) with a sector premium in routine relative to manual (abstract relative to routine) in 1960 interacted with time dummies. The models cover the period 1970-2018. The set of controls, the state and year fixed effects are included in all models. The models are weighted by the commuting zone share of the national population. State level clustered standard errors in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

10 Appendix 2

Alternative specification of the regression model

In this paper I am interested in how sorting into marriage along earnings as a sorting trait among newly married couples is associated with earnings polarization - widening of the relative earnings gap at the upper end of the earnings distribution and narrowing of the relative earnings gap at the lower end of the earnings distribution in US since 1950s-1960s.

Sorting into marriage is measured by a coefficient of marital sorting with respect to earnings among couples where a husband and a wife are 27-36 years old. The age brackets are chosen to restrict the sample to recently married couples and to guarantee that college educated individuals have labor market experience. I follow previuos literature and assume that individuals sort into marriages with respect to perceived potential earnings of a marriage partner (Oppenheimer (1988), Sweeney (2002), Xie et al. (2003)). Since potential earnings are not observed, I use partners' current earnings as a proxy for potential earnings.

Relative earnings gaps at the lower and upper tales of the earnings distribution are described by earnings premiums across broad industrial sector and broad occupational groups.

Ideally, I would want to measure relative earnings gaps at the time when a decision to marry a specific person is made. Naturally, timing of this type of decisions is not possible to observe. Neither is the exact marriage date known in IPUMS. Since current situation on the labor market is correlated with the situation on the labor market several years back, current relative earnings gaps are correlated with relative earnings gaps some time ago when a marriage decision was made. Therefore, I approximate relative earnings gaps at the time of a marriage decision with current relative earnings gaps.

Thus, I regress current coefficient of marital sorting against current relative earnings gaps at the upper and lower parts of the earnings distribution as specified by the regression model 1. The regression model 1 answers to the question how the coefficient of marital sorting is associated with the relative earnings gaps at the lower and upper ends of the earnings distribution. Positive (negative) estimate of the population parameter β_1 means that commuting zones with greater relative earnings gap at the upper part of the earnings distribution are characterized by greater (lower) marital economic homogamy. While positive (negative) parameter estimate of the population parameter β_2 means that commuting zones with greater relative earnings gap at the lower part of the earnings distribution are characterized by greater (lower) marital economic homogamy.

It might be suggested to instead use a regression specification where the outcome variable - coefficient of marital sorting - specified in long term differences i.e. decade differences. And the independent variables - relative earnings gaps at the lower and upper ends of the earnings distribution - are measured at the beginning of a decade. The regression model is then as following:

$$\begin{aligned}\Delta Marital\, Sorting_{pst} = \\ &\beta'_0 + \beta'_1\, Rel.\, Earnings\, Gap\, Lower\, End_{pst_0} \\ &+ \beta'_2\, Rel.\, Earnings\, Gap\, Upper\, End_{pst_0} \\ &+ X'_{pst_0} + \gamma'_s + \gamma'_{t_0} + u'_{pst}, \quad (4)\end{aligned}$$

where p stands for commuting zone (728) in state s (50). Marital sorting, $\Delta Marital\, Sorting_{pst}$, is a decade change in rank correlation coefficient constructed as a rank correlation over wife's and husband's earnings over a decade t_0 to t_1. $Rel.\, Earnings\, Gap\, Lower\, End_{pst_0}$ and

$Rel.\, Earnings\, Gap\, Upper\, End_{pst_0}$ are relative earnings gaps at the lower and upper ends of the earnings distribution in commuting zone p in state s at the start of a decade t_0 to t_1. The equation 4 is then composed of five stacked equations: four equations represent a decade each and one equation represents an eight year period. The equation covers a period between 1970 and 2018.

X'_{pst_0} are a set of controls measured at a start of a decade t_0 to t_1, γ'_s are state fixed effects and γ'_{t_0} are start of a decade fixed effects. And u'_{pst} is an error term.

I claim that the alternative specification 4 is not suitable to answer to the research question in this paper. There are at least two reasons to that. First, specification of the outcome variable in the decade differences is not suitable for my research question. Ten year period is a quite long period of time. Many individuals that were married at the end of a decade were very young and had no labor market experience at the beginning of a decade. Therefore, it does not seem reasonable to assume that situation on the labor market ten years ago could have a strong effect on a recent marriage decision.

Second, the specification 4 itself answers to a question which is different to the one I am interested in this paper. More precisely, the specification

4 answers to the question how initial relative earnings gaps at the lower and upper ends of the earnings distribution are associated with subsequent changes in the coefficient of marital sorting. Put it differently, the specification 4 answers to the question how relative earnings gaps at the lower and upper ends of the earnings distribution at the beginning of a decade are associated with decade changes in the coefficient of marital sorting.

A positive (negative) estimate of parameter β_1' in equation 4 means that the coefficient of marital sorting will increase by more (by less) per decade in commuting zones with initially greater relative earnings gap at the lower end of the earnings distribution. Similarly, a positive (negative) estimate of parameter β_2' in equation 4 means that the coefficient of marital sorting will increase by more (by less) per decade in commuting zones with initially greater relative earnings gap at the upper end of the earnings distribution.

My expectation regarding the direction of the parameter estimates β_1' and β_2' from equation 4 is following. The estimation results from the empirical part of this paper suggest that greater relative earnings gaps at the upper and the lower ends of the earnings distribution are associated with greater coefficient of marital sorting. Then, commuting zones with initially greater earnings gaps should have had greater coefficient of marital sorting. As commuting zones with initially greater relative earnings gap at the lower/upper tale of the earnings distribution had less room for earnings polarization thereafter (figures 7 and 8), commuting zones with initially greater relative earnings gap at the lower/upper tale of the earnings distribution should initially have had greater coefficient of marital sorting and less room for the coefficient of marital sorting to increase even further.

I estimate model 4 with OLS and 2SLS. Appendix 2 Table 9 presents estimation results. The estimation results support my expectations. 2SLS estimates of the population parameters β_1' and β_2' are negative and highly significant. 2SLS estimation results suggest that commuting zones with initially greater earnings gap at the lower/upper tale of the earnings distribution saw smaller changes in the coefficient of marital sorting by decade between 1970 and 2018. The 2SLS estimation results mean that in commuting zones with *greater* earnings gap at the lower/upper tale of the earnings distribution at the beginning of a decade the coefficient of marital sorting increased *by less* per decade relatively to commuting zones with initially lower gap at the lower/upper tale of the earnings distribution at the beginning of a decade. Alternatively, in commuting zones with *lower* earnings gap at the lower/upper tale of the earnings distribution at the beginning of a decade the coefficient of marital sorting increased *by more* per decade relatively to commuting zones with initially lower gap at the lower/upper tale of the earnings distribution at the beginning of a decade.

The model 4 allows to study how much the coefficient of marital sorting changes by decade depending on the relative earnings gap at the lower and upper ends of the earnings distribution at the beginning of a decade. In comparison, model 1 allows to study how the coefficient of marital sorting is associated with the relative earnings gaps at the lower and upper ends of the earnings distribution. Model 1 is preferable in this paper.

Table 9: Changes in the coefficient of marital sorting and the earnings polarization over broad industrial sectors and broad occupational groups, the US 1970-2018

VARIABLES	(1) OLS	(2) OLS	(3) 2SLS	(4) OLS	(5) OLS	(6) 2SLS
Panel A: Relative earnings gap measures, industrial sectors						
Lower end of the earnings distribution						
Manufacturing premium$_{-1}$	-0.163***	-0.167***	-0.488***			
	(0.042)	(0.051)	(0.092)			
Upper end of the earnings distribution						
High-skilled services premium$_{-1}$	-0.220***	-0.213***	-0.616***			
	(0.049)	(0.046)	(0.103)			
Panel B: Relative earnings gap measures, occupational groups						
Lower end of the earnings distribution						
Routine premium$_{-1}$				-0.012	0.010	-0.215**
				(0.047)	(0.041)	(0.103)
Upper end of the earnings distribution						
Abstract premium$_{-1}$				-0.023	-0.060	-0.314***
				(0.058)	(0.056)	(0.110)
R-squared	0.101	0.126	0.093	0.089	0.118	0.091
Controls	No	Yes	Yes	No	Yes	Yes
Fstat			26 19			19 10

Notes: The number of observations is 3 640 (728 commuting zones $\times$ 5 periods.) The outcome variable is constructed as decade changes (four decade changes over the period between 1970 and 2010 and an eight period change between 2010 and 2018) of a coefficient of marital sorting. Independent variables are measured at the beginning of a decade. In Column 3, the 2SLS specification instruments for the sector premium in manufacturing relative to low-skilled services (high-skilled services relative to manufacturing) with a sector premium in manufacturing relative to low-skilled services (high-skilled services relative to manufacturing) in 1960 interacted with the start of a decade dummies. In Column 6, the 2SLS specification instruments for the occupational group premium in routine relative to manual (abstract relative to routine) with an occupational group premium in routine relative to manual (abstract relative to routine) in 1960 interacted with the start of a decade dummies. The models cover the period 1970-2018. The set of controls, the state and start of a decade fixed effects are included in all models. The models are weighted by the commuting zone share of the national population at the beginning of a decade. State level clustered standard errors in parenthesis. *p<0.10, ** p<0.05, *** p<0.0010.

Chapter 3

New Careers, Labor Market Turmoil and Gender: Evidence From Russia 2000-2016*

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1 Introduction

Entering the labor market as a college graduate[2] in a bad economy has immediate and obvious disadvantages. Graduates might face underemployment, job mismatch and lower entry wages since there are fewer jobs from which to choose. What is less obvious is if the effect of this unlucky career start will persist during the whole working life or if it might fade away over time? On the one hand, if job changes are common and beneficial, then as the economy picks up, young workers can easily switch to new jobs, and, therefore, they will only lose a few years of total labor market experience. On the other hand, if individuals accumulate the wrong type of human capital during their first years on the labor market, they will be less productive, which will have a negative effect on their labor market outcomes even in the long run (Kahn, 2010).

The quality of the first job and entry wage might be less important for the career development of workers who will potentially have frequent job interruptions and a lower labor market attachment during prolonged periods of time relative to workers with a more stable labor market attachment. Women belong to this group of workers since women withdraw from the labor force upon childbirth and more often work part-time after the arrival of a child relative to men. Thus, the effect of graduating in a bad economy might be of a smaller magnitude for women relative to that for men (Kondo, 2007).

On the other hand, one might expect the effect to go in the opposite direction. If women relative to men on average graduate from majors that are hit harder during a recession (Altonji et al., 2014), or if, due to industrial and occupational segregation, right after graduation, women relative to men land in the occupations and industries that experience a greater adverse effect during a recession (Berman & Pfleeger (1997), Konovalova & Maksimov (2017)), then the entry wages of women relative to those of men might be pushed down relatively more which might have a larger effect on the wage level both in the short and the long run. In addition, the fact that women relative to men have more options outside of the labor market, such as child-rearing and household production, might disproportionately affect the labor supply and the wage growth of women both in the short and the long run.

[2] College graduates constitute a natural group to study the effect of entering the labor market in a bad economy for two reasons. First, this is a highly skilled group of workers with good career prospects. Second, the majority of young people start to work directly after completing a college degree and only a small share continues to graduate school.

For instance, some couples that are planing to have a child some time after the woman's completion of higher education and where a woman graduates in a recession might make a decision to have a child earlier, since the opportunity cost of staying away from the labor market and taking care of a child is lower for women during the recession. This holds under the assumption that women take a large share of parental leave and take a greater responsibility for a young child. On the other hand, couples that are planing to have a child shortly after the woman completes her studies might postpone childbearing in an uncertain economic period and the woman will enter the labor market.

In this paper I study the effects of graduating from institutes of higher education in a bad economy in Russia 2000-2016. First, I study the effect of starting a career under unfavorable economic conditions for the whole population of college graduates, i.e. the joint effect for highly educated men and women. Then, I investigate if there is any gender difference in the effect of entering the labor market in a bad economy. And, finally, I study the potential mechanisms behind the estimated effects.

My findings suggest that highly educated individuals (men and women) who graduated in a recession have an initially lower hourly wage as compared to their luckier counterparts. A one percentage point increase in the unemployment rate upon graduation implies a 4.0-5.5 percent lower hourly wage. The negative effect fades away as the economy improves. Nevertheless, it remains present years after the graduation.

Highly educated men who graduated in a bad economy have an initially lower wage relative to men who graduated under more favorable conditions. A one percentage point higher unemployment rate upon graduation translates into a 6.1 to 11.2 percent wage loss. The initial negative effect gradually dissipates as the economy recovers, but it still persists several years after graduation. Although no immediate effect of graduating in a recession on the probability of being employed among college educated men is identified, a large negative effect on the employment probability in this group does pop up five to seven years after graduation.

Contrary to the effect on men, I do not identify any immediate effect of graduating in a bad economy on the hourly wage among women. However, the negative effect appears three to five year after graduation. Three years after graduation, the effect on the hourly wage among women is of the same magnitude as that among men. However, as compared to men, the negative effect on the hourly wage among women tends to increase over time.

An analysis of the potential mechanisms shows that men and women who graduated in a bad economy did, on average, have lower quality jobs which might explain the lower hourly wages right after graduation and over time. No gender difference in the effect of graduating in a bad economy on the job quality is identified. Additionally, women graduating in a recession tend to transit faster to parenthood.

The identification of the causal effect of graduating in a bad economy is a hard task as the timing of graduation might be correlated with the labor market conditions. For instance, if an individual expecting to graduate soon foresees her prospects on the labor market to be poor, she might decide to stay at school for an additional term or two until the situation on the labor market improves. A potential solution to the problem of endogenous timing of graduation is to instrument an endogenous timing of graduation with an indicator for an exogenous timing of graduation (Kahn, 2010).

More precisely, I use the regional unemployment rate as a measure of the situation on the labor market (Kahn, 2010). Then, I instrument the unemployment rate upon actual graduation with the unemployment rate at the hypothetical age of graduation in the region where an individual resided at the age of 14. I use the age at which individuals generally graduate from the institutes of higher education in Russia as the hypothetical age of graduation (20 or 22 depending on the type of institute of higher education), i.e. the age determined by the way in which the education system is formed. The region of residence at the age of 14 is treated as exogenous as it cannot be directly affected by an individual due to young age.

A potential concern is that due to the cyclical nature of economic development, the unemployment rates might be correlated over time. To account for this, I include the regional unemployment rate in each year of observation to ensure that the estimates on the unemployment rate upon graduation do not pick up the current situation on the labor market which might be correlated with historical unemployment rates.

A growing literature in economics studies the effect of graduating in a bad economy on labor market outcomes. Kahn (2010) analyzes the effects on white non-immigrant males in the US. Oreopoulos et al. (2012) use a large longitudinal employer-employee data set to analyze the effect on male college graduates in Canada. Fernández-Kranz & Rodríguez-Planas (2018) study the analogous effect for males in Spain. Cockx & Ghirelli (2016) investigate the effect on highly educated males in Belgium.[3] The object of study in

[3]Cockx & Ghirelli (2016) also study the effect on low-educated males in Belgium. Her-

Bostrom (2019a) is male college graduates in Sweden. All these studies unanimously find large, negative, and persistent consequences on wages and earnings in the short and long run. Altonji et al. (2014) specifically study the effect of graduating in a recession on the labor market outcomes by different college majors. Altonji et al. (2014) show that majors with typically higher earnings such as economics, finance, management and administration and engineering, exhibit smaller declines in most labor market outcomes as measured when graduating in a bad economy.

Kondo (2007) studies the differential effect of the unemployment rate upon entry on the labor market outcomes across race and gender (African Americans and women) in the US. Kondo (2007) finds negative effects of both white and black men on some outcomes, but no impact either of white or black women on any outcome. Liu & Chen (2014) pool all educational groups separately for men and women in Taiwan. The authors find a negative effect on the labor market outcomes in the pooled samples. Liu & Chen (2014) do not identify any effect in the separate gender and education groups, however. Päällysaho (2017) uses matched employer-employee panel data on male and female university graduates with a Master degree to study the effect of entering the labor market in a recession in Finland. The author finds weaker effects on the annual earnings among women relative to men. Päällysaho (2017) explains the identified gender difference by educational and occupational segregation. Bostrom (2019b) investigates gender differences from entering the labor market in a recession in Sweden. Bostrom (2019b) focuses on men and women who have graduated with business, law and engendering degrees in order to compare the the effect between men and women with similar prospects on the labor market. Bostrom (2019b) finds small gender differences in the effect among graduates with business, law and engendering degrees. The difference in the effect varies across fields of study, however.

In this paper, I study the effect of graduating in a bad economy among highly educated men and women in Russia. The US, Canada, Spain, Belgium, Sweden, Finland, Taiwan - whose college graduates were an object of study in the previous work - and Russia are characterized by important differences in the quality of political and economic institutions, fundamental economic structures and the functioning of the labor markets, which implies that the magnitude and the persistence of the effect on college graduates might differ across countries. At the same time, Russia represents an interesting case to

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shbein (2012) studies the effect of graduating from high school in a bad economy for both men and women separately in the US.

investigate the effect of graduating in a bad economy. During the period of study, Russia underwent a period of expansion 2000-2008 with an average annual GDP growth of seven percent, stagnation in 2009 with a negative GDP growth rate of almost eight percent, a slow recovery between 2010 to 2013 and negative to zero growth rates after that. The geographic regions in Russia are additionally characterized by a substantial variation in the unemployment rates. Moreover, women in Russia are highly educated and have a high labor force participation rate.

This paper contributes to the literature in several ways. First, this paper studies the effect of graduating in an adverse economy on the labor market outcomes and the potential channels behind this in a country with important differences in the functioning of the institutions and the labor market relative to the countries studied in the previous papers. Therefore, the results in this paper might improve our understanding of how the careers of college graduates are affected by a start under adverse economic conditions in countries with different institutional, economic and labor market profiles.

Then, this provides evidence for the gender difference in the effect of starting a career under economically unfavorable conditions and the potential mechanisms behind this. Previous studies using data from the US and Taiwan do not identify any effect among women (Kondo (2007), Liu & Chen (2014)), while studies using data from Finland and Sweden do find the effect among women and some differences between genders (Päällysaho (2017), Bostrom (2019b)). Since the economic structure, the institutions and the functioning of the labor market in Russia differ from those in the US, Taiwan, Finland and Sweden, it is not obvious whether there might be any effect among highly educated women in Russia. The magnitude of the gender differences and the potential mechanisms behind them might also differ across countries. Hence, the results in this paper might improve our knowledge of the gender differences of starting a career in a recession and the potential mechanism behind them in countries that differ along these dimensions.

Finally, this paper adds to a very broad literature studying gender differentials on the labor market and factors explaining them (among many others see Mandel & Semyonov (2005), Bertrand et al. (2010), Goldin (2014), Henrik Jacobsen et al. (2015) etc.).[4]

[4] This paper is also related to the earlier literature studying the effect of youth unemployment on career development later in life (for example, Gregg (2001), Neumark (2002), Burgess et al. (2003), Gregg & Tominey (2005), Raaum & Røed (2006), Raaum & Røed (2006), etc.).

This paper is organized as follows. Section 2 gives a brief discussion of economic theory and predictions. Section 3 describes an education system in Russia. Section 4 presents data and a descriptive analysis. Section 5 lays out an econometric methodology. Section 6 presents results, potential mechanisms and robustness checks. And section 7 discuses and concludes the paper.

2 Relevant Theory and Predictions

Different economic theories provide different expectations about the potential effect of graduating from college under adverse economic conditions. According to the job search theory suggesting that job hunting has a positive effect on future wage growth, the consequences of initial unfavorable labor market experience can easily be overcome if the job changes are common and beneficial. If an individual faces unemployment or a bad job-match during the first few years on the labor market, then, as the economy recovers, the individual can switch to another job and therefore only loses one year or two of accumulated labor market experience. This holds if one assumes diminishing marginal returns to experience (Kahn, 2010).

Another block of theories suggests that if workers who enter the labor market during a recession develop discrepancies in human capital accumulation, then they will be less productive and, consequently, earn less in comparison to those workers who enter the labor market under favorable economic conditions, even years after graduation and, therefore, one will see long-term effects (Kahn, 2010). This discrepancy might come via general human capital accumulation (Jovanovic, 1979b) or some type of specific human capital investment (Jovanovic (1979a), Neal (1999), Gibbons & Waldman (2004) etc.)

The reasoning behind the job search theory and the theories referring to human capital accumulation seems to be more relevant for workers who are expected to be permanently attached to the labor market with very few or no job interruptions. For individuals with a lower labor force attachment and for individuals who tend to have more frequent job interruptions, the initial job mismatch and underemployment right after graduation from college might be less important. In other words, the quality of the first job and the entry wage might be less important for the career development of workers who will potentially have frequent job interruptions and a lower number of working hours during prolonged time periods relative to workers with a more permanent labor market attachment. Women might belong to this group of individuals since women withdraw from the labor force upon childbirth more often than men and work part-time after their return to the labor market. Then, the effect of graduating in a bad economy might be of a smaller magnitude for women relative to that for men.

On the other hand, one might expect the effect to go in the opposite direction. Altonji et al. (2014) show that graduates in, on average, better paying majors experience a smaller decline in earnings and wages when they graduate in a recession relative to graduating in, on average, less well-paying majors. If women relative to men tend to graduate more often from lower paying majors, their initial wages and career development will be affected more than those of men who graduate in, on average, better paying majors. Further, if, due to industrial and occupational segregation, women land in the industries and occupations which are more affected during a stagnation period right after graduation, their wages will be more compressed right at the outset of their careers relative to men who get their first job in the industries which are less affected (Berman & Pfleeger (1997), Ogloblin (1999), Ogloblin (2005), Konovalova & Maksimov (2017)). These effects might shift the initial wage levels and have further consequences for the wage growth.

Finally, the fact that women relative to men typically have more options outside of the labor market, such as home production and childbearing, might contribute to labor supply decisions of women right after graduation if graduating in a recession. Consider, for example, a household decision about the timing of child-bearing.[5] Assume that a woman in a couple graduates in a bad economy. On the one hand, a couple who was planning to have a child anyway, might decide to have a child right after the woman graduates since the opportunity cost is lower than if she had graduated in a good economy. Several years later when the child moves to childcare and the economy improves, the woman might enter the labor market avoiding potential underemployment or job mismatch. Since women take the largest share of parental leave in the vast majority of families, the childbearing decision will only affect the labor market outcomes of a woman in a partnership. On the other hand, a couple who was planning to have a child shortly after graduation might postpone it in a time of economic uncertainty and a newly graduated woman will enter the labor market.

To sum up, it is not obvious if the initial disadvantages of starting a career under adverse economic circumstances will have any long-term effect on the

[5] See, for example, Sobotka et al. (2010), Hashimoto & Kondo (2012) and Hofmann & Hohmeyer (2015).

career development of college graduates or if it will fade away with time. Nor is it clear if the expected effect on women should be of the same, a greater or a lower magnitude relative to that on men. Empirical testing is necessary to answer these questions.

3 Education System in Russia

Education in Russia is predominantly provided by the state and is regulated by the Ministry of Education and Science. The education system consists of pre-school education, general education, technical or vocational education and higher education. Children of the age from 1 to 7 can enroll in the institutions of pre-school education represented by nurseries (age 1 to 3) and kindergartens (age 3 to 7). At the age of 6-7, children start general education. The majority of children starts studying at the age of 7. General education can be divided into three stages: primary general education (years 1-3), lower secondary education or basic general education (years 5-9) and upper secondary education or complete secondary general education (years 10-11). Technical or vocational education is given at two levels: basic vocational education and middle level professional education. Middle level professional education is a non-university higher education. Finally, there are two types of higher education: non-university higher education (middle level professional education) and university higher education.

Primary general education and basic general education together take 9 years and are compulsory. Upon completion of 9 years of education at the age 14-15, all students are required to take a final exam to obtain a Certificate of Basic General Education. This certificate allows its holder to be admitted to either upper secondary education (which is required for further university higher education) or to vocational and middle level professional education (or non-university higher education). The standard duration of secondary complete general education is 2 years (years 10 and 11). Students usually obtain their upper secondary education at the age of 16-17.

Students can apply to the institutes of higher non-university education (technical schools) after 9 or 11 years of general education depending on the technical school. Students entering technical school after 9 years of general education follow 3- to 5-year programs consisting of general and vocational education, while students entering technical school after 11 years of general education follow 2- to 3-year vocational programs. The majority of students start after 9 years of general education and follow 3-year programs. Training is offered within the following fields of study: technology, agronomy, economy, services, teaching, health (paramedical professionals), culture and art. About 50% of the curriculum are practically oriented. The programs include three periods of external practical training. Submitting a final dissertation is mandatory. Students with a completed non-university higher education can continue with a university higher education but they need to sit competitive entrance examinations and are admitted on the same terms as applicants from general secondary school (NORRIC, 2005). The number of students applying to an institute of higher university education after completing a technical school is limited.

After the successful completion of upper secondary education, students can apply to institutes of higher university educations (universities, academies, and institutes) at the age of 16-17. Institutes of higher education award the following degrees: Bakalavr degree (4 years), Specialist degree (5 sometimes 6 years), and Magistr degree (2 years after the Bakalavr degree). The Specialist degree is more practically oriented, while the Magistr degree is more research oriented. The majority of students obtain a Specialist degree. Around half of all students get their education for free while others pay tuition fees.

In general, students enter institutes of higher education directly after the completion of the general education. Students who go though the education system without any periods of absence usually graduate at the age of 20 years if they choose non-university higher education and at the age of 22 if they choose university higher education. Therefore, the general age of graduation is determined by the way in which the education system is built.

4 Data and Descriptive Statistics

In this paper I study the effect of starting a career in a bad economy among highly educated men and women in Russia in 2000-2016. To identify the effect of interest, I need a set of labor market outcomes and a variable capturing the labor market conditions upon graduation. I use the unemployment rate at the regional level (Kahn, 2010) as the latter.

Data

I use individual level data from the Russia Longitudinal Monitoring Survey

(RLMS-HSE).[6] RLMS-HSE is a nationally representative survey designed to monitor the effects of Russian reforms on the health and economic welfare of households in the Russian Federation. The data was first collected in 1996 and then in 1998. Starting from 2000, the survey has been conducted yearly. The size of the survey was reduced in 2013 (RLMS-HSE, 2016).

In 2013, the Russian Federation consisted of 83 federal subjects. There were six types of federal subjects — 21 republics, nine krais, 46 oblasts, two federal cities, one autonomous oblast, and four autonomous okrugs. For convenience, I call all six types of federal subjects regions. In my graduates sample I have data for individuals from 30 regions.[7]

Regions has different geographical and population sizes. Regions serve as a first level administrative division in Russia. Each region has a state government with a state legislature that is elected democratically. The highest executive position in the state government - the Governor - is appointed directly by the President of Russia, though. All regions have a capital city - the regional (or administrative) center - which is generally the biggest city. There are four types of settlements in each region: regional center, town, urban type settlement (small town with urban infrastructure) and rural settlement.

In 2000, the Russian Federation was divided into seven Federal districts - Central, Southern, North Western, Far Eastern, Siberian, Ural and Volga Federal Districts. Federal districts are not the constituent units of the country. They were introduced to improve the central government's supervision of federal subjects. In 2010, the new North Caucasian Federal District split from the Southern Federal District. All eight federal districts are present in my data.

For all individuals, I can identify date of birth, type of a settlement (regional center, town, urban type settlement or rural settlement), all levels of education obtained, type of higher education received (higher university education or higher non-university education[8]), the year when each level of education was completed, the number of years studied, gender and major. Further,

[6] Russia Longitudinal Monitoring survey, RLMS-HSE, conducted by the National Research University Higher School of Economics and ZAO "Demoscope" together with Carolina Population Center, University of North Carolina at Chapel Hill and the Institute of Sociology RAS, http://www.cpc.unc.edu/projects/rlms-hse [accessed 2018-09-11].

[7] Moscow and St Petersburg are federal cities. These cities also serve as capitals of the Moscow and Leningradskaya oblast, respectively. Due to data restrictions, I treat Moscow as part of Moscow oblast and St Petersburg as part of Leningradskaya oblast.

[8] For a description of different types of higher education in Russia, see Section 3 Educa-

I can identify a current region of residence and for how long an individual has been living in this region, i.e. either from birth or a moving-in year. I keep individuals who graduated from technical schools (the institutes of higher non-university education) at the age between 18 and 22 and individuals who graduated from universities at the age between 21 and 26.[9] Further, I restrict the sample to all men and women graduating between 2000 and 2016.

For the empirical analysis, I need to know i) the region where an individual entered the labor market and ii) the region where an individual resided at an early age. As an early age region of residence, I use a region where an individual lived at the age of 14 (Kahn, 2010). RLMS-HSE only contains information about the current region of residence and for how long an individual has been living in this region. Thus, in terms of information about the region of labor market entry and the region of residence at an early age, the sample of graduates consists of three groups of individuals. The first group consists of individuals who were born in and lived in the same region at the age of 14. The second group contains individuals who were born in some other region, but moved into the region of current residence at the age of 14 at the latest. This means that the regions where individuals resided at the age 14 and entered the labor market after graduation were the same.[10] These two groups of individuals can be included in the analysis sample. For individuals in the third group, I can identify regions where individuals entered the labor market, but not the regions of residence at the age of 14, since these individuals moved out from the region of residence at the age of 14, after their fourteenth birthday. There are 408 such individuals, of whom 183 are men and 225 are women, that cannot be included in the analysis sample. I am left with 2 235 unique individuals who belong to the first two groups. 33 of these individuals have both technical college and a university degree. These individuals are dropped from the sample.[11] The final sample contains 2 202 individuals, where 937 are males and 1 265 are females.

Table 1 shows the number of individuals graduating from technical schools

tion System in Russia. In the following analysis, students with both types of higher education are pooled together. A dummy for the type of higher education is included in all regressions.

[9] The hypothetical age of graduation from technical schools and universities is 20 and 22, respectively. See Section 3 Education System in Russia.

[10] For a small number of individuals, who satisfy the graduation age and year of graduation requirements, I do not have any information about the region of labor market entry. These individuals moved to the current region of residence after graduation.

[11] These individuals are omitted since they might comprise a highly selected group. Including these individuals in the analysis sample does not change the estimation results.

and universities by year of graduation and gender. The number of graduates in the sample was increasing at the beginning of the time period studied. This is explained by the fact that new respondents were added to the RLMS-HSE every year. The size of the survey was reduced in 2013, which clarifies the sharp decrease in the number of students graduating yearly since 2013. All modifications to the sample size were made in a way that allowed us to preserve the representativeness of the sample (RLMS-HSE, 2016).

I construct two variables to describe the labor market supply on the extensive margin: a dummy for being employed, which is set to unity if an individual is employed and to zero if an individual is not employed and looking for job,[12] and the probability of being employed part-time. The typical length of a working week in Russia is 40 hours. Hence, the part-time dummy is set to 1 for workers working fewer than 40 hours per week and zero otherwise. To describe the labor market supply on the intensive margin, I construct variable hours in a typical work week. A final outcome variable is the log average hourly wage expressed in 2016 regional prices.

Data for the regional unemployment rate and the inflation rate used to inflate the average hourly wage are collected from the yearly statistical books *Russian Regions. Socio-economic Indicators* published on-line on the official website of the Russian Federation Federal State Statistics Service (ROSSTAT).[13]

There are several problems with the data. The first is that the number of observations decreases as the number of potential years of experience increases. Due to the combination of various data restrictions in RLMS-HSE and ROSSTAT, the analysis window is limited to the individuals graduating between 2000 and 2016. The second is a relatively small sample size of RLMS-HSE which was additionally exacerbated by a cut in the data collection from 2013 (RLMS-HSE, 2016). The third is a general attrition problem. The fourth is a non-respondence of surveyed individuals in some years. As a result, while for some individuals I have observations for each year of potential experience, for other individuals I only have observations for a few non-consecutive years of potential experience. The fifth is that those individuals who changed their region of residence after the age of 14 cannot be included in the analysis. I discuss this in detail in the below subsection.

[12] Women that are on maternal leave, looking after a child aged below three and housewives are considered to be outside of the labor force.

[13] http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1138623506156 [accessed 2018-09-11].

Internal validity

15.4 percent of the initial sample of college graduates changed their place of residence after the age of 14. RLMS-HSE does not allow us to identify if individuals moved within the same region from one type of settlement to another, for example, from a rural type of settlement to a regional center, or to a different region. RLMS-HSE does not follow individuals who change their region of residence either. If individuals decide to move differentially depending on their expectations about the labor market conditions upon graduation, there will be a differential selection in regions with favorable and unfavorable labor market conditions, i.e. in regions with low and high unemployment rates. Hence, movers will differ from stayers which might bring the internal validity of the estimation results into question.[14]

To investigate this concern, I check if movers relative to stayers more often live in some particular federal districts, regions and types of settlement, and if movers and stayers differ in terms of available background characteristics and labor market outcomes. If movers more often choose to move to different federal districts, regions and type of settlements than those in which stayers live and differ systematically with regard to the background characteristics and the labor market outcomes relative to stayers, the internal validity of the results might be questioned.

First, I study if movers relative to stayers sort into some particular federal districts and regions. Appendix Table 9 presents the shares of movers and stayers by federal district, region, differences in shares and standard errors. Federal districts were created with the purpose of governing and control of Russian regions by the central government and therefore, the regions were grouped into federal districts according to their geographical location. There are no particular economic och political ties between regions within the same federal district. Hence, the shares of movers and stayers by federal district should be analyzed with caution. Another way of grouping the regions might entail different results. The region is the most accurate administrative unit to compare shares of movers and stayers.

There were eight federal districts in the Russian Federation 2013. All eight districts are present in my data. Movers relative to stayers do more often relocate to the North Western federal district, while 10.5 percent of the movers relative to 8.7 percent of the stayers reside in this district. Movers relative to stayers do less often reside in the North Caucasian federal district,

[14]For convenience, I call college graduates that did not change their region of residence after the age of 14 stayers, while I call graduates who changed residence region movers.

7.5 percent vs. 9.0 percent. Although the differences between the shares of movers and stayers residing in these two federal districts are statistically significant at 5 and 1 percent significance levels, they are numerically small. The statistically and economically significant difference between the share of movers and stayers is found for the Siberian and Volga federal districts. 15.9 percent of the movers relative to 10.1 percent of the stayers reside in the Siberian federal district which amounts to a 5.84 percentage point difference. 16.1 percent of the movers relative to 22.7 percent of the stayers reside in the Volga federal district which results in a 6.55 percentage point difference. No statistically and economically significant differences between the shares of movers and stayers is found for four other federal districts (Central, Southern, Far Eastern and Ural).

In 2013, the Russian Federation consisted of 83 regions. 30 regions out of 83 are present in my data. The shares of movers and stayers residing in 30 regions are roughly balanced. Although there are no regions that are strongly preferred or disliked by movers, in some regions there are statistically and economically significant differences between the shares of movers and stayers. For example, 4.9 percent of the movers and 2.9 percent of the stayers reside in Smolenskaya oblast, while 1.7 percent of the movers and 4.6 percent of the stayers live in Lipetskaya oblast. These two regions belong to the Central federal district. Two regions in the Siberian federal district are more often preferred by movers. 6.2 percent of the movers and 2.6 percent of the stayers reside in Tomskaya oblast, and 6.7 percent of the movers and 4.4 percent of the stayers live in Krasnoyarsky krai. Orienburgskaya oblast, which belongs to the Volga federal district, is preferred less by movers, 1.4 percent of the movers relative to 4.3 of the stayers reside in this region. Few other regions have statistically significant differences between the shares of movers and stayers. The differences between those regions are economically small, though.

In subsection 6.3, I analyze if my main estimation results are robust to the omission of federal districts and regions where the difference in shares between movers and stayers is economically and statistically significant. I re-estimate the main regression model 1 and the main regression model 1 fully interacted with a female dummy omitting such federal districts and regions. I find that the OLS and IV estimation results are robust to omitting these federal districts and regions (Appendix Table 12).

Then, I check if movers as compared to stayers do more often reside in some particular type of settlement. Appendix Table 10 contains descriptive statistics for movers and stayers as well as differences and standard errors of sample means. The four last rows in Appendix Table 10 show the shares of movers and stayers by four types of settlement. Movers relative to stayers do more often reside in regional centers and less often in towns. 56 percent of the movers live in regional centers, while only 49 percent of the stayers live in regional centers. While only 22 percent of the movers live in towns, 28 percent of the stayers live in towns. Both differences are statistically significant. I also find that a slightly smaller share of movers relative to stayers live in urban-type settlements and rural settlements, 7 percent relative to 6 percent and 15 percent relative to 17 percent. The latter difference is statistically significant.

Further, I analyze if movers and stayers differ in terms of observable characteristics and labor market outcomes (Appendix Table 10).[15] Movers do more often have a higher education obtained at the university - 68 vs. 59 percent. Further, movers have a longer labor market experience relative to stayers - 6.27 vs. 4.88 years. The potential explanation is that movers are observed for a longer period of time. Descriptive statistics for the variable Year of observation and Year of graduation indicate this. On average, movers graduate slightly earlier than stayers, 2006.2 vs. 2006.54. Movers are also more often observed in the more recent years: the mean year of observation for movers is 2012.67, while the mean year of observation for stayers is 2011.40. The mean differences between year of graduation and year of observation are statistically significant.

Note that there is no statistically significant difference in the labor market conditions upon graduation. Movers, however, currently reside in the regions with a slightly lower unemployment rate - 5.58 vs. 5.85 percent. Although the difference between the current unemployment rates is statistically significant, it is numerically small.

When it comes to outcome variables, movers relative to stayers are, on average, more often employed - 94 percent of the movers relative to 90 percent of the stayers have a job. Movers relative to stayers do also slightly more often work part-time - 16 percent vs. 14 percent - and more hours per week, 43.51 vs. 42.71 hours per week. Movers relative to stayers also have slightly higher log hourly wages - 4.55 vs. 4.36. The differences in outcome variables are statistically significant, although they do not concern substantial numerical differences in the labor market outcomes between movers and stayers.

[15] RLMS-HSE only contains very limited information about grades at high school or parents' characteristic. contains descriptive statistics, differences in means and standard errors.

In subsection 6.3, I compare OLS and IV estimation results of the main regression model 1 and the main regression model 1 fully interacted with a female dummy among movers, stayers and the pooled sample of movers and stayers. The outcome variable is the log hourly wage. I find similar results across all three samples (Appendix Table 11).

To conclude this, differences between the shares of movers and stayers residing in different regions as well as differences in the current unemployment rate suggest that there is indeed some between regional migration. A bulk share of movers, however, seems to relocate within regions from rural settlements and towns to regional centers. No difference in the unemployment rate upon graduation, a greater share of movers residing in regional centers and better labor market outcomes among movers indicate this. In general, regional centers have stronger labor markets which might explain the greater probability of being employed and the higher log hourly wage among movers.[16]

Note that I use *regional* unemployment rate as the measure of the economic conditions upon graduation. Since *within* regional migration seems to prevail over *between* regional migration, the OLS estimation among movers, stayers and the pooled sample of movers and stayers leads to similar results and the estimation results are robust to omitting the federal districts and regions with economically and statistically significant differences between the shares of movers and stayers, I conclude that the estimation results for the sample of stayers should be valid for the whole sample of graduates.

Descriptive statistics

The aim of this paper is to study how entering the labor market under economically unfavorable circumstances impacts the career development of college graduates in Russia over time. To start with, I present some simple descriptive evidence for the effect of graduating in a bad economy on the log hourly wage. I assign the unemployment rates in each region and year of graduation into one of three unemployment levels: low, when the unemployment rate was below 7 percent, middle, when the unemployment rate was between 7 and 10 percent, and high, when the unemployment rate was above 10 percent. Then, I plot the development of the log hourly wage

[16] Andrienko & Guriev (2003) show that the migration *between* Russian regions is low and that the liquidity constraints constitute the main obstacle to the reallocation. Migration within region, for instance, from towns to regional centers, is presumably more frequent and affordable for a larger share of the population.

by the level of regional unemployment upon graduation and the number of potential years of experience. The panel a of Figure 1 presents a plot of the log hourly wage for men, while the panel b of Figure 1 presents the same plot for women.

The plots on Figure 1 present clear evidence that the economic conditions under which college graduates enter the labor market play an important role in the development of the log hourly wage over time. Individuals graduating under different economic circumstances start at different wage levels and those who start under adverse economic conditions seem to never catch up with those who start under more favorable economic conditions. This pattern is clearly seen for both men and women. The difference in the levels of the log hourly wage is the most pronounced between those who start at low and high levels of unemployment.[17] However, these plots are naive in the sense that they do not take into account the myriad of other factors that might affect hourly wages. The analysis in a later part of the paper presents estimates for the causal effect of graduating in a bad economy on the labor market outcomes of highly educated men and women.

Table 2 contains descriptive statistics for the sample. 59 percent of the sample consist of women. The possible explanation for this is that fewer men than women receive a higher education in Russia. The mean number of potential experience years for men is 5.01 which is 0.27 years higher than that for women. The mean number of potential experience years for women is 4.74. The mean age of graduation from university for men is 22.69 and 22.76 for women. The mean age of graduation from technical school for men and women is 19.89 and 19.87, respectively. 57 percent of the men and 60 percent of the women have a university education.

The mean unemployment rate upon graduation is 7.03 percent for men and 7.06 percent for women. The mean unemployment rate at the hypothetical age of graduation is 7.16 percent for men and 7.15 percent for women. The mean unemployment rate in the current region of residence is 5.80 for men and 5.90 for women.

Regarding other characteristics of the sample, 89 percent of the men and 91 percent of the women are employed, of whom 8 percent of the men and 19 percent of the women are employed part time. Women work fewer hours in an average week. The mean number of weekly hours worked for men is 44.91, the mean number of weekly hours worked for women is 41.18. The log hourly wage for men and women is 4.50 and 4.26, respectively.

[17]These plots do also clearly demonstrate the gender gap in the log hourly wage.

The majority of men and women live in the regional centers, 49 percent, followed by towns, 28 percent. Only 6 and 17 percent reside in urban-type or rural settlements, respectively.

5 Model and Identification Strategy

The main equation of interest is as follows:

$$Y_{irt} = \beta_0 + \beta_1 U_{rs} + \beta_2 U_{rs} \times PE_{ist} + \beta_3 U_{rs} \times PE_{ist}^2 + \beta_4 PE_{ist} + \beta_5 PE_{ist}^2 + \theta Year_s + \nu District_{dt} + \alpha U_{rt} + \delta Year_t + \gamma X_i + \epsilon_{irt}, \quad (1)$$

where Y_{irt} is one of the outcome variables for an individual i, residing in region r and observed in year t. U_{rs} is a regional unemployment rate upon graduation, i.e. the unemployment rate in the region of graduation r and the year of graduation s. PE_{st} is the number of potential years of experience, i.e. the number of years elapsed by year t after graduation in year s. $U_{rs} * PE_{ist}$ is an interaction term between the unemployment rate upon graduation and the number of potential years of experience elapsed since the graduation. PE_{st}^2 is a square of potential years of experience, and $U_{rs} \times PE_{ist}^2$ is its interaction term between the unemployment rate at graduation and the experience years squared.

The timing and region of graduation might be correlated with the entry wage and further wage growth. To control for the timing of the career start, I include year of graduation fixed effects, $Year_s$. Since all individuals in the sample start and spend their labor market careers in the same region, it is enough to control for the current region of residence. Due to the small sample size of RLMS-HSE and the large number of regions, the number of students graduating each year and from each region is low. Therefore, to control for the place of graduation and residence, I include fixed effects of the next largest geographical unity federal districts, $District_{dt}$.

Further, I include the current unemployment rate, i.e. the unemployment rate at the region of residence r in year t, U_{rt}, to guarantee that my estimates do not capture the current situation on the labor market. Time fixed effects, $Year_t$, are included to account for the factors affecting all regions unanimously such as changes in laws and regulations. I also include the month of the interview fixed effects.

Finally, X_i is a set of control variables. It includes a female dummy, a university dummy set to 1 if an individual i studied at the university, and 0 if an individual studied at technical school and dummies for nine majors. It also includes three types of settlement dummies: regional center, town and urban-type settlement. The dummy for rural type of settlement is omitted and serves as a baseline. The error term, ϵ_{irt}, is clustered at the region-year of graduation.

Two main coefficients of interest are β_1 and β_2. Given that all conventional assumptions of the regression model are satisfied, β_1 will represent an immediate or an initial effect of graduating into an adverse economy, while β_2 will capture the "over-time effect", i.e. how the initial effect evolves over time as individuals proceed with their careers. If the estimate for β_2 is positive, it means that, on average, the labor market outcomes show some recovery as individuals gain more years of experience.

Identification strategy

The estimation of the equation (1) with simple OLS might produce biased estimates as the timing of entering the labor market might be correlated with the conditions on the labor market, and, therefore, the variables, U_{rs} and PE_{ist} are endogenous, $E[\epsilon_{irt}|U_{rs}, PE_{ist}] \neq 0$. There are several sources of correlation between the timing of entering the labor market and the conditions on the labor market. For example, a student observing a weak labor market right before her graduation might decide to take several more courses and, thus, stay at school until the situation on the labor market improves. Another practice that is common in many higher educational institutions in Russia allows students to directly affect the timing of graduation. Many universities initially enroll students in the 4-year Bakalavr programs; however, at the beginning of their fourth year, the student might decide if she continues to the Specialist program and, therefore, studies 1 or 2 more years or graduates with a Bakalavr Diploma which allows her to continue with the Magistr program (2 years) or finishes her studies and enters the labor market. The decision to continue with her education or graduate with a Bakalavr Diploma and start working might be impacted by the expected prospects on the labor market approximately 10 months later or any other unobserved factors.

A potential solution to the problem of the endogenous timing of graduation is to instrument an endogenous timing of graduation with an indicator of an exogenous timing of graduation (Kahn, 2010). The idea is to instrument the unemployment rate upon graduation with the unemployment rate at the hypothetical age of graduation in the region where an individual resided at the age of 14. I use the age at which individuals generally graduate from the institutes of higher education in Russia as the hypothetical age of graduation. The region of residence at the age of 14 is treated as exogenous in the sense that it could not be directly affected by an individual due to her young age.

Thus, the unemployment rate in the region and year of graduation, U_{rs}, is instrumented with the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14, i.e. the unemployment rate the individual would have faced if she had graduated at the hypothetical age of graduation and had entered the labor market in the region of residence at the age of 14. Since all individuals in the analysis sample lived at the age of 14 and entered the labor market in the same region, I effectively instrument the unemployment rate upon graduation with the unemployment rate which was in the region of residence in the year when the individual turned 20, if she has a degree from technical school and 22 if she has a degree from the university.

As the timing of graduation is endogenous, so is the number of potential years of experience, PE_{ist}. Therefore, I instrument the number of potential years of experience with the number of expected years of experience, i.e. the years of experience an individual would have had if she had graduated at the hypothetical age of graduation. The squared potential experience, PE_{ist}^2, is instrumented with the expected experience squared. The interaction term $U_{rs} * PE_{ist}$ is instrumented with the interaction of the instrument for the unemployment rate and the instrument for the number of years of experience. The interaction term $U_{rs} * PE_{ist}^2$ is instrumented with the interaction of the instrument for the unemployment rate and the instrument for the number of experience years squared.

The instruments should satisfy two assumptions. This instrument relevance assumption, saying that the instrument must have a clear effect on the endogenous variable, is satisfied by construction. Appendix Tables 14 and 15 show F-statistics from the first-stage regressions. The F-statistics are greater than conventionally accepted (Angrist & Pischke, 2008).

The exclusion restriction says that the instruments should have no effect on the outcome variable directly and only indirectly through the first stage (Angrist & Pischke, 2008). It means that conditional on all covariates, individual labor market outcomes at any point in time after graduation are not directly associated with the unemployment rate at the hypothetical age of graduation in the region where an individual resided at the age of 14 and only indirectly via the unemployment rate upon graduation.

The potential concern for the violation of the exclusion restriction is that historical unemployment rates might be correlated with today's situation on the labor market. To account for this, I include the regional unemployment rate at each year of observation to ensure that the estimates do not pick up the current situation on the labor market which might be correlated with historical unemployment rates.

Conditional on covariates (female dummy, major, type of higher education, current unemployment rate at the region of residence, dummies for year of graduation, federal district fixed effects, dummies for the type of settlement, time fixed effects, month of the interview fixed effects), the instruments are exogenous to the outcome variable, as they represent exogenous timing - determined by the way the education system is built - and the exogenous place of graduation - motivated by the place of residence at the age of 14. Therefore, the exclusion restriction is fulfilled.

If these two assumptions hold, the estimates of the population parameters β_1 and β_2 would together capture the casual effect of graduating in a bad economy. As OLS estimates cannot control for the endogeneity problem, I expect OLS estimates to be biased downwards in absolute terms relative to the IV estimates. The main coefficients of interest are identified by within federal districts across region-year of graduation variation.

6 Results

In this section, I first present the estimation results. Then, I analyze the potential mechanisms behind the identified effects. Finally, I present several robustness checks.

6.1 Estimation Results

I begin this subsection by presenting the immediate effects of graduating in a bad economy. First, I describe joint effects, then I show the gender difference effect. Then, I turn to the cumulative effect of graduating in a bad economy fitted for one, three, five and seven years after graduation. The cumulative effects are presented for the whole sample of graduates and separately by gender.

Immediate effects

Table 3 presents the estimation results of the effect of graduating in a bad economy on the labor market outcomes for the whole sample of high school graduates, i.e. the joint effect for men and women. For each outcome, I present the estimation results of model 1 estimated with OLS and IV.

Table 3 columns 1-2 present the estimation results of the effect of graduating in a bad economy on the first outcome on the extensive margin of labor supply. An OLS estimate on the U_{rs} term is negative and statistically significant at the 5 percent significance level. A one percentage point increase in the unemployment rate upon graduation translates into a 1.1 lower probability of having a job for highly educated men and women. A corresponding IV estimate is, however, small, positive and statistically not different from zero.

Further, I do not find any effect on the second outcome on the extensive margin of labor supply - the probability of being employed part-time (Table 3 columns 3-4). Nor is any statistically significant effect on the intensive margin of labor supply - average hours worked per week - identified (Table 3 columns 5-6).

Table 3 column 7-8 present the estimation results of the joint effect on the log hourly wage. I find a negative statistically significant effect on the log hourly wage for highly educated individuals. A one percentage point increase in the unemployment rate upon graduation results in a 4.0-5.5 percent lower hourly wage. The OLS and IV estimates are significant at the 1 and 5 percent significance levels, respectively. The estimates on the interaction terms between the unemployment rate and years of experience are positive but statistically not different from zero.

To investigate if there is any gender difference in the effect of graduating in a bad economy I estimate model 1 fully interacted with the female dummy which is set to unity for women, and zero otherwise. Then, the parameter estimate on the unemployment rate at graduation term, U_{rs}, will show the immediate effect of graduating in a bad economy for highly educated men, while the parameter estimate on the interaction term between the female dummy and the unemployment rate upon graduation, $female \times U_{rs}$, will show the gender difference in the immediate effect. The sum of the parameter estimates on the unemployment rate at graduation term, U_{rs}, and the interaction term between the female dummy and the unemployment rate upon graduation, $female \times U_{rs}$, will show the immediate effect of graduating in a bad economy for highly educated women. The effects are estimated relative to men graduating under more favorable conditions on the labor market.

The estimation results are presented in Table 4. When it comes to the effect of graduating in a bad economy for highly educated men, I do not identify any effect on the probability of being employed (Table 4 columns 1-2). When it comes to women, an OLS estimate on the interaction term $female \times U_{rs}$ is negative and statistically significant at the 10 percent significance level. A one percentage point increase in the unemployment rate upon graduation results in a 1.2 percent lower probability of being employed relative to highly educated men graduating in a bad economy. An OLS estimate on the interaction term with potential experience is positive, small and statistically significant at the 5 percent significance level, suggesting that as the economic conditions improve, the probability of having a job among women increases.

Regarding the estimations with IV, I do not find any immediate effect of graduating in a bad economy on the probability of being employed among men. An IV estimate on the U_{rs} term is positive and imprecisely estimated. An IV estimate on the interaction term between U_{rs} and years of experience is, however, negative, larger in magnitude than the corresponding OLS estimate and statistically significant at the 10 percent significance level. It suggests that as men proceed with their careers, the probability of having a job decreases slightly. An IV estimate on the interaction term $female \times U_{rs}$ is negative and larger in magnitude than the corresponding OLS estimate, although not precisely estimated. An IV estimate on the interaction term between $female \times U_{rs}$ and years of experience is positive and statistically significant at the 10 percent significance level. It suggests that as the economy improves, women relative to men have slightly better chances to be employed.

No effect is identified on the probability of being employed part time and the length of the working week either for men or for women (Table 4 columns 3-6).

Further, an OLS estimate suggests that men graduating in a bad economy do, on average, have a 6.2 percent lower hourly wage for each percentage point increase in the unemployment rate upon graduation relative to men graduating under more favorable economic conditions (Table 4 column 7). The OLS estimate is significant at the 1 percent significance level. An OLS estimate on the interaction terms between unemployment rate and years of experience is positive and statistically highly significant, suggesting that the initial negative effect of graduating in a bad economy fades away as men proceed with their careers. The OLS estimate on the interaction term $female \times U_{rs}$ is positive and statistically significant at the 5 percent significance level, indicating that the initial effect of graduating in a bad economy is 3.2 percent smaller for highly educated women relative to highly educated men. A one percentage point increase in the unemployment rate upon graduation results in a 2.9 percent lower hourly wage for highly educated women relative to men graduating under more favorable economic conditions. An OLS estimate on the interaction term with potential experience is negative, highly significant and larger in magnitude than the corresponding effect for men. It suggests that as the economy picks up, women experience a further wage deterioration relative to their male counterparts.

An IV estimate of the immediate effect of graduating in a bad economy for men is almost twice as large as the corresponding OLS estimate suggesting that the OLS estimates are indeed downward biased relative to the IV estimates (Table 4 column 8). The IV estimate is statistically significant at the 5 percent significance level. Men graduating in a bad economy do, on average, have an 11.2 percent lower hourly wage for each percentage point increase in the unemployment rate upon graduation relative to men who graduated under more favorable economic conditions. An IV estimate on the interaction term with years of experience is positive, greater in magnitude than the corresponding OLS estimate and significant at the 10 percent significance level.

The IV estimate on the interaction term $female \times U_{rs}$ is positive, more than twice as large as the corresponding OLS estimate, but it is imprecisely estimated. An IV estimate on the interaction term with experience years is negative, greater in magnitude than the corresponding OLS estimate and statistically significant at the 10 percent level. Fitted effects of graduating in a recession for women estimated with OLS and IV (the parameter estimate on U_{rs} plus the parameter estimate on the interaction term $female \times U_{rs}$) are presented in Table 6 panel A columns 5 and 6. The fitted effect estimated with IV is slightly lower in magnitude than the corresponding fitted effect estimated with OLS, but it is not statistically significant. Hence, I do not find any strong evidence for the immediate effect of graduating in a bad economy among highly educated women.

Cumulative effects

Above I presented the immediate effects of graduating in a bad economy. Further, I investigate the cumulative effects of graduating in a bad economy. I focus on two labor market outcomes: the probability of being employed and the log hourly wage.

Table 5 Panel B addresses cumulative effects on probability of being employed fitted for one, three, five and seven years after graduation. For convenience, Table 5 Panel A also repeats the immediate effect of graduating in a bad economy. Columns 1-2 contain cumulative joint effects. The cumulative effects estimated with OLS are small, negative and decline slightly in magnitude as individuals proceed with their careers. The effects are statistically significant for one, three and five years after graduation. The cumulative joint effects estimated with IV are small, negative and in contrast to the cumulative joint effects estimated with OLS they increase slightly over time. Only the cumulative effect for five years after graduation is significant at the 10 percent significance level.

When it comes to highly educated men, the cumulative effects on the probability of being employed estimated with OLS and IV are negative and increasing as individuals proceed with their careers. The effects estimated with IV are larger in magnitude than the corresponding effects estimated with OLS. The cumulative effects estimated with OLS are significant for three, five and seven years after graduation, while the cumulative effects estimated with IV are significant for five and seven years after graduation. College men who graduated in a bad economy run a 1.1-2.2 and 1.3-3.8 percent, respectively, lower probability of being employed five to seven years after graduation for every percentage point increase in the unemployment rate upon graduation. This is a statistically and economically significant effect. The negative effect on the probability of having a job among college men might be explained by a job mismatch and the accumulation of the wrong type of human capital.

When it comes to highly educated women, the cumulative effects on the probability of being employed estimated with OLS and IV are negative and decreasing as individuals proceed with their careers. Only the cumulative effects estimated with OLS for one and three years after graduation are statistically different from zero.

Table 6 Panel B further addresses the cumulative effect on the hourly wage for the whole sample of graduates and separate effects for men and women. Table 6 Panel A also repeats the immediate effects of graduating in a bad economy. Table 6 Panel B columns 1-2 contain joint effects. The cumulative effects estimated with both OLS and IV suggest that the immediate negative effect of graduating in a recession gradually fades away as individuals proceed with their careers. The cumulative effects estimated with OLS are statistically significant for one, three, five and seven years after graduation. The cumulative effects estimated with IV are statistically significant only for one and three years after graduation. The cumulative effect three years after graduation is equal to two thirds of the initial effect. Five and seven years of graduation, the cumulative effects are equal to less than a half and one fifth of the initial effect, respectively.

Table 6 Panel B columns 3-4 present the cumulative effects on the hourly wage among highly educated men. The initial wage loss for men dissipates over time. The cumulative effects estimated with OLS are negative and statistically significant for 1, 3 and 5 years after graduation. The cumulative effects estimated with IV are statistically significant for 1 and 3 years after graduation. The cumulative effects estimated with IV suggest that the wage loss one and three years after graduating, respectively, is equal to two thirds and a quarter of the size of the initial wage loss. Highly educated men have a 5.3-8.6 and a 3.7-3.6 percent lower hourly wage one and three years after graduation, respectively, for each percentage point increase in the unemployment rate upon graduation. Five and seven years after graduation, the cumulative effects estimated with IV turn positive, although statistically imprecise.

Table 6 Panel B columns 5-6 present the cumulative effects on the hourly wage among highly educated women. In contrast to the cumulative effect among men, the effect on women increases slightly over time. The cumulative effects estimated with OLS are statistically significant for 1 and 3 years after graduation. The cumulative effect estimated with IV one year after graduation is negative but imprecisely estimated. The cumulative effects estimated with IV 3 and 5 years after graduation are negative and statistically significant at the 1 and 5 percent significance level, respectively. The cumulative effect estimated with IV 7 years after graduation is negative but imprecise. Highly educated women graduating in a recession have a 3.5-3.4 and a 3.8-4.0 percent lower hourly wage three and five years after graduation, respectively, for each percentage point increase in the unemployment rate upon graduation.

To sum up, out of all labor market outcomes analyzed, I found the effect of graduating in a bad economy only on the probability of being employed and the log hourly wage. Highly educated individuals graduating in a recession have an initial substantial wage loss. The negative effect gradually dissipates as the economy improves. It persists years after graduation, however.

Further, graduating in a bad economy leads to an initial large wage loss for highly educated men. The initial wage loss gradually fades away as men proceed with their careers. However, the negative effect remains years after graduation. Although no immediate effect of graduating in a bad economy on the probability of being employed among college men is identified, the negative effect does appear several years after graduation. Highly educated men graduating in a recession face lower chances of being employed 5 to 7 years after graduation.

Finally, I do not find any strong evidence suggesting that women graduating in a bad economy also face an initial wage loss. However, I do find the negative effect of graduating in a bad economy for women three to five years after graduation. In contrast to men, the negative effect on the wage among women tends to increase over time. Moreover, the effect of graduating in a bad economy on the hourly wage is of the same magnitude among women as among men three years after graduation.

6.2 Mechanisms

Having shown that starting a career in a bad economy has a negative impact on the labor market prospects of new graduates, I next study the potential mechanisms behind this.

Quality of the job

The quality of the first job might have a non-negligible impact on the individual's wage and income later in life. When graduating in a thin labor market, individuals might suffer from a lower entry wage and a greater job mismatch. Oreopoulos et al. (2012) show that the lower quality of the first job combined with search frictions that become larger with age is an important factor explaining the long-term career losses. Liu et al. (2015) show that the mismatch between a worker and an industry is another mechanism behind career losses. In particular, Liu et al. (2015) define the mismatch between a worker and an industry if a worker is matched to the industry which does not value her skills. Liu et al. (2015) show that the labor market conditions at the time of graduation have a persistent effect on match quality and skill mismatch in Norway.

In this subsection, I analyze how graduating in a bad economy affects the quality of the occupation. As a measure of occupation quality, I construct an occupational rank. To construct the occupational rank I first calculate the occupation mean hourly wage.[18] Then, I rank occupations according to their mean hourly wage from 1 to 39, where 1 is the lowest rank and 39 is the highest rank and merge occupational rank to the graduates sample. The mean occupational rank is 23.87 (the standard error is 9.28).

Then, I estimate model 1 where I use the constructed occupational rank as an outcome variable. Table 8 presents estimates for the association between graduating in a bad economy and occupational rank. Table 8 columns 1 and 2 present the estimation results of joint effects. Whereas an OLS estimate is small and statistically not different from zero, an IV estimate of the joint effect is statistically significant at the 1 percent significance level. The IV estimate suggests that highly educated individuals graduating in a bad economy are, on average, engaged in lower ranked occupations. A one percentage point increase in the unemployment rate upon graduation results in a 1.47 points lower ranked occupation. Considering the average sample rank of 23.87, this is an economically large effect. A positive and statistically significant IV estimate for the interaction term between the unemployment rate upon graduation and potential years of experience suggests that individuals tend to move to higher ranked occupations as their careers proceed.

Table 8 columns 3 and 4 present estimation results for model 1 fully interacted with the female dummy. An IV estimate on the effect of graduating in a bad economy is larger in magnitude than the corresponding OLS estimate and significant at the 10 percent significance level. An IV estimate on the interaction term between the female dummy and the unemployment rate at the time of graduation, $female \times U_{rs}$, is small and positive but imprecisely estimated. The IV estimates of the term U_{rs} and the interaction term $female \times U_{rs}$ are jointly significant at the 5 percent significance level. I compute the effect of graduating in a bad economy estimated with IV for women (sum of the parameter estimates on the term U_{rs} and the interaction term $female \times U_{rs}$). The computed effect is equal to -1.47 (standard error .68) and significant at the 5 percent significance level. The results suggest that men and women who graduated in a bad economy have occupations with a lower ranking. A one percentage point higher unemployment

[18] The mean occupation hourly wage is calculated for all workers in the economy aged 16-64 with a valid wage and hours worked 2000-2016. Hourly wages are expressed in 2016 regional prices. The mean hourly wage is calculated for 39 occupations which correspond to the first two digits in the ISCO-08 classification.

rate upon graduation results in an, on average, 1.52 and 1.47 points lower ranked occupation among men and women, respectively. Given the average occupational rank of 23.87, this is an economically important effect.

The results suggest that there is no gender difference in the effect of graduating in a bad economy on the quality of the job.

Transition to parenthood

Several studies investigate the association between graduating in a bad economy and the transition to parenthood. Hofmann & Hohmeyer (2015) use German data with a 30 year observation period. The authors employ a duration analysis to uncover the causal effect on fertility of graduation from college in a bad economy. They show that negative labor market prospects affect female but not male fertility. In particular, women do, on average, transit to the first pregnancy faster when they graduate in a bad economy and the effect is stronger among older women relative to younger ones. Moreover, the effect is largest between the second and fourth year after graduation and it fades afterwards. Additionally, women graduating in a bad economy do, on average, have more children. Hashimoto & Kondo (2012) show that Japanese high-school educated women graduating in a recession have a lower probability of having children, while highly educated women have a higher probability of having children. Maclean et al. (2015) use American data. The authors estimate the linear probably model to analyze the impact of the economic conditions at the time of entering the labor market on the probability of having children and being married at the age of 45. Maclean et al. (2015) find that men who left school when the state unemployment rate was high are less likely to be married and have children at the age of 45, but are more likely to be divorced. Women are more likely to have children, however.

In this subsection, I analyze if individuals who graduated under unfavorable economic conditions transited to parenthood shortly after graduation. More precisely, I analyze if the probability of having a child within two years after graduation is associated with graduating in a recession. I construct a dummy variable that takes the value of one if an individual becomes a parent within two years after graduation, and zero otherwise. Then, I regress the constructed dummy variable against the unemployment rate upon graduation, the type of higher education, major, female dummy, dummies for year of graduation, federal district fixed effects and type of settlement dummies. Each individual has only one observation. Appendix Table 7 presents estimation results of the effect of graduating in a bad economy on the probability of having a child within two years after graduation. Columns 1 and 2 present estimates of the joint effect. An OLS estimate of the effect is positive, small and statistically significant at the 5 percent significance level. An IV estimate is positive, highly statistically significant and greater in magnitude that the corresponding OLS estimate. The probability of having a child within two years after graduation for the whole sample of high school graduates increases by 0.5-0.7 percentage points with each percentage point increase in the unemployment rate upon graduation. Given the sample mean of 5.9 percent, the estimated effect is economically important.

Table 7 Columns 3 and 4 present the estimation results from a regression model described above fully interacted with the female dummy. An OLS estimates on U_{rs} is small, positive and statistically significant at the 10 percent significance level. An OLS estimate on the interaction between U_{rs} and the female dummy is positive, small and statistically not different from zero. These two parameter estimates are jointly significant at the 5 percent significance level. The fitted effect for women calculated as the parameter estimate on the term U_{rs} plus the parameter estimate on the interaction term $female_i \times U_{rs}$ is equal to .006 and significant at the 5 percent significance level.

An IV estimate of the effect of graduating in a bad economy for men is positive, large and significant at the 5 percent significance level. An IV estimate on the interaction term with the female dummy is positive but imprecisely estimated. The fitted effect for women calculated as a parameter estimate on U_{rs} plus the parameter estimate on the interaction term $female_i \times U_{rs}$ is equal to .008 and statistically significant at the 5 percent significance level.

The estimation results suggest that a one percentage point increase in the unemployment rate upon graduation translates into a 0.3-0.5 percentage point greater probability of having a child within two years after graduation among highly educated men. Further, highly educated women graduating in a recession experience a 0.6-0.8 percentage point higher probability of having a child within two years after graduating relative to men graduating under more favorable conditions. 4.12 percent of the men and 7.35 percent of the women in the sample had a child within two years after graduation. Considering these sample means, the estimated effects are economically large. The large economically significant effect on men can potentially be explained by family formation patterns and a small difference in age between family partners.

6.3 Robustness Check

Internal validity

As discussed in section 4, one of the main data problems is that individuals who changed their region of residence after the age of 14 cannot be included in the analysis sample. If movers' place of residence, observed characteristics and outcome variables differ systematically from those of stayers, then the estimation results are not internally valid. I test the internal validity of my results in two ways.

First, I check if the main regression results are sensitive to the exclusion of the federal districts and regions that differ in the shares of residing movers and stayers. The outcome variable is the log hourly wage. The shares of movers and stayers are economically and statistically significantly different in two federal districts: Siberia and Volga (Appendix Table 9). Thus, I re-estimate model 1 and model 1 fully interacted with the female dummy omitting the Siberian and Volga districts. The estimation results are presented in Appendix Table 12 Panel A. The estimates are in line with the main estimates presented in Tables 3 and 4. The OLS and IV estimates of joint effects are of the same magnitude as the main estimates and statistically significant at the 5 percent significance level (columns 1-2). When it comes to the estimates of the separate gender effects, the OLS and IV estimates on the U_{rs} term are slightly smaller than the corresponding main estimates and statistically significant. Estimates on the other terms have the same signs and similar magnitudes as the corresponding main estimates, but they are imprecise.

Further, I re-estimate model 1 and model 1 fully interacted with the female dummy omitting regions where the difference between shares of movers and stayers is greater than one percentage point and statistically significant. The omitted regions are the following: Smolenskaya blast, Lipetskaya oblast, Komi Republic, Tomskaya oblast, Krasnoyarsky krai, Khanty-Mansi Autonomous Okru, Orienburgskaya oblast, Permskaya oblast and Kabardino-Balkar Republic. Appendix Table 12 Panel B contains the estimation results. The OLS and IV estimates of the joint effects are slightly larger in magnitude than the main estimates and statistically significant at the 5 percent significance level (columns 5-6). Regarding the estimates of separate gender effects, the IV estimate on the U_{rs} term is slightly smaller in magnitude than the corresponding main estimate and statistically significant at the 10 percent significance level. Other estimates have the same signs and a similar magnitude as the corresponding main estimates, but are imprecisely estimated. I conclude that the estimation results are robust to the exclusion of the federal districts and regions that differ in terms of the shares of movers and stayers.

Second, I study the regression estimates of the effect of graduating in a bad economy among movers, stayers and both. I estimate the main regression model 1 with the OLS for samples of movers, stayers and the pooled sample of movers and stayers. The outcome variable is the log hourly wage. Appendix Table 11 presents the estimation results. Table 11 columns 1-3 contain the estimation results for joint effects. The estimates of the immediate effect of graduating in a bad economy on the log hourly wage are highly significant across all three samples. The estimates for separate samples of movers and stayers are equal to -6.3 and -3.8, respectively. The estimate for the pooled sample of movers and stayers is equal to -4.0.

Next, I estimate the main regression model 1 fully interacted with the female dummy with an OLS for the samples of movers, stayers and the pooled sample of movers and stayers. Table 11 columns 4-6 display the estimation results. The estimates of the immediate effect of graduating in a bad economy on the log hourly wage are negative and highly significant for the sample of stayers and the pooled sample. The estimated effects are also of a similar magnitude, -6.1 vs. -5.9. The estimate of the effect for the sample of movers is negative and equal to -3.5. However, it is statistically not different from zero.

When it comes to the interaction term $female_i \times U_{rs}$, the estimate for the sample of movers is negative although imprecisely estimated. The estimate on the interaction term for the pooled sample is positive and imprecise. Only the estimate for the sample of stayers is positive and statistically significant at the 10 percent significance level.

Since the estimation results are robust to the omission of the geographic unities which differ in terms of the shares of movers and stayers, and since the estimation results are similar among movers, stayers and both, I conclude that the estimation results are internally valid.

Selection into higher education

The selection into higher education is a matter of concern when studying university graduates (Kahn, 2010). The economic conditions at the time of finishing the general education as well as the expectations about future economic conditions at the time of finishing higher education might affect the choice of major and even the decision to apply for higher education. This will affect the pool of potential graduates and the type of competence they would have when exiting the university. In other words, if the current situation or expectations about the future situation on the labor market can motivate some individuals to apply for higher education, different cohorts of graduates will not be identical. Additionally, because of the cyclical nature of the economy, the economic conditions at the time of finishing the general education and 3-5 years later will be correlated (Kahn, 2010). I analyze this potential confounding factor in the following way. I analyze an association between the probability of finishing higher education and economic conditions at the time of obtaining the general education (Kahn, 2010).

To the main analysis sample of college graduates I add individuals who did not reallocate after the age of 14, studied at universities or technical colleges and who would have graduated between 2000 and 2016, had they competed higher education. As an outcome variable, I construct a dummy variable set to unity if an individual completed higher education between 2000 and 2016 and zero otherwise. 87 percent of the men and 93 percent of the women completed higher education between 2000 and 2016. Further, I regress the outcome variable against the unemployment rate in the year when individuals finished general school,[19] dummies for year of graduation from the institute of higher education, federal district dummies and type of higher education dummy.

The estimation results for the joint effect are presented in Appendix Table 13 column 1, while the estimation results from a fully interacted model with the female dummy are presented in Appendix Table 13 column 2. The estimation results show that the probability of finishing higher education is not related to the economic conditions in the year of finishing the general education for the whole sample of graduates and separately for men and women.

7 Discussion and Conclusion

In this paper, I study what effect entering the labor market under adverse economic conditions had on the career development of highly educated indi-

[19]For individuals who studied at technical colleges, this is a year of completing compulsory general education, while for individuals who studied at universities, this is a year of completing upper secondary education. For those individuals who completed compulsory general education and upper secondary education before 2000, I use national unemployment rates since regional employments rates have only been available since 2000.

viduals in Russia 2000-2016. I also analyze if there is any gender difference in effect of graduating in a bad economy. The potential mechanisms behind the identified effects are further investigated. I use regional unemployment rates as a measure of the economic situation on the labor market upon graduation. The instrumental variable technique is used to isolate the causal effect of interest.

In line with the previous literature, I find a large negative effect on the hourly wage for highly educated men. While the OLS estimates are of the same magnitude, the IV estimates are of a greater magnitude in this paper relative to those in Kahn (2010). The estimates of the initial effect on the hourly wage range from -6.2 to -9.1 percent in Kahn (2010), while they range from -6.1 to -11.2 in this paper. As highly educated men proceed with their careers, the initial effect on wages dissipates faster in this paper relative to that in Kahn (2010).

In contrast to Kahn (2010), I do identify an economically and statistically significant effect on the probability of being employed for highly educated men. However, the negative effect does not pop up until five to seven years after graduation.[20].

In contrast to Päällysaho (2017) and Bostrom (2019b), I do not identify any immediate effect of graduating in a bad economy on the hourly wage among women. However, I do find a negative statistically and economically significant effect among highly educated women which appears three to five years after graduation. A one percentage point increase in the unemployment rate upon graduation results in a 3.5-3.4 and 3.8-4.2 percent lower wage three and five years after graduation, respectively.

A potential explanation for the immediate and lasting wage losses is that unlucky graduates have lower quality jobs. No gender difference in the quality of the job among graduates in a recession is identified.

Further, women graduating in a recession are more likely to have a child soon after graduation. As the opportunity cost of staying away from the labor market is lower during a recession, some women may choose to opt out from the labor force and stay home with a child.

The results in this paper improve our understanding of how the careers

[20]No effect on the probability of being employed among highly educated men is identified in Oreopoulos et al. (2012) or Fernández-Kranz & Rodríguez-Planas (2018). Päällysaho (2017) does find a negative effect on the probability of being employed among men. The effect is mainly driven by cohorts who graduated during the 1990s depression

of highly educated men and women are affected by a start under adverse economic conditions and the potential mechanisms behind this in countries with important differences in the quality of political and economic institutions, fundamental economic structures and the functioning of the labor markets.

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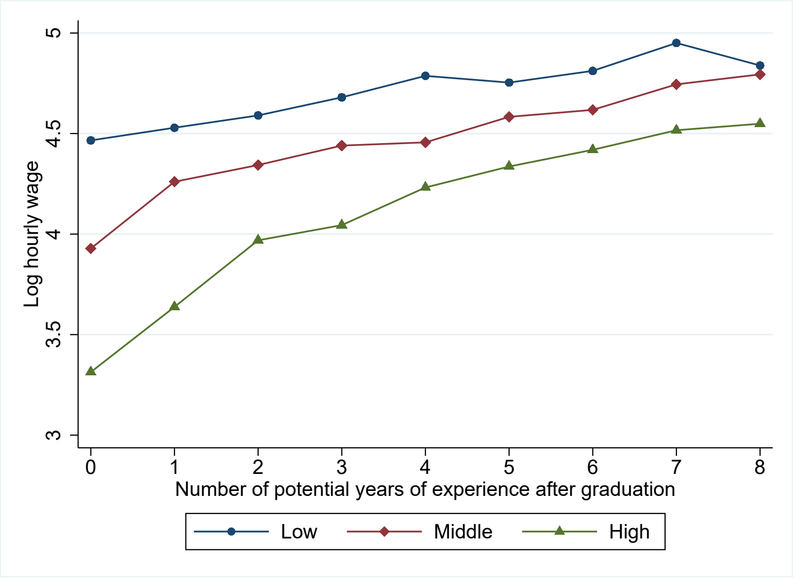
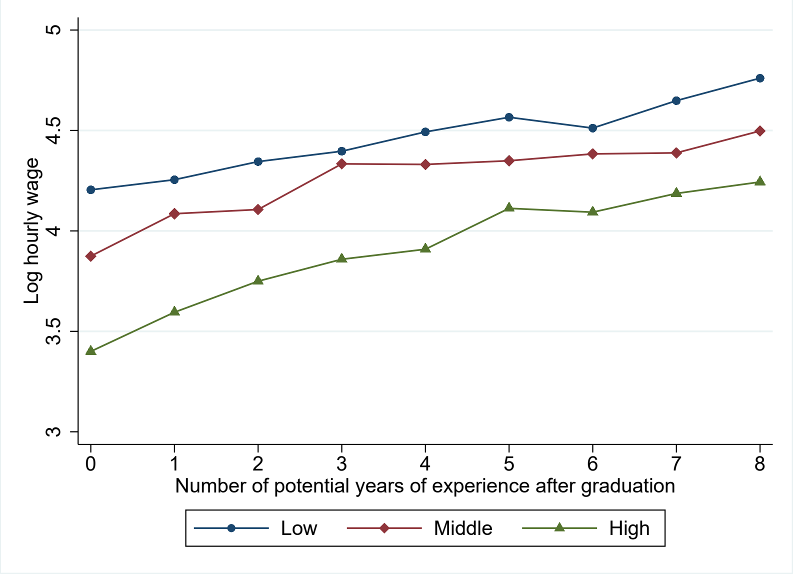
8 Figures



(a) Men



(b) Women

Figure 1: The log hourly wage by the level of regional unemployment upon graduation and the number of potential years of experience by gender

9 Tables

Table 1: The number of students graduating from institutes of higher education by gender and year of graduation

Year	Men:	Women:	Total:
2000	24	28	52
2001	32	44	76
2002	64	84	148
2003	78	87	165
2004	65	88	153
2005	82	124	206
2006	83	113	196
2007	71	126	197
2008	91	105	196
2009	69	102	171
2010	86	93	179
2011	56	84	140
2012	58	65	123
2013	32	35	67
2014	22	34	56
2015	20	39	59
2016	4	14	18
2000-2016	937	1 265	2 202

Notes: Tabulation for individuals who graduated from universities at the age between 21 and 26 and individuals who graduated from technical schools at the age between 18 and 22 by gender.

Table 2: Descriptive statistics

	(1)	(2)	(3)	(4)	(5)	(6)
	Men & Women:		*Men:*		*Women:*	
	mean	sd	mean	sd	mean	sd
Pr. employed	0.90	0.30	0.89	0.32	0.91	0.29
Pr. employed part-time	0.14	0.35	0.08	0.27	0.19	0.39
Hours in typical working week	42.71	10.24	44.91	11.10	41.18	9.29
Log hourly wage	4.36	0.67	4.50	0.63	4.26	0.68
Unempl. rate at grad.	7.05	3.35	7.03	3.36	7.06	3.35
Unempl. rate at hypoth. age of grad.	7.15	3.43	7.16	3.45	7.15	3.41
Unempl. rate, current	5.85	2.70	5.80	2.73	5.90	2.67
Female	0.59	0.49	0.00	0.00	1.00	0.00
University	0.59	0.49	0.57	0.50	0.60	0.49
Year of graduation	2 006.54	3.92	2 006.50	3.97	2 006.58	3.89
Major	2.35	1.08	2.49	1.32	2.26	0.86
Potential experience, years	4.88	3.70	5.01	3.82	4.74	3.76
Expected experience, years	5.25	3.83	5.38	3.86	5.17	3.81
Age of graduation, tech. college	19.88	1.06	19.89	1.05	19.87	1.06
Age of graduation, university	22.73	1.09	22.69	1.06	22.76	1.12
Federal district	4.18	2.61	4.20	2.65	4.17	2.58
Regional center	0.49	0.50	0.49	0.50	0.48	0.50
Town	0.28	0.45	0.28	0.45	0.29	0.45
Urban-type settlement	0.06	0.24	0.06	0.24	0.06	0.24
Rural settlement	0.17	0.37	0.17	0.37	0.16	0.37
Year of observation	2011.40	3.51	2011.51	3.48	2011.32	3.53

Notes: The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women who graduated from technical schools at the age between 18 and 22 between 2000 and 2016. University is set to unity if university education and 0 if technical school education. Expected experience, years is expected years of experience if graduating at the hypothetical age of graduation.

Table 3: Joint effect of graduating in a bad economy

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Pr. empl.		*Pr. empl. part-time*		*Hours/week*		*Log hourly wage*	
VARIABLES	OLS	IV	OLS	IV	OLS	IV	OLS	IV
U	-0.011**	0.002	0.006	0.015	0.224	0.829	-0.040***	-0.055**
	(0.005)	(0.011)	(0.006)	(0.017)	(0.171)	(0.506)	(0.011)	(0.027)
U × PE	0.001	-0.003	-0.001	-0.005	-0.007	-0.099	0.002	0.007
	(0.001)	(0.003)	(0.001)	(0.005)	(0.040)	(0.139)	(0.003)	(0.008)
U × PE^2	-0.000	0.000	0.000	0.000	0.001	0.006	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.009)	(0.000)	(0.001)
Observations	10,144	10,144	9,492	9,492	9,492	9,492	6,217	6,217
R-squared	0.091	0.088	0.073	0.068	0.060	0.057	0.515	0.511

Notes: The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women who graduated from technical schools at the age between 18 and 22 between 2000 and 2016. Other variables are the years of potential experience and the square of potential experience. The control variables include female dummy, dummies for educational majors, dummy for a type of higher education (unity for university, 0 for technical college), the current unemployment rate in the region of residence, dummies for the year of graduation, time fixed effects, the month of interview fixed effects, federal districts fixed effects, dummies for a type of settlement. IV specification instruments for the unemployment rate upon graduation (U), its interaction with potential experience and the potential experience squared with the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14, its interaction with expected experience and squared expected experience. Standard errors are clustered at the region-year of graduation level. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 4: Gender difference in the effect of graduating in a bad economy

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Pr. empl.		*Pr. empl. part-time*		*Hours/week*		*Log hourly wage*	
VARIABLES	OLS	IV	OLS	IV	OLS	IV	OLS	IV
U	-0.005	0.016	0.005	-0.013	0.287	0.651	-0.061***	-0.112**
	(0.006)	(0.017)	(0.008)	(0.020)	(0.284)	(0.897)	(0.014)	(0.050)
U × PE	-0.001	-0.008*	-0.002	0.003	0.020	-0.045	0.009***	0.027*
	(0.002)	(0.005)	(0.002)	(0.005)	(0.062)	(0.251)	(0.003)	(0.014)
U × PE^2	0.000	0.001*	0.000	-0.000	-0.001	0.001	-0.001***	-0.002*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.016)	(0.000)	(0.001)
female × U	-0.012*	-0.025	-0.001	0.036	-0.088	0.277	0.032*	0.086
	(0.007)	(0.020)	(0.011)	(0.031)	(0.348)	(1.063)	(0.019)	(0.062)
female × U × PE	0.004**	0.010*	0.002	-0.011	-0.049	-0.098	-0.011**	-0.030*
	(0.002)	(0.006)	(0.003)	(0.009)	(0.076)	(0.288)	(0.004)	(0.017)
female × U × PE^2	-0.000	-0.001*	-0.000	0.001	0.003	0.008	0.001***	0.002*
	(0.000)	(0.000)	(0.000)	(0.001)	(0.005)	(0.019)	(0.000)	(0.001)
Observations	10,144	10,144	9,492	9,492	9,492	9,492	6,217	6,217
R-squared	0.105	0.099	0.094	0.084	0.074	0.070	0.529	0.518

Notes: The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women who graduated from technical schools at the age between 18 and 22 between 2000 and 2016. Other variables are potential experience and square of potential experience. The control variables include dummies for educational majors, dummy for a type of higher education (unity for university, 0 for technical college), the current unemployment rate in the region of residence, dummies for the year of graduation, time fixed effects, month of interview fixed effects, federal districts fixed effects, dummies for a type of settlement, female dummy as well as interaction terms between female dummy and potential experience, potential experience squared and all control variables. The IV specification instruments for the unemployment rate upon graduation (U), its interaction with potential experience and the potential experience squared with the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14, its interaction with expected experience and squared expected experience. The IV specification also instruments for the interaction term between the female dummy and the unemployment rate at graduation (female × U), its interaction with potential experience and the potential experience squared with the interaction term between female dummy and the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14, its interaction with expected experience and squared expected experience. Standard errors are clustered at the region-year of graduation level. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 5: Immediate and cumulative effects of graduating in a bad economy on the probability of being employed

	(1)	(2)	(3)	(4)	(5)	(6)
	Joint effect		*Effect on men*		*Effect on women*	
	OLS	IV	OLS	IV	OLS	IV
A. Immediate effect						
	-0.011**	0.002	-0.005	0.016	-0.017***	-0.009
	0.005	0.011	0.006	0.017	0.006	0.014
B. Fitted effects for selected years of experience						
Years after graduation						
1	-0.010**	-0.001	-0.006	0.008	-0.015***	-0.008
	0.004	0.009	0.005	0.013	0.005	0.011
3	-0.008**	-0.006	-0.009*	-0.007	-0.009**	-0.005
	0.003	0.005	0.005	0.007	0.004	0.006
5	-0.006*	-0.011*	-0.011*	-0.022**	-0.004	-0.003
	0.003	0.006	0.006	0.010	0.004	0.007
7	-0.004	-0.016	-0.013*	-0.038**	0.001	-0.000
	0.004	0.012	0.008	0.018	0.006	0.013
Observations	10,144	10,144	10,144	10,144	10,144	10,144
R-squared	0.091	0.088	0.105	0.099	0.105	0.099

Notes: The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women who graduated from technical schools at the age between 18 and 22 between 2000 and 2016. Other variables are potential experience and the square of potential experience. Control variables include dummies for educational majors, dummy for a type of higher education (unity for university, 0 for technical college), the current unemployment rate in the region of residence, dummies for year of graduation, time fixed effects, month of interview fixed effects, federal districts fixed effects, dummies for a type of settlement, female dummy as well as interaction terms between female dummy and potential experience, potential experience squared and all control variables. The IV specification instruments for the unemployment rate upon graduation (U), its interaction with potential experience and the potential experience squared with the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14, its interaction with expected experience and squared expected experience. The IV specification also instruments for the interaction term between the female dummy and the unemployment rate upon graduation (female $\times$ U), its interaction with potential experience and the potential experience squared with the interaction term between the female dummy and the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14, its interaction with expected experience and squared expected experience. Standard errors are clustered at the region-year of graduation level. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 6: Immediate and cumulative effects of graduating in a bad economy on the log hourly wage

	(1)	(2)	(3)	(4)	(5)	(6)
	Joint effect		*Effect on men*		*Effect on women*	
	OLS	IV	OLS	IV	OLS	IV
A. Immediate effect						
	-0.040***	-0.055**	-0.061***	-0.112**	-0.029**	-0.026
	0.011	0.027	0.014	0.050	0.014	0.033
B. Fitted effects for selected years of experience						
Years after graduation						
1	-0.036***	-0.044**	-0.053***	-0.086***	-0.031**	-0.029
	0.009	0.021	0.012	0.038	0.011	0.025
3	-0.032***	-0.033***	-0.037***	-0.036**	-0.035***	-0.034***
	0.006	0.010	0.010	0.016	0.008	0.013
5	-0.028***	-0.021	-0.021*	0.014	-0.038***	-0.040**
	0.008	0.015	0.011	0.023	0.010	0.017
7	-0.025*	-0.010	-0.004	0.064	-0.042***	-0.046
	0.012	0.028	0.014	0.048	0.015	0.032
Observations	6,217	6,217	6,217	6,217	6,217	6,217
R-squared	0.515	0.511	0.529	0.518	0.529	0.518

Notes: The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women who graduated from technical schools at the age between 18 and 22 between 2000 and 2016. Other variables are potential experience and square of potential experience. The control variables include dummies for educational majors, dummy for a type of higher education (unity for university, 0 for technical college), the current unemployment rate in the region of residence, dummies for year of graduation, time fixed effects, month of interview fixed effects, federal districts fixed effects, dummies for a type of settlement, female dummy as well as interaction terms between female dummy and potential experience, potential experience squared and all control variables. The IV specification instruments for the unemployment rate upon graduation (U), its interaction with potential experience and the potential experience squared with the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14, its interaction with expected experience and squared expected experience. The IV specification also instruments for the interaction term between the female dummy and the unemployment rate upon graduation (female $\times$ U), its interaction with potential experience and the potential experience squared with the interaction term between the female dummy and the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14, its interaction with expected experience and squared expected experience. Standard errors are clustered at the region-year of graduation level. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 7: Effect of graduating in a bad economy on the probability of having a child within two years after graduation

VARIABLES	(1) OLS	(2) IV	(3) OLS	(4) IV
U	0.005**	0.007***	0.003*	0.005**
	(0.002)	(0.003)	(0.002)	(0.003)
female × U			0.003	0.003
			(0.004)	(0.004)
Observations	2,202	2,202	2,202	2,202
R-squared	0.033	0.033	0.046	0.046

Notes: The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women who graduated from technical schools at the age between 18 and 22 between 2000 and 2016. The controls in columns 1-2 include dummies for educational majors, the dummy for a type of higher education (unity for university, 0 for technical college), dummies for year of graduation, federal districts fixed effects and dummies for a type of settlement. Columns 3-4 add female dummy and interaction terms between the female dummy and all control variables. The IV specification in column 1 instruments for the unemployment rate at graduation (U) with the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14. The IV specification in column 4 additionally instruments for the interaction term between the female dummy and the unemployment rate at graduation (female $\times$ U) with an interaction term between the female dummy and the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14. Standard errors are clustered at the region-year of graduation level. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 8: The effect of graduating in a bad economy on occupational rank

VARIABLES	(1) OLS	(2) IV	(3) OLS	(4) IV
U	-0.060	-1.469***	-0.021	-1.522*
	(0.156)	(0.538)	(0.235)	(0.925)
U × PE	-0.016	0.423***	-0.038	0.334
	(0.036)	(0.162)	(0.057)	(0.274)
U × PE^2	0.002	-0.026**	0.004	-0.017
	(0.003)	(0.011)	(0.004)	(0.018)
female × U			-0.026	0.053
			(0.293)	(1.144)
female × U × PE			0.028	0.190
			(0.067)	(0.342)
female × U × PE^2			-0.003	-0.018
			(0.005)	(0.023)
Observations	6,197	6,197	6,197	6,197
R-squared	0.191	0.128	0.212	0.138

Notes: The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women who graduated from technical schools at the age between 18 and 22 between 2000 and 2016. Other variables are potential experience and the square of potential experience. The control variables include dummies for educational majors, dummy for a type of higher education (unity for university, 0 for technical college), the current unemployment rate in the region of residence, dummies for year of graduation, time fixed effects, month of interview fixed effects, federal districts fixed effects, dummies for a type of settlement, female dummy. Columns 3-4 also add interaction terms between the female dummy and potential experience, potential experience squared and all control variables. The IV specification instruments for the unemployment rate upon graduation (U), its interaction with potential experience and the potential experience squared with the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14, its interaction with expected experience and squared expected experience. The IV specification in column 4 also instruments for the interaction term between the female dummy and the unemployment rate at graduation (female × U), its interaction with the potential experience and the potential experience squared with the interaction term between female dummy and the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14, its interaction with expected experience and squared expected experience. Standard errors are clustered at the region-year of graduation level. * significant at 10%, ** significant at 5%, *** significant at 1%.

10 Appendix

Table 9: Share of movers and stayers by region of residence

	(1)	(2)	(3)	(4)
	Movers:	*Stayers:*		*Δ:*
	mean	mean	diff	se
Central:	0.280	0.294	-0.0142	0.0147
Moscovskaya oblast	0.168	0.154	0.0139	0.0119
Smolenskaya oblast	0.049	0.029	0.0198	0.0059***
Tverskaya oblast	0.006	0.011	-0.0057	0.0032
Tulskaya oblast	0.021	0.025	-0.0038	0.0050
Kaluzhskaya oblast	0.006	0.008	-0.0019	0.0029
Lipetskaya oblast	0.017	0.046	-0.0299	0.0063***
Tambovskaya oblast	0.013	0.023	-0.0097	0.0046*
Southern:	0.091	0.081	0.0099	0.0089
Volgogradskaya oblast	0.018	0.018	0.0001	0.0043
Krasnodarsky krai	0.073	0.061	0.0124	0.0080
North Western :	0.105	0.087	0.0185	0.0093**
Leningradskaya oblast	0.050	0.048	0.0022	0.0070
Komi Republic	0.055	0.041	0.0137	0.0068*
Far Eastern:	0.031	0.036	-0.0045	.0059
Primorsky krai	0.025	0.023	0.0021	0.0050
Amurskaya oblast	0.006	0.015	-0.0083	0.0036*
Siberian:	0.159	0.101	0.0584	.0103***
Tomskaya oblast	0.062	0.026	0.0357	0.0061***
Altaisky krai	0.030	0.030	0.0001	0.0056
Krasnoyarsky krai	0.067	0.044	0.0233	0.0071**
Ural:	0.097	0.084	0.0125	0.0091
Chelyabinskaya oblast	0.046	0.046	0.0001	0.0068
Kurganskaya oblast	0.025	0.022	0.0029	0.0049
Khanty-Mansi Autonomous Okrug	0.026	0.015	0.0111	0.0043*
Volga:	0.161	0.227	-0.0655	0.0131***
Nizjnij Novgorod oblast	0.024	0.029	-0.0057	0.0054
Chuvash Republic	0.009	0.018	-0.0086	0.0041*
Penzenskaya oblast	0.007	0.008	-0.0014	0.0029
Tatarstan	0.035	0.035	-0.0008	0.0060
Saratovskaya oblast	0.042	0.040	0.0020	0.0064
Udmurt Republic	0.017	0.026	-0.0091	0.0049
Orenburgskaya oblast	0.014	0.043	-0.0289	0.0060***
Permskaya oblast	0.014	0.027	-0.0128	0.0050**
North Caucasian:	0.075	0.090	-0.0150	0.0090*
Kabardino-Balkar Republic	0.006	0.021	-0.0150	0.0042***
Rostovskaya oblast	0.051	0.042	0.0092	0.0067
Stavropolsky krai	0.018	0.025	-0.0069	0.0049

Notes: The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women who graduated from technical schools at the age between 18 and 22 by gender between 2000 and 2016. Movers are those who changed their region of residence after the age of 14 and are excluded from the main analysis sample. Stayers represent the main analysis sample.

Table 10: Descriptive statistics for movers and stayers

	Movers:		*Stayers:*		Δ:	
	mean	sd	mean	sd	mean	sd
Pr. employed	0.94	0.23	0.90	0.30	0.043	0.006***
Pr. employed part-time	0.16	0.37	0.14	0.35	0.015	0.008*
Hours in typical working week	43.51	10.82	42.71	10.24	0.806	0.230***
Log hourly wage	4.55	0.53	4.36	0.67	0.192	0.018***
Unempl. rate at graduation	7.09	3.06	7.05	3.35	0.046	0.065
Unempl. rate, current	5.58	2.18	5.85	2.70	-0.281	0.051***
Female	0.61	0.49	0.59	0.49	0.025	0.009**
University	0.68	0.46	0.59	0.49	0.091	0.009***
Year of graduation	2 006.20	3.72	2 006.54	3.92	-0.348	0.077***
Major	2.34	0.93	2.35	1.08	-0.013	0.020
Potential experience, years	6.27	3.89	4.88	3.70	1.390	0.108***
Expected experience, years	6.98	3.88	5.25	3.83	-1.719	0.076***
Age of graduation, tech. college	19.94	1.02	19.88	1.06	0.062	0.036**
Age of graduation, university	22.75	1.13	22.73	1.09	0.024	0.027
Federal district	4.08	2.47	4.18	2.61	-0.102	0.051**
Regional center	0.56	0.50	0.49	0.50	0.075	0.009***
Town	0.22	0.41	0.28	0.45	-0.063	0.008***
Urban-type settlement	0.07	0.25	0.06	0.24	0.004	0.004
Rural settlement	0.15	0.36	0.17	0.37	-0.015	0.007**
Year	2012.67	2.27	2011.40	3.51	1.270	0.065***

Notes: The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women who graduated from technical schools at the age between 18 and 22 by gender between 2000 and 2016. University is set to unity if university education and 0 if technical school education. Movers are those who changed their region of residence after the age of 14 and they are excluded from the main analysis sample. Stayers represent the main analysis sample. University is set to unity if university education and 0 if technical school education. Expected experience, years is expected years of experience if graduating at the hypothetical age of graduation.

Table 11: The effect of graduating in a bad economy on the log hourly wage, internal validity test

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Movers	Stayers	All	Movers	Stayers	All
U	-0.063***	-0.038***	-0.040***	-0.035	-0.061***	-0.059***
	(0.021)	(0.011)	(0.010)	(0.034)	(0.014)	(0.014)
U × PE	0.011**	0.002	0.003	0.002	0.009***	0.007**
	(0.005)	(0.003)	(0.003)	(0.008)	(0.003)	(0.003)
U × PE^2	-0.001*	-0.000	-0.000	0.000	-0.001***	-0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
female × U				-0.024	0.032*	0.027
				(0.045)	(0.019)	(0.017)
female × U × PE				0.011	-0.011**	-0.007*
				(0.010)	(0.004)	(0.004)
female × U × PE^2				-0.001*	0.001***	0.001*
				(0.001)	(0.000)	(0.000)
Observations	1,486	6,217	7,703	1,486	6,217	7,703
R-squared	0.306	0.484	0.462	0.404	0.529	0.509

Notes: The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women who graduated from technical schools at the age between 18 and 22 between 2000 and 2016. The models are estimated with OLS for three samples: movers, stayers and all. Other variables are potential experience and the square of potential experience. The control variables include dummies for educational majors, dummy for a type of higher education (unity for university, 0 for technical college), the current unemployment rate in the region of residence, dummies for year of graduation, time fixed effects, month of interview fixed effects, federal districts fixed effects, dummies for a type of settlement, female dummy. Columns 4-6 also add the interaction terms between female dummy and potential experience, potential experience squared and all control variables. Standard errors are clustered at the region-year of graduation level. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 12: The effect of graduating in a bad economy on the log hourly wage, internal validity test

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	A. Two federal districts are omitted				*B. Nine regions are omitted*			
VARIABLES	OLS	IV	OLS	IV	OLS	IV	OLS	IV
U	-0.040***	-0.055**	-0.053***	-0.106*	-0.041***	-0.062**	-0.049***	-0.098*
	(0.013)	(0.025)	(0.017)	(0.054)	(0.011)	(0.028)	(0.016)	(0.059)
U × PE	0.001	0.005	0.006*	0.023	0.001	0.008	0.004	0.025
	(0.003)	(0.007)	(0.003)	(0.014)	(0.003)	(0.008)	(0.004)	(0.018)
U × PE^2	0.000	-0.000	-0.000**	-0.001	0.000	-0.000	-0.000	-0.001
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
female × U			0.020	0.072			0.015	0.056
			(0.023)	(0.068)			(0.021)	(0.071)
female × U × PE			-0.009*	-0.026			-0.004	-0.025
			(0.005)	(0.017)			(0.005)	(0.021)
female × U × PE^2			0.001**	0.002*			0.000	0.002
			(0.000)	(0.001)			(0.000)	(0.002)
Observations	3,807	3,807	3,807	3,807	4,393	4,393	4,393	4,393
R-squared	0.505	0.501	0.523	0.512	0.543	0.535	0.554	0.541

Notes: Panel A omits two federal districts where the difference between the shares of movers and stayers is statistically and economically significant. Panel B omits twelve regions where the difference between the shares of movers and stayers is greater than one percentage point and statistically significant. The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women who graduated from technical schools at the age between 18 and 22 between 2000 and 2016. Other variables are potential experience and the square of potential experience. The control variables include dummies for educational majors, dummy for a type of higher education (unity for university, 0 for technical college), the current unemployment rate in the region of residence, dummies for year of graduation, time fixed effects, month of interview fixed effects, federal districts fixed effects, dummies for a type of settlement, female dummy as well as interaction terms between female dummy and potential experience, potential experience squared and all control variables. The IV specification instruments for the unemployment rate upon graduation (U), its interaction with potential experience and the potential experience squared with the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14, its interaction with expected experience and squared expected experience. The IV specification also instruments for the interaction term between the female dummy and the unemployment rate upon graduation (female × U), its interaction with potential experience and the potential experience squared with the interaction term between the female dummy and the unemployment rate at the hypothetical age of graduation in the region of residence at the age of 14, its interaction with expected experience and squared expected experience. Standard errors are clustered at the region-year of graduation level. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 13: The probability of graduating from the institutes of higher education and the economic conditions when finishing general education, robustness check

VARIABLES	(1)	(2)
$U_{gen.educ}$	-0.002	-0.003
	(0.003)	(0.004)
University	-0.044***	-0.087***
	(0.015)	(0.018)
female× $U_{gen.educ}$		0.001
		(0.005)
female × University		0.076***
		(0.024)
Observations	2,435	2,435
R-squared	0.058	0.109

Notes: The sample is restricted to individuals who studied at universities or technical colleges and who graduated or who would have graduated between 2000 and 2016, had they completed higher education. The outcome variable is set to unity if graduating from a university or technical college, 0 otherwise. The controls in column 1 include a dummy for the type of higher education (unity for university, 0 for technical college), dummies for the year of completing general education, federal districts fixed effects and type of settlement dummies. Column 2 adds the female dummy and the interaction term between the female dummy and all controls. Standard errors are clustered at the region-year of completing general education. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 14: First stage of instrumental variable regression, joint effect specification

	(1)	(2)	(3)	(4)	(5)
Proxy instruments	U	U × PE	U × PE^2	PE	PE^2
U proxy*	0.518***	-1.467***	-15.390***	-0.159***	-0.832***
	(0.036)	(0.175)	(2.150)	(0.014)	(0.224)
U proxy × PE proxy**	0.024***	0.954***	0.376	0.053***	-0.042
	(0.006)	(0.049)	(0.777)	(0.004)	(0.063)
U proxy × PE proxy^2	-0.001	-0.000	0.903***	-0.003***	0.016***
	(0.000)	(0.005)	(0.081)	(0.000)	(0.005)
PE proxy	-0.211***	-0.609**	-27.959***	-0.017	-6.651***
	(0.040)	(0.262)	(3.961)	(0.016)	(0.346)
PE proxy^2	0.000	-0.041	-0.774	0.022***	0.687***
	(0.003)	(0.037)	(0.559)	(0.002)	(0.044)
Observations	6,217	6,217	6,217	6,217	6,217
R-squared	0.881	0.958	0.952	0.986	0.966
F-stat proxy instruments	76.02	226.8	324.2	31.41	479.9
F-stat all instruments	78.20	351.3	329.7	4140	751.2

Notes: The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women who graduated from technical schools at the age between 18 and 22 between 2000 and 2016. The sample is restricted to men and women with a positive hourly wage. The control variables include dummies for educational majors, a dummy for a type of higher education (unity for university, 0 for technical college), the current unemployment rate in the region of residence, dummies for year of graduation, time fixed effects, month of interview fixed effects, federal districts fixed effects, dummies for a type of settlement and a female dummy. U proxy* is the unemployment rate at the hypothetical age of graduation. PE proxy** is years of experience given graduation at the hypothetical age of graduation. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 15: First stage of instrumental variable regression, gender difference in effect specification

Proxy instruments	(1) female × U	(2) female× U× PE	(3) female× U × PE^2	(4) female× PE	(5) female× PE^2
U proxy*	0.544***	-1.363***	-14.239***	-0.160***	-0.714*
	(0.045)	(0.229)	(2.841)	(0.023)	(0.382)
U proxy × PE proxy**	0.022***	0.922***	0.060	0.051***	-0.065
	(0.007)	(0.058)	(0.993)	(0.007)	(0.098)
U proxy × PE proxy^2	-0.000	0.002	0.914***	-0.003***	0.012*
	(0.000)	(0.006)	(0.102)	(0.000)	(0.007)
PE proxy	-0.209***	-0.302	-27.087***	-0.041*	-7.644***
	(0.054)	(0.319)	(5.085)	(0.024)	(0.538)
PE proxy^2	-0.004	-0.087**	-1.054	0.023***	0.756***
	(0.004)	(0.043)	(0.722)	(0.003)	(0.058)
female × U proxy	-0.034	-0.095	-1.005	0.003	-0.122
	(0.053)	(0.261)	(3.671)	(0.027)	(0.438)
female × U proxy × PE proxy	0.001	0.037	0.315	0.003	0.027
	(0.009)	(0.076)	(1.208)	(0.007)	(0.110)
female × U proxy × PE proxy^2	-0.000	-0.003	0.006	0.000	0.008
	(0.001)	(0.008)	(0.141)	(0.000)	(0.008)
female × PE proxy	-0.009	-0.413	0.184	0.044	1.727***
	(0.074)	(0.467)	(6.628)	(0.028)	(0.622)
female × PE proxy^2	0.005	0.060	0.225	-0.001	-0.126*
	(0.006)	(0.061)	(0.985)	(0.004)	(0.076)
Observations	6,217	6,217	6,217	6,217	6,217
R-squared	0.884	0.959	0.954	0.986	0.968
F-stat proxy instruments	48.05	124.2	166.1	17.59	243.5
F-stat all instruments	61.58	309.6	248	3325	584.4

Notes: The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women graduated from technical schools at the age between 18 and 22 between 2000 and 2016. The sample is restricted to men and women with a positive hourly wage. Control variables include dummies for educational majors, dummy for a type of higher education (unity for university, 0 for technical college), the current unemployment rate in the region of residence, dummies for year of graduation, time fixed effects, month of interview fixed effects, federal districts fixed effects, dummies for a type of settlement, female dummy as well as interaction terms between female dummy and all control variables. U proxy* is the unemployment rate at the hypothetical age of graduation. PE proxy** is years of experience given graduation at the hypothetical age of graduation. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 15: First stage of instrumental variable regression, gender difference in effect specification, cont.

Proxy instruments	(1) female × U	(2) female× U× PE	(3) female× U × PE^2	(4) female× PE	(5) female× PE^2
U proxy*	0.000	0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
U proxy × PE proxy**	-0.000	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
U proxy × PE proxy^2	0.000	0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
PE proxy	0.000	0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
PE proxy^2	-0.000	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
female × U proxy	0.510***	-1.459***	-15.243***	-0.157***	-0.836***
	(0.044)	(0.213)	(2.889)	(0.016)	(0.248)
female × U proxy × PE proxy	0.023***	0.959***	0.375	0.054***	-0.038
	(0.008)	(0.062)	(0.945)	(0.005)	(0.069)
female × U proxy × PE proxy^2	-0.000	-0.000	0.920***	-0.003***	0.020***
	(0.001)	(0.007)	(0.109)	(0.000)	(0.006)
female × PE proxy	-0.218***	-0.714**	-26.903***	0.003	-5.917***
	(0.053)	(0.357)	(5.041)	(0.019)	(0.381)
female × PE proxy^2	0.001	-0.028	-0.829	0.022***	0.630***
	(0.005)	(0.050)	(0.755)	(0.002)	(0.055)
Observations	6,217	6,217	6,217	6,217	6,217
R-squared	0.962	0.969	0.957	0.991	0.974
F-stat proxy instruments	37.86	136.6	143.5	23.27	295.9
F-stat all instruments	27.06	308.4	218	2449	485.3

Notes: The sample is restricted to men and women who graduated from universities at the age between 21 and 26 and to men and women graduated from technical schools at the age between 18 and 22 between 2000 and 2016. The sample is restricted to men and women with a positive hourly wage. Control variables include dummies for educational majors, dummy for a type of higher education (unity for university, 0 for technical college), the current unemployment rate in the region of residence, dummies for year of graduation, time fixed effects, month of interview fixed effects, federal districts fixed effects, dummies for a type of settlement, female dummy as well as interaction terms between female dummy and all control variables. U proxy* is the unemployment rate at the hypothetical age of graduation. PE proxy** is years of experience given graduation at the hypothetical age of graduation. * significant at 10%, ** significant at 5%, *** significant at 1%.

Sammanfattning (summary in Swedish)

USA och övriga utvecklade samhällen har genomgått en myriad av snabba förändringar vad gäller samhällets och arbetsmarknadens struktur och funktionssätt under senare delen av 1900-talet och 2000-talets början. De huvudsakliga drivkrafterna bakom dessa förändringar har varit strukturomvandling (Kuznets (1957), Baumol (1967), Jorgenson & Timmer (2010), Herrendorf et al. (2013), Bárány & Siegel (2018) osv.), importkonkurrens och offshoring (Crino (2009), Kemeny & Rigby (2012), Autor et al. (2013), Becker et al. (2013), Autor et al. (2014), Acemoglu et al. (2016) osv.) och införandet av en ny datorbaserad teknologi (Autor et al. (2003), Autor et al. (2006), Goos & Manning (2007), Goos et al. (2009), Autor & Dorn (2013), Goos et al. (2014), Michaels et al. (2014) osv.). Medan forskare inom nationalekonomi och relaterade områden har ägnat mycket tid åt att studera hur dessa drivkrafter har påverkat olika branscher inom näringslivet, företag och arbetsmarknader, har mycket mindre tid ägnats åt att studera vilken effekt förändringar på arbetsmarknaden till följd av dessa drivkrafter haft på utfall för familjer och barn. Denna avhandling består av tre fristående kapitel. De två första kapitlen gör ett försök att fylla detta tomrum.

I det första kapitlet i denna avhandling, *Barnlöshet, antal barn och arbetsmarknaden vid tiden för ny teknologi, USA 1980–2018*, studerar jag vilken effekten var av förändringar på arbetsmarknaden till följd av införandet av en ny datorbaserad teknologi på familjefertilitetsutfallen i USA 1980–2018. Mer specifikt är jag intresserad av vilken effekt familjefertilitetsutfallet i USA 1980–2018 hade på förändringar på arbetsmarknaden som ägde rum samtidigt för båda partnerna i hushållet till följd av införandet av en ny datorteknologi sent på 1970-talet. Med andra ord är jag intresserad av den totala effekten av alla förändringar på arbetsmarknaden till följd av införandet av en ny teknologi på familjefertilitetsutfallet i USA 1980–2018.

Datorbaserad teknologi infördes inte på amerikanska arbetsplatser förrän i slutet på 1970-talet. Strax efter detta inleddes en kraftig minskning i priset på datorkraft. Införandet av datorer i USA ledde till breda förändringar på arbetsmarknaden som kan beskrivas med två viktiga företeelser. Den första är jobbpolarisering, dvs en snabbare sysselsättningsökning inom ett högavlönat yrke som domineras av abstrakta arbetsuppgifter och ett lågavlönat yrke som domineras av manuella arbetsuppgifter i förhållande till ett medelavlönat yrke som domineras av rutinartade arbetsuppgifter (Autor et al. (2003), Autor & Dorn (2013)). Den andra är en förskjutning i den relativa efterfrågan och avkastningen på analytiska och sociala förmågor (Bacolod & Blum (2010), Beaudry & Lewis (2014), Autor (2015), Deming (2017)).

Mellan 1980 och 2018 ökade andelen barnlösa kvinnor i åldersgruppen 20–39 i USA från 0,40 till 0,54 procent, medan andelen kvinnor i samma åldersgrupp med minst två barn minskade från 0,41 till 0,29 procent. Dessutom blev förekomsten av en uppskjuten fertilitet – mätt som andelen kvinnor i åldersgruppen 40–44 med ett barn under fem år – mer än två gånger så vanlig. Andelen kvinnor 40–44 år med små barn steg från 0,5 till 0,12 procent mellan 1980 och 2018.

Jag använder en modell där en ”rutinartad uppgift” ersätts till följd av den tekniska utvecklingen, där den tekniska utveckling tar formen av lägre priser på datorkraft (Autor & Dorn, 2013). Med utgångspunkt i förväntningarna i teorierna inom s k fertilitetsekonomi (Becker (1960), Becker (1965), Willis (1973) och Hotz et al. (1997), de teoretiska förväntningarna i Autor & Dorn (2013) och de empiriska resultaten Autor & Dorn (2013), Bacolod & Blum (2010), Beaudry & Lewis (2014), Deming (2017) osv, förväntar jag mig att pendlingszoner med en historiskt större specialisering inom rutinartade arbetsuppgifter karakteriserades av ett snabbare införande av datorteknologi och efterföljande större förändringar i familjefertilitetsutfall i USA 1980–2018. Min hypotes är att pendlingszoner med en historiskt större specialisering inom rutinartade arbetsuppgifter infört datorteknologi snabbare sedan sent 1970-tal och följaktligen erfor större förändringar på arbetsmarknaden. Större förändringar på arbetsmarknaden ledde i sin tur till större förändringar i familjefertilitetsutfallen.

Jag finner att andelen kvinnor 20–39 år med minst ett och minst två barn minskade mer i pendlingszoner med en historiskt större specialisering inom rutinartade uppgifter. Resultatet är statistiskt och ekonomiskt högt signifikant och drivs av högskoleutbildade kvinnor.

När det gäller den uppskjutna fertiliteten ökade andelen kvinnor i åldersgruppen 40–44 med ett barn under fem år mer i pendlingszoner med en historiskt större specialisering inom rutinartade arbetsuppgifter mellan 1980 och 2018. Med andra ord ökade förekomsten av den uppskjutna fertiliteten mer i pendlingszoner med den större andelen av sysselsättningen koncentrerad i rutinartade arbetsuppgifter. Minskningen i andelen kvinnor 20–39 år med minst ett och minst två barn hade en större omfattning jämfört med ökningen i andelen kvinnor 40–44 år med ett litet barn.

I det andra kapitlet i denna avhandling, *Äktenskaplig ekonomisk homogami och inkomstpolarisering, USA 1970–2018*, studerar jag effekten på familjebildningen i USA 1970–2018 av förändringar på arbetsmarknaden till följd av strukturomvandlingen. Framför allt studerar jag hur polariseringen av inkomster pådriven av strukturomvandlingen påverkade hur lika makar är i förhållande till sina arbetsinkomster i USA 1970–2018. Polariseringen av inkomster innebär att det relativa inkomstgapet i den övre delen av inkomstfördelningen har blivit större, medan det relativa inkomstgapet i den nedre delen av inkomstfördelningen har minskat i USA sedan 1950–1960-talet.

Jag definierar mått på relativa inkomstgap över tre breda industrisektorer och tre breda yrkesgrupper. Uttryckt som breda industrisektorer beskriver måtten utvecklingen av det relativa inkomstgapet mellan personer sysselsatta inom den högkvalificerade tjänstesektorn och tillverkningssektorn och det relativa inkomstgapet mellan personer sysselsatta inom tillverkningssektorn och den lågkvalificerade tjänstesektorn i USA 1970–2018. Uttryckt som breda yrkesgrupper beskriver måtten utvecklingen av det relativa inkomstgapet mellan personer sysselsatta inom yrkesgrupper med dominerande abstrakta arbetsuppgifter och yrkesgrupper med dominerande rutinartade arbetsuppgifter och ett relativt inkomstgap mellan personer sysselsatta inom yrkesgrupper med dominerande rutinartade arbetsuppgifter och yrkesgrupper med dominerande manuella arbetsuppgifter i USA 1970–2018.

Äktenskaplig ekonomisk homogami beskrivs med en rangkorrelationskoefficient över makas och makes inkomster där maka och make var mellan 27 och 36 år gamla. Mellan 1960 och 2018 ökade koefficienten av äktenskaplig ekonomisk homogami från 0,12 till 0,32.

Jag grundar mina teoretiska förväntningar på de teoretiska slutsatserna i den modell som utvecklats i Fernandez et al. (2005). För att identifiera ett orsakssamband använder jag resultat från den teoretiska modellen utvecklad i Bárány & Siegel (2018). Denna modell förklarar den polarisering av arbetsmarknaden som inleddes med strukturomvandling i USA på 1950-1960-talet.

Mina teoretiska förväntningar får stöd i empiriska resultat. Resultaten visar att pendlingszoner med ett större relativt inkomstgap både i den övre och nedre delen av inkomstfördelningen kännetecknas av en större inkomstjämlikhet hos gifta par. Däremot kännetecknas pendlingszoner med lägre relativa inkomstgap både i den övre och nedre delen av inkomstfördelningen av en lägre inkomstjämlikhet för gifta par. Dessutom har förändringarna i det relativa inkomstgapet i den övre delen av inkomstfördelningen en större effekt på hur lika partner inom äktenskap är än förändringar i inkomstgapet i den nedre delen av inkomstfördelningen.

I det tredje kapitlet i denna avhandling, *Nya karriärer, recession och kön - bevis från Ryssland 2000–2016*, vänder jag min uppmärksamhet mot en annan forskningsfråga och ett annat land. I detta kapitel studerar jag effekten av att erhålla sin examen under en lågkonjunktur i Ryssland 2000–2016. I synnerhet studerar jag effekten av att erhålla sin examen under en lågkonjunktur för högskoleutbildade män och kvinnor, könsskillnaden i effekten och eventuella mekanismer bakom de uppskattade effekterna.

Att identifiera den kausala effekten av att erhålla sin examen under en lågkonjunktur är en utmaning eftersom tidpunkten då man tar sin examen kan vara korrelerad med situationen på arbetsmarknaden. För att identifiera den kausala effekten instrumenterar jag en endogen tidpunkt för erhållandet av examen med en exogen tidpunkt för erhållandet av examen (Kahn, 2010).

Jag finner att högutbildade män som erhåller sin examen under en lågkonjunktur har lägre lön direkt efter arbetsmarknadsinträdet. Trots att den första effekten minskar i takt med att den ekonomiska aktiviteten i ekonomin återhämtar sig, kvarstår den negativa effekten flera år efter att mannen erhållit sin examen. I motsatts till effekten för män finner jag ingen initial effekt på löner bland högutbildade kvinnor. Den negativa effekten dyker dock först upp tre till fem år efter att personen erhållit sin examen. I motsatts till effekten bland män ökar den negativa effekten på arbetsinkomster bland kvinnor över tiden.

En analys av de potentiella mekanismerna visar att män och kvinnor som erhöll sin examen under en lågkonjunktur i genomsnitt hade ett arbete med lägre kvalité vilket kan förklara lägre löner direkt efter att de erhållit sin examen och över tiden. Ingen könsskillnad i jobbkvalité är identifierad. Dessutom tenderade högutbildade kvinnor som erhöll sin examen under en lågkonjunktur att få ett barn snabbare.

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