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EQUAL PAY FOR EQUAL WORK? WAGE AND PRODUCTIVITY DIFFERENTIALS DURING SLOVENIA'S TRANSITION

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ABSTRACT

The paper investigates how the transition to a market economy has affected the relationship between wages and productivity across different types of workers and over time. Using a rich longitudinal dataset spanning the 1992-2001 period, this study explores this relationship across workers based on age, education and gender in Slovenia after its secession from Yugoslavia in 1991. The results indicate that the first ten years of transition to a market economy dramatically altered the relationship between the relative wages and productivity of different types of workers, yet yielded relatively little convergence towards the equilibrium wage relativities one would expect to observe were wages of workers to equal the value of their marginal product. The estimates indicate that relative wage and productivity differentials decreased for older workers, increased for educated workers, and remained relatively constant for women.

POVZETEK

Prispevek proučuje vpliv tranzicije v tržno gospodarstvo na razmerje med plačami in produktivnostjo glede na demografske značilnosti in skozi čas. Na podlagi obširne longitudinalne baze podatkov za obdobje od leta 1992 do 2001 je narejena analiza relativnih razmerij med plačami in produktivnostjo delavcev glede na starost, izobrazbo in spol v Sloveniji po odcepitvi od Jugoslavije leta 1991. Rezultati kažejo, da so se v prvih desetih letih tranzicije razmerja med relativnimi plačami in produktivnostjo različnih vrst delavcev močno spremenila, vendar so obenem še vedno ostala daleč od ravnovesnih vrednosti, kjer bi bila razmerja plač enaka razmerju mejnih proizvodov dela. Ekonometrične ocene kažejo, da so se razlike med relativno plačo in produktivnostjo za starejše delavce zmanjšale, za višje izobražene delavce povečale, za ženske pa ostale relativno nespremenjene.

JEL Codes: J24, J31, P31
Keywords: labor productivity; matched employer-employee data; transitional economies

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1. Introduction

Since the collapse of socialism, transition economies have faced the difficult task of introducing market forces into the wage determination process. Under socialism, the wage setting process was primarily guided by ideological principles instead of market forces, resulting in elaborate but largely arbitrary wage grids, compressed wage structures, and wages that largely failed to reflect differences in productivity across workers and firms. We would expect that transition would correct these labor market distortions to contribute to an efficient allocation of resources, a process that would presumably lead to a greater alignment of the wages of workers with their marginal products.

To what extent have market forces indeed shaped wage determination in transition economies? A large body of the literature has focused on changes to the earnings premium associated with schooling and other personal characteristics during the transition period, and the findings, although not entirely consistent, point to sharply higher returns to education, to falling returns to work experience, and to comparatively modest changes in the relative wages of women.[1] But do these results imply commensurate changes in the productivity of these groups of workers? Do wage increases for educated workers during transition reflect an increase in the marginal product of

[1] The increase in wage differentials associated with education has been the most widely studied and documented (see Fleisher, Sabirianova and Wang, 2005, for a survey). Evidence of the effect of transition on the returns to work experience and gender is not as clear-cut. In their survey of the gender wage inequality literature, Paci and Reilly (2004) find evidence of a decrease in the average gender wage gap in most transition economies; as Hunt (2002) and Liu (2007) point out, however, declining employment amongst lower-wage females is a part of explanation. As for work experience, Flanagan (1993), Rutkowski (1997) and Kollo and Kertesi (1999) provide evidence that the experience-earnings profile has flattened during transition for the Czech Republic, Poland and Hungary, respectively, but some other studies show no such trends (for example, Orazem and Vodopivec 1995).

education, or do they represent a temporary, transitional adjustment to equilibrium wage relativities? Have older, more experienced workers been able to apply their skills and knowledge in the radically different economic conditions – and if not, have commensurate adjustments of wages taken place? Without independent measures of worker productivity, these questions cannot be answered unambiguously. While changes in relative wages of workers based on demographic categories such as age, educational attainment and gender may reflect changes in underlying relative productivity, changes in relative wages could also be attributed to other factors. These include changes in institutions, shifts in the relative labor supply of particular demographic groups, skill-biased technical change and other factors affecting labor demand (Andren, Earle and Sapatoru, 2005), or changes to the premia employers are willing attach to their discriminatory tastes. Given the dramatic economic and social changes that occurred during transition, drawing conclusions about productivity changes based solely on wage equations rests on rather untenable assumptions.

Seeking the answers to the above questions and as a novelty in the literature on transition countries, this paper explores the relationship between wages and productivity over a protracted period for one transition country, Slovenia. It employs a rich, longitudinal matched employer-employee database to estimate firm-level wage and production functions that yield relative wage and productivity differentials, comparable across demographic groups and over time. Moreover, by exploiting the panel nature of the data, the paper also checks the robustness of the results by accounting for selection bias arising from changing composition of the workforce, an important issue given the changes in labour

force participation and increase in worker mobility between firms during transition.

This paper finds that the first ten years of Slovenia's transition to a market economy dramatically altered the relative wages and productivity of different types of workers, yet yielded little convergence towards the equilibrium wage relativities one would expect to observe in a competitive labor market. The wages of more educated workers increased in line with increases in their productivity, but the initial disparity between the two remains; returns to work experience fell, but failed to keep pace with decreases in the productivity of older workers; and the productivity and wages of women relative to men remained largely unchanged. Underlying the changing relationships were structural changes affecting the productivity of labor and capital inputs and the exit of less productive workers from the labor market.

The structure of the paper is as follows. Section 2 discusses the impact of transition reforms on the labor market and examines why the theoretical predictions regarding the changes in the relative wages and productivity of various demographic characteristics are ambiguous. Section 3 describes the process of constructing the longitudinal, matched employer-employee database from the multiple data sources, and Section 4 outlines the model used to estimate the relative wage and productivity differentials. Section 5 summarizes the results of other studies that employ a similar methodology, [2] and Section 6

[2] These, all of which are for non-transition economies, are Hellerstein, Neumark and Troske (1999) for the USA, Hellerstein and Neumark (1999) for Israel, Haegeland and Klette (1999) for Norway, Jones (2001) for Ghana, Crepon, Deniau, and Perez-Duarte (2002) for France, and Illmakunnas, Maliranta and Vainiomaki (2004) for Finland, Lopez-Acevedo, Tinajero and Rubio (2005) for Mexico, and Van Biesebroeck (2007) for three Sub-Saharan countries. Their results are presented in greater detail in Section 5.3.

presents of the Slovenian data. The final section discusses policy implications and directions for future research.

2. Institutional background and theoretical predictions regarding the evolution of relative wage and productivity differentials during transition

What theoretical predictions can we make concerning changes in productivity during transition, and how did these compare with relative wages? In order to provide a context with which to interpret the empirical results, the section below discusses transition reforms that arguably affected worker productivity and examines their empirical implications predictions. Because the observed wages during transition presumably reflect both underlying worker productivity and the wage-setting mechanisms, the wage-determination process is also discussed.

2.1 The effects of labor market outcomes on productivity

Transition reforms affected worker productivity through several key labor market effects: they changed the structure of employment by age and education, altered labor force participation rates, and increased the flow of workers between employers, inactivity and unemployment. In Slovenia, young and old workers suffered disproportionate losses in employment as a result of transition reforms - the share of workers under 30 years old steadily decreased during the 1990 to 2001 period, from 32.1 to 24.9 percent, and the share of workers over 50 fell from 12.2 to 7.2 percent from 1990 to 1993, before rising again to 9.7 percent in 2001 (Vodopivec, 2004). Both push and pull factors were at work: facing difficult access to jobs, many young people opted to enroll in

tertiary education while many older workers opted to retire. For younger workers, the appeal of continuing their schooling past the high-school level was reinforced by the increasing wage premium associated with education and by an anomalous Slovenian institution whereby student status confers considerable benefits.[3] In an effort to limit unemployment, older workers were offered early retirement schemes under relatively attractive conditions.[4] The structure of employment exhibited a marked increase in the share of educated workers: the employment share of those with high school or higher education increased in every year from 1991 to 2001, from 35.2 percent to 47.6 percent; conversely, the share of those with no more than elementary school education decreased in every year during that period, from 34.8 to 21.5 percent. The structural reforms also increased job flows as firm entry was encouraged and bankruptcies were allowed to occur. For instance, the job reallocation rate, defined as the sum of the job creation and destruction rates, peaked at 35 percent at the onset of transition in Slovenia (Scarpetta and Vodopivec, 2006). This is similar to the increases found in other transition economies but considerably higher than the 25 percent typically found in developed market economies.

The above discussion leads to several contrasting hypotheses regarding how the productivity associated with various worker characteristics was affected by the transition to a market economy. Regarding the productivity of older

[3] While Slovenia already exhibited a relatively high rate return to schooling under socialism, the increase from the pre-reform period to the late reform period – about 3.5 percentage points per year of schooling – is comparable to that seen in other transition economies (Fleisher, Sabirianova, Wang, 2005). Furthermore, full-time Slovenian students continue to enjoy a variety of fringe benefits in addition to their tuition-free education, such as tax-free part time employment, subsidized meals and housing, and free health insurance.

[4] The early retirement schemes offered fairly generous conditions: pensions were set at 85 percent of the pension base, which was determined by the average of the ten highest annual inflation-adjusted incomes in the pensioner's career (Orazem and Vodopivec, 1995). In contrast to wages, pensions were fully indexed to inflation.

workers relative to younger workers, the productivity of older workers could have increased, on the one hand, if the early retirement programs of the mid-1990's either led less productive older workers to exit the labor force disproportionally or, by making older workers artificially scarce, placed a premium on their skills and experience. On the other hand, there are several factors that might have decreased the productivity of older workers. First, the sharply increased worker flows, which for some workers would result in separations from firms where they had worked for their entire career, would imply significant losses of firm-specific capital, a problem particularly acute for older workers. Second, the increase in job flows, a natural by-product of restructuring as successful firms and industries expand employment while others contract, implies that workers were increasingly led into different occupations and industries. As such, these workers would also experience a decrease in the value of their industry- or occupation-specific human capital, as large number of workers shifted from industrial jobs into the service sector. And third, even for old workers who remained at their jobs and firms, the changing market conditions – the need for firms to restructure, innovate, and compete – could imply a decrease in the value of both firm-specific and general human capital. This is because older workers were accustomed to working in an economy that was perpetually in a steady-state (with stable supply and demand) and with constitutionally guaranteed job security. Younger workers, through a more critical perception of the disequilibria present in the newly liberalized markets, may have been better positioned to exploit the opportunities afforded to them in the less regulated economic environment.

A similar set of contrasting hypotheses emerge regarding the impact of transition on the productivity of different educational groups. On the one hand, several factors may have led to a decrease in the relative productivity of educated workers. First, the surge in college and university enrollment significantly increased the relative supply of educated workers, both by restricting the inflow of low-skilled labor market entrants and increasing the inflow of college graduates.[5] Second, given the the large drops in per student expenditure and the absence of major institutional reforms to modernize the tertiary education system, the relative worth of education obtained during the transition may have arguably decreased. Third, the over-supply of certain vocations and over-subscription in certain fields of study implies a decrease of the value of education of individuals engaged in those professions and fields. Socialist educational systems tended to be geared towards satisfying the industrialization priorities of socialist planners, emphasizing the natural sciences (e.g., engineering) over the social sciences, with apprenticeship training that was both more extensively provided and more narrowly focused than what is typically observed in market economies (Flanagan, 1998). Finally, the unfavorable job market conditions could have forced educated workers to accept jobs for which they were over-qualified, leading to inferior job matches.

However, there are several competing factors may have led to an increase in the productivity of educated workers. First, economy-wide restructuring (e.g., investments in new technological processes, development of previously

[5] In 1990, Slovenia had 33.5 thousand students; by 2001, the number of students at higher educational institutions tripled, and by 2005, there were 115 thousand students, comprising 8 percent of the 1.4 million working age population (Statistical Office of Slovenia). Expenditure on education, however, failed to match the surge in tertiary enrollment and from 1995 to 2003 expenditure on higher education increased by only a third. Given the absence of significant reforms to the tertiary education system in recent decades, the decrease in expenditure per student arguably decreased the quality of education.

neglected sectors such as financial services) could have resulted in labor demand shifts that favored skilled labor. Second, the entry of private universities could have filled the curriculum gap of state schools (e.g. by offering business courses) and otherwise helped improve the quality of education through increased competition (Kraft and Vodopivec, 2003). Third, the transition to a market economy from the steady state observed in socialism may lead to an increase in the value of the ability to deal with disequilibria. As Schultz (1975) argues, education hones this ability by "enhancing the ability… to perceive new classes of problems, to clarify such problems, and to learn ways of solving them" (p. 835). Finally, to the extent that education may be endogenous to an individual's general cognitive ability, we may expect its observed value to increase with the onset of transition.

The effects of transition reforms on the relative productivity of women are not clear. According to several aggregate labor market indicators, women fared similarly to men in Slovenia: the ratio of their average wages relative to men remained constant at around 0.88, the slight decline in their labor force participation rates paralleled the decline among men, their share of employment in labor force stayed within a percentage point of 46% during the entire 1990 to 2001 period (Vodopivec, 2004). They exhibited a slightly lower decrease in unemployment rates, by 2 percentage points instead of the 4.3 witnessed for men from 1993 to 2001.

2.2 The wage determination process and Slovenian macroeconomic context

While in the long run we can expect that changes in productivity are reflected in wages, it is the wage-determination process that importantly shapes wages in the short run. Below we briefly describe the evolution of the wage setting mechanism in Slovenia, starting with the system that Slovenia inherited from Yugoslavia.

As in other communist countries, wage determination in Yugoslavia was highly regulated and wages were sharply compressed in comparison to capitalist firms (Haltiwanger and Vodopivec, 2003). The government set each firm's total "socially warranted" wage bill which was partially contingent upon a firm's success but largely influenced by egalitarian principles. Above-average firms cross-subsidized below-average firms via a massive system of discretionary taxes and subsidies (Vodopivec, 1993). Individual workers' base wages within a firm were set by wage scales that were proposed by the firm's Worker's Council and voted on through a firm-wide referendum.

Following its independence from Yugoslavia in 1991, Slovenia reformed its wage-setting mechanism. Collective bargaining agreements, legally binding for all firms, assumed a major role in the wage determination process. These collective bargaining agreements mandate minimum pay scales based on characteristics such as education, labor market experience, and overtime. For example, a standard stipulation in collective bargaining agreements is that workers are granted a 0.5 percent increase in their base wage for each year of labor market experience. Despite the high level of disaggregation in the collective bargaining agreements, the system allows for idiosyncratic deviations in wages, which may arise on a firm-specific or even worker-specific basis, because the

collective bargaining agreement prescribes what is generally a wage floor. Results from previous empirical studies indicate that the system still allows for considerable flexibility in the wage determination process in practice, allowing for sufficient variation for meaningful analysis (see, for example, Haltiwanger and Vodopivec, 2003).

At the aggregate level, wages and productivity experienced a large fall after the breakup of Yugoslavia (Table 1). The sudden drop in real wages at the beginning of transition was followed by a period of runaway, high wage growth in the government sector in the early 1990's, with wage pressures spilling over into the real economy (Silva-Jauregui, 2004). After the mid-1990's, wage growth was considerably restrained. Due to their large initial drop, however, real wages had fallen to 76% of their 1990 levels by 1992 and did not recover this loss until 1998. This fall was particularly dramatic given that GDP had fallen to only 86% its 1990 level by 1992 and that it surpassed its pre-transition level by 1996; labor productivity recovered even more quickly, exceeding its pre-transition level by 1994. In the early years of transition, labor productivity growth was largely driven by labor shedding from previously over-staffed state-owned firms (De Loecker and Konings, 2006), and the subsequent growth in employment was largely driven by privatized or newly-created private firms. The moderate real wage growth would aid in boosting competitiveness in the private sector, restraining government expenditure for social payments linked to wage increases (such as pension payments), and aid in the governments disinflation policy, which eventually enabled Slovenia to adopt the euro in 2007. As a result of these factors, growth in real wages lagged behind growth in aggregate

productivity for the majority of the period in question, making the pay stipulations from collective bargaining agreements non-binding for many firms.

The above discussion highlights the multiple contemporaneous factors that were occurring in the labor market during the course of transition. The resulting wages profiles across demographic groups that have been widely studied were thus the outcomes of various competing forces, chief amongst them being policies to promote macroeconomic stabilization and competitiveness, the imposition of hard budget constraints associated with privatization and decreased state interference in the economy, and union demands for wage increases in the face of high inflation. In order to accurately disentangle the net effects of these numerous factors and obtain a better understanding of the end outcomes, it is critical to be able to compare relative wages with relative productivities over time -- a significant advantage of the methodology and data used in this study.

3. Methodology and data

Ideally, measuring the relationship between wages and productivity would involve relating an individual workers' wage with that worker's effect, at the margin, on the firm's total output. An obvious problem in attempting to link the two in an empirical model is that while measuring an individual workers' wage is relatively straightforward, obtaining a meaningful estimate of his or her marginal productivity is typically not.[6]

[6] A notable exception arises in cases where workers are self-sufficient and independent labor inputs, e.g. Lazear and Shaw's (2008) study of glass installers in an autoglass company.

As in Hellerstein, Neumark, and Troske (1999), we employ an approach in which production functions and wage equations are estimated at the level of the firm. This approach has the benefit of facilitating direct comparisons of the wage and productivity differentials. Below we review the methodology and examine how the availability of panel data can add to this framework.

3.1 Model for estimating productivity differentials

Consider a simple production function in which value-added output for firm *i* (Y_i)is a function of capital inputs K_i and a quality of labor aggregate QL_i. Using a translog production function, the model can be described as

$$\ln(Y_i)= \ln(A) + \alpha \ln(K_i) + \beta \ln(QL_i) + g(K_i,QL_i) +\gamma_i X_i + \mu_i \quad (1)$$

where A is a coefficient capturing technical efficiency, g(K,QL) represent the second order terms of the translog production function, X_i is a vector of dummy variables capturing firm characteristics such as ownership type and industry, and μ_i is the stochastic error term.

For each firm, assume for simplicity that we can differentiate workers based on a single characteristic, their gender, and that workers are perfectly substitutable inputs with potentially different marginal products. If we define φ_F to denote the productivity of women relative to men, such that $MPL_{women}/MPL_{men}= \varphi_F$, we can define QL as

$$QL_i=L_i \cdot (1+ (\varphi_F-1) \frac{Fi}{Li}) \quad (2)$$

were L_i is the total number of workers in firm *i*, F_i is the number of women in firm *i*, and φ_F is the marginal productivity of women relative to men.

Substituting equation (2) into equation (1) yields a firm level production from which φ_F can be estimated.

The actual data permit us to distinguish the each firms workforce not only based on gender, but also by education and age. Workers are classified into six education groups (completed elementary school, vocational school, high school, 2-year college, and at least 4-year college) and four age categories (less than 30 years old, 30-39, 40-49, more than 50 years old). A firm's workforce can thus be fully described by each of the 48 possible combinations that these multiple dimensions capture, and obtaining exact estimates for each of these groups would require including 47 terms for the productivity differentials (φ's) relative to the omitted group in the production function.

In order to reduce the dimensionality of the problem, a simplifying restriction on the model is imposed. The productivity differentials of workers in one demographic category are assumed to be equal for those same types of workers in another demographic category. Thus, for example, the productivity differentials of young women (those in the first age category, less than 30 years old) relative to young men are assumed to be equal to the productivity differentials of the oldest women (those more than 50 years old) relative to the oldest men. Similarly, the productivity differentials of the youngest women relative to the oldest women are constrained to be equal to the productivity differentials of the youngest men relative to the oldest men. With these simplifying restrictions, the quality of labor term becomes

$$QL_i = L_i \cdot [1+(\varphi_F -1) \frac{Fi}{Li}] \cdot [1 + (\varphi_{EDU2}-1) \frac{EDU2i}{Li} + (\varphi_{EDU3}-1) \frac{EDU3i}{Li} + (\varphi_{EDU4}-1) \frac{EDU4i}{Li} + (\varphi_{EDU5}-1) \frac{EDU5i}{Li} + (\varphi_{EDU6}-1) \frac{EDU6i}{Li}] \cdot [1 + (\varphi_{AGE2}-1) \frac{AGE2i}{Li} + (\varphi_{AGE3}-1) \frac{AGE3i}{Li} + (\varphi_{AGE4}-1) \frac{AGE4i}{Li}] \quad (3)$$

where $EDU2_i$-$EDU6_i$ reflect the number of workers with completed elementary school, vocational school, high school, 2-year college, and at least 4-year college in firm *i*, respectively; and $AGE2_i$, $AGE3_i$ and $AGE4_i$ reflect the number of workers aged 30-39, 40-49, and over 50 years in firm *i*, respectively. Note that because of the way the coefficients are defined, productivity differentials between different groups should be interpreted based on whether the coefficients are different from one, and not from zero. Thus, a finding that $\varphi_F = 1.25$ would imply that women are 25% more productive than men.

The central premise of the above framework – that workers with different characteristics may have potentially different marginal products – can be further applied to differentiate workers along a variety of different dimensions. Specifically, we examine whether workers who entered and/or exited employment during the 1992-2001 period had different marginal products by sub-dividing the age groups into categories based on their employment history. This enables us to examine the impact of worker flows on the observed productivity differentials of various age groups during transition. While the data permit the testing of other hypotheses, e.g. allowing us to examining the quality of job matches of workers before and after switching employers, such questions are beyond the scope of this paper.

3.2 Model for estimating wage differentials

To ensure that the estimated wage differentials are directly comparable to the estimated productivity differentials, the model for wages uses the same worker groups and is also estimated at the level of the firm. The specification is as follows:

$$\ln(W_i) = \ln(\delta) + \ln\left[(L_i + (\lambda_F - 1)\frac{Fi}{Li}\right] \cdot \left[1 + (\lambda_{EDU2} - 1)\frac{EDU2i}{Li} + (\lambda_{EDU3} - 1)\frac{EDU3i}{Li} + (\lambda_{EDU4} - 1)\frac{EDU4i}{Li} + (\lambda_{EDU5} - 1)\frac{EDU5i}{Li} + (\lambda_{EDU6} - 1)\frac{EDU6i}{Li}\right] \cdot \left[1 + (\lambda_{AGE2} - 1)\frac{AGE2i}{Li} + (\lambda_{AGE3} - 1)\frac{AGE3i}{Li} + (\lambda_{AGE4} - 1)\frac{AGE4i}{Li}\right] + \gamma_i X_i + \mu_i \quad (4)$$

where δ is a constant to be estimated, W_i is the total wage bill in the firm, the wage differential coefficients λ correspond to their respective definitions for equation (3), the definitions of the demographic groups and the vector of dummy variables capturing firm characteristics, X_i, are also identical to those in equation (3), and μ_i is the stochastic error term.

Estimating the equation in (4) along with the augmented production function in (1) yields directly comparable measures of marginal productivity (φ) and wage differentials (λ). The restrictions of equiproportionate distributions of wage differentials across varying demographic characteristics are retained as in (3), and that the coefficients again need to be interpreted based on whether they differ from 1, and not 0.[7]

In addition to the specifications above, another set of regressions tests the hypothesis that changes in wage differentials were influenced by significant shifts in the composition of the labor force. By classifying individuals based on their employment history (i.e., based on whether they were employed at the beginning and/or end of the 1992-2001 period) and including this variable in the labor quality term described above, we can determine how the entry and exit

[7] For the purposes of this paper, the terms relative wage differential and relative wage are used interchangeably to denote the λ's from the wage equations. As such, they express the wages of a certain group relative to the base group within that demographic category. Similarly, the terms marginal productivity differential and relative productivity are used to denote the φ's from the production function equations. These terms should be distinguished from the ratio of relative wage and productivity differentials (λ/φ), which express the extent to which a certain group's wages reflect their productivity relative to the base group within that demographic category
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of specific groups from employment influenced wage and productivity differentials over time.

One final point about the methodology concerns a fundamental issue of identification in the model (Hellerstein *et al*, 1999). The marginal productivity differentials arise from the covariation across firms in the composition of their workforce and their output. That is, in addition to assuming that all workers are perfect substitutes, the model assumes that, subject to such firm-level controls as industry and size, workers with identical demographic characteristics have identical marginal products across firms. Similarly, in the wage equation, across firms with identical firm-level characteristics such as industry and size, the average wages of workers with identical demographic characteristics are assumed to be the same. As such, a finding that one demographic group is less productive than a second demographic group could have two distinct explanations: a.) the first group could be less productive relative to the second group within a given firm, or b.) the first group could be clustered in low-productivity firms, with the productivity of both groups generally the same within firms. This identification problem is further investigated for the wage equations below using individual level wage data to determine which effect is predominant, and the results indicate that intra-firm wage heterogeneity accounts for the majority of the wage variation.

3.3 Data

The data used to construct the longitudinal matched employer-employee database were compiled using several administrative databases that cover the universe of Slovenian workforce participants and business subjects in the non-

agricultural business sector, subject to measurement errors. They include two databases incorporating individual-level data on wages and demographic characteristics and two databases with data on firms. The individual databases are described in greater detail below.

1. The **business registry** keeps information about the births and deaths, as well as changes of selected attributes, of both legal and physical business subjects (that is, firms), as well as of public institutions. The register is "transaction-based," that is, only births, deaths, and changes are recorded. The register was maintained by the Statistical Office of Slovenia until 2003; this task has since been assumed by the Agency for Public Statistics and Services.
2. **Accounting data** is provided by all legal business subjects once a year, and it provides a rich set of variables both from income statements and balance sheets, as well as information on the industry, location, number of workers, and months of operation within a year of the firm. The register was maintained by the Statistical Office of Slovenia until 2003; this task has since been assumed by the Agency for Public Statistics and Services.
3. The **work history database** includes detailed information on workers in formal-sector jobs, including data on age, educational attainment, gender, and employer. The database is maintained by the Statistical Office of the Republic of Slovenia.
4. The **workers' earnings database** includes information on earnings for workers employed in formal sector jobs, number of hours worked in regular time and overtime, and the duration of the earnings period, allowing for wage rates to be calculated across workers. The database is maintained by the Pension and Disability Fund.

The data span the calendar years during the 1992-2001 period. During the period prior to 1992, Slovenia experienced hyperinflation, making the reliability of data from preceding years questionable. A related problem for the estimation of production function regressions – namely, a change in accounting standards in 1994 that lead to a revaluation of assets – is mitigated by the inclusion of the labor quality controls mitigates the effects of such changes; in addition, the primary focus of this study is the relationship between the relative wage and productivity differentials in a given year. In order to construct a matched employer-employee database, the worker- and firm-level databases were merged according to the universal firm identifier codes used for tax purposes. In addition, unique identification codes for workers and firms, respectively, allowed the data to be linked across time to create a panel database.

Summary statistics for the resulting dataset are presented in Table 2.

4. Results

To preview the results, we find that - consistent with the wage determination literature in transition economies - the dispersion of relative wages and productivity over time increases with regard to education and decreases with regard to age/experience. On the other hand, the changes in relative wages are not as large in magnitude as changes in relative productivity, so we do not find evidence of convergence to equilibrium wage relativities - issues discussed in greater detail below.

The results are presented in the following sequence. To establish a baseline for comparison purposes, we first present the results of a standard Mincerian individual-level wage regressions. We then present the results of the firm-level wage and productivity regressions, first examining their examining

their evolution over time and investigating the effect of worker flows on relative wages and productivity. Finally, as a sensitivity analysis of these results, we examine the influence of workers flows on the relative wages and productivity of cohorts of workers by age group.

4.1 Worker-level Wage Regressions

Table 3 below presents estimates from individual-level wage regressions based on data for the entire 1992-2001 period using the same control variables that are employed in the base firm-level wage equation and production function estimates.[8] The first column presents a model with a standard Mincer specification. These results roughly parallel the results of similar studies: the wage-experience profile is weakly concave, the wage premium associated with education varies from 9 percent for those with completed elementary school to 112 percent for those with a 4-year college education relative to individuals with unfinished elementary school, and a considerable (21 percent), statistically significant gender wage gap exists. In order to weigh the relative importance of intra-firm and inter-firm variation in wages in explaining economy-wide differentials, and thus provide a metric for gauging the reliability of firm-level regression estimates, the second column of Table 3 examines within-firm wage differentials by adding firm fixed effects to the regression in column 1. The age coefficients are only slightly affected by the inclusion of firm-level fixed effects, indicating that most of the variation in wages arises within firms across different types of workers. The lower wage disparity between men and women suggests

[8] We use dummy variables for the demographic characteristics instead of the more commonly used continuous variables to parallel the specification used in calculating the firm-level wage and productivity differentials.

that women work in lower-paying firms than men, while the slight decrease in the coefficients for education indicates a lower dispersion of wages within firms than in the entire sample. In general, only a small share of the variation in wages is attributable to varying wage levels *across* firms, and most of the variation arises *within* firms. Consequently, the methodology for estimating firm-level wage equations by summing up the individual-level wage equations within each firm for the purposes of estimating the firm-level wage equations should yield broadly valid results.[9]

<Table 3>

4.2 Productivity and Wage Differentials, 1992-2001

We now turn to the results of estimations of equations (1) and (7) on the firm-level data spanning the 1992-2001 period. Due to the way the parameters enter the model, the regressions are estimated using nonlinear least squares. Note that while these results are useful for establishing baseline comparisons, they mask the considerable variation that occurred over time.

<Table 4>

Age. The results indicate that for the 1992-2001 period as a whole, the relative productivity of all three groups of workers aged 30 or more was not statistically significantly different from the productivity of workers under 30. By contrast, the relative wage differentials indicate that based on the comparable firm-level estimates, older workers earn a wage premium that ranges from 7.1 percent for workers 30-39 years old to 30.2 percent for those 50 or over, and the

[9] To the extent that the fixed effects estimates are closer to zero than the standard wage regression estimates, the results of the firm-level regressions will tend to be biased towards understating (compressing) the economy-wide wage differentials; under the null hypothesis of competitive labor markets, a similar caveat applies to the productivity differentials.

difference between the marginal productivity and wage differentials is statistically significant.

Education. The differentials associated with education show large differences in productivity, but comparatively smaller differences in wages. Workers with completed elementary education are 7.8 percent more productive than those with uncompleted elementary education, while those with at least four year college degrees are 127 percent more productive; however, the wage premiums associated for these two groups are only 4.9 and 75 percent, respectively. In general, with the exception of vocational school graduates, the wage premiums paid to educated individuals are about two thirds of what their marginal product of labor would warrant.

Gender. Interestingly, women appear to be 6.5 percent less productive than men, but the firm-level wage equations indicate their wages are in fact 1.5 percent greater. The latter results seem to be at odds with individual-level wage regressions reported above, which indicate that women are paid significantly less than men. How can we reconcile these findings? Note that the fixed-firm-effects differential from the worker-level regressions (Table 3) for women (-14.3 percent) is smaller in magnitude than the differential from the standard wage equation (-21 percent), indicating that women work in firms with generally lower wages. Moreover, we should note that the estimation results in Table 4 are not calculated with employment weights, which would be necessary for more direct comparisons. In results not reported here, using employment weights in the estimation of firm-level wage equations yields coefficient estimates that are 5.4 percentage points below parity with men.

The other coefficients are also of some interest. The second order coefficients of the translog production function are statistically significant, indicating that the marginal rate of substitution between capital and labor is not constant. It is also interesting to note that the standard errors of the coefficient estimates are consistently higher in the production function estimates. This may indicate a higher degree of heterogeneity amongst firms in their productivity than in their wage policies, and corroborate the finding that collective bargaining agreements impose restrictions that result in less variation than individuals' productivity differentials would warrant.

4.3 Productivity and Wage Differentials by Year, 1992-2001

The figures below, which plot the coefficients for cross-sectional estimations of the above firm-level regressions with specifications identical to those described above, illustrate the dramatic changes that occurred over the 1992-2001 period.

<Figure 1a>

Age. Turning first to the marginal productivity differentials, we see a dramatic decline across all groups of older workers. In 1992, older workers were more productive than young workers, with workers 50 years and over 40.4% more productive than workers under 30. By 1994, the differences in productivity across age groups are no longer statistically significant; after 1999, workers who are older than 40 are significantly *less* productive than those under 30 – about 5 percent less productive, on average, in 2001 for both workers aged 40-49 and those 50 and over. The productivity profiles of workers aged 30-39 displays a similar fall in productivity in the first half of the period, with a slight

increase toward the end. One possible interpretation of this trend is a cohort effect, with workers who were in their twenties in the beginning of the period gradually falling under the second age group towards the end of the period.

Interestingly, out of all the cross-sectional estimates for the Slovenian data, the age-productivity profile in 1992 most closely resembles the weakly concave profile documented by other studies employing a similar methodology on data for non-transition economies, a finding which will be discussed in greater detail below. The age-productivity profiles at the onset of transition were thus similar to those observed in stable market economies, and the restructuring accompanying the transition to a market economy disrupted this relationship.

How did this fall in the productivity of older workers affect their relative wages? Turning to the wage differentials in Figure 1a, we see a significant decrease in the wage premium associated with older workers: for workers over 50, for example, the premium decreased from 80.5 percent in 1992 to 18.1 percent in 2001. Despite this dramatic fall, however, the relative wages for workers aged 30 or above remain above parity with respect to workers under 30 throughout the entire period. This empirical finding is particularly interesting in light of typical stipulations in collective bargaining agreements regarding the required increases in base wages related to work experience. While the exact particulars vary somewhat depending on specific sectoral agreements and over time, collective bargaining agreements generally specify a 0.5 percent wage increase for every year of work experience.[10] For a worker at the end of his or her career, this translates into a roughly 20 percent wage premium relative to a

[10] While the exact percent is permitted to vary depending on the agreement reached between the employers' and employees' unions, the fact that workers with more work experience must receive *some* increase in their base pay is prescribed by the Law on Labor Relations.

young worker, which closely corresponds to the wage premium of workers aged over 50 years.

<Figure 1b>

The disparity between the wages and productivity is clearly illustrated in Figure 1b, which graphs the ratio of relative productivity to relative wages from Figure 1a. The fact that the ratio generally was closer to parity in 1992 than in subsequent years indicates that older workers are increasingly being paid more than their marginal productivity differentials would warrant, and that wages are in fact *not* approaching their equilibrium wage relativities.

<Figure 2a>

Education. Similarly dramatic changes during the 1992-2001 period are evident in the relative productivity coefficients relating to education. Between 1992 and 2001, the most educated workers experienced a 60 percentage point increase in their productivity relative to workers with uncompleted elementary school (from 2.09 to 2.7); for 2-year college and high school graduates, the increases were 15 and 9 percent, respectively. The relative wage differentials also became more dispersed over the observation period; for workers with at least a high-school education, the relative wages increased. This increase was most dramatic for 4-year college graduates, whose relative wage differentials increased from 1.53 to 2.02.

<Figure 2b>

As shown in Figure 2b, the increases in wages were not large enough to significantly close the wage-productivity gap; for the most educated workers, the 49 percent point increase in wages over this period lagged behind their 60 percentage point increase in productivity. The implication of this result is that

the increased wage differentials observed in Slovenia during the 1992-2001 period can be justified in terms by the increased relative productivity of educated workers: that is, the effects of increases in the demand for educated workers were large enough to counteract the relative labor supply shifts. In fact, due at least partly to the sheer magnitude of the productivity increases, the ratio between marginal productivity and relative wages remained remarkably unchanged between 1992 and 2001.

<Figure 3>

Women. The relative wage and productivity differentials of women show relatively insignificant changes over the 1992-2001 period, both in terms of relative wages and productivity. The relative productivity differential fluctuates between 0.87 and 0.99, and for the majority of the period is not statistically significantly different from 1. The relative wage differential fluctuates even more closely around 1. The relatively insignificant changes in both differentials stand in stark contrast to the dramatic changes in the observed differentials by age and education. A possible interpretation is that regardless of the multiple economic factors that had considerable effects on the wage and productivity profiles according to age and education, the net effect of the various competing factors on the relative wage and productivity differentials of women was comparatively insignificant.

4.4 Sensitivity Checks for Productivity and Wage Differentials by Year, 1992-2001

In order to test the hypothesis that changes in relative wages and productivity across different age groups are attributable to a survivor bias that

favored certain subsets of workers, the results from this section are based on categorizing workers into four groups based on their employment history over the 1992-2001 period:

a.) separated - individuals employed in 1992, but not in 2001,

b.) newly hired - individuals employed in 2001, but not in 1992,

c.) employed throughout - individuals employed in 1992 and 2001, and

d.) employed in the interim - individuals employed in neither 1992 nor 2001. Workers in each of these groups are assumed to be qualitatively different inputs in the firm-level production functions with potentially different marginal products. Similarly, they are assumed to have potentially different relative wages in the firm-level wage equations. In each of the cases discussed below, the omitted group is comprised of individuals less than 30 years old who were employed neither in 1992 nor 2001.[11]

The results indicate that, with the exception of productivity differentials for the youngest workers, workers in the "employed throughout" category consistently witnessed both the highest productivity and wage differentials, workers with interim employment witnessed the lowest, while new hires and separations were consistently in between.[12] Also, the general trend of decreasing relative productivity and wages is consistent across all the older age groups.

<Figures 4, 5, 6>

[11] Note that throughout the analysis, individuals are grouped into age categories based on their age in each respective year. Thus, the analysis presented here does not track specific cohorts across time, and most individuals will fall into a different age category in 2001 then they did in 1992. In results not presented here we find that, with the exception of the group aged 18-29, tracking cohorts instead of age categories did not substantively change the conclusions.

[12] The results from the first age group, individuals under 30 years old, do not contain statistically significant results; this is largely due to the fact that how the groups are defined sharply limits the number of people in these groups (e.g. the "employed throughout" category contains only those who were employed at age 20 or younger and were also employed 10 years later).

Figures 4, 5, and 6 show the relative productivity and wage differentials across individuals aged 30-39, 40-49, and over 50, respectively, grouped based on their employment in 1992 and 2001. With the exception of a few point estimates, the most productive and highest paid workers are those who were employed throughout; conversely, the least productive and lowest paid workers tend to be the interim employed (employed in neither 1992 nor 2001). The graphs confirm that the dramatic fall in the productivity of workers over 29 years was not due to the exit of less productive workers from labor force, but was broad-based and reflected the general trend of falling productivity for older workers. The relative wages of older workers appear to have fallen dramatically as well, but they failed to drop towards equilibrium wage relativities.

4.5 Cross Country Comparisons

Previous empirical analyses using a comparable methodology have been done for several developed market economies (USA, Israel, Norway, France, Finland) and developing countries (Ghana, Mexico, Tanzania, Kenya, Zimbabwe). These results are helpful in understanding the productivity differentials associated with various demographic characteristics in countries without the burden of a socialist legacy. Furthermore, they illustrate the extent to which we could expect relative wages correspond to relative productivity in a long-run, competitive equilibrium and the relative importance of other factors, such as long-term incentive contracts or discrimination. The results of these studies are summarized in Table 5 (note that φ and λ respectively refer to the productivity and wage differentials of the specified group relative to the omitted group):

<Table 5>

Several stylized facts emerge from these findings. First, the marginal productivity of women is consistently lower than that of men, as the estimates for φ generally range from 0.75 to 0.9. The estimates for women's wage differentials appear to be slightly lower than their productivity differentials, although the difference tends to be statistically insignificant (and thus we cannot interpret the disparity as evidence of discrimination). Second, better educated workers are more productive, with the most educated (skilled) workers approximately twice as productive as the least educated (skilled). Their wage differentials also appear to be slightly lower than their productivity would warrant, indicating a certain degree of wage compression. Third, the relationship between productivity and job tenure or age can be interpreted as (weakly) concave, although the evidence for this is hardly conclusive. In general, the relative wage and productivity differentials appear to correspond fairly closely by age and education, and to a lesser extent by gender.

7. Conclusion

This paper examines the evolution of wage and productivity differentials using matched employer-employee panel data from Slovenia over the 1992-2001 period. The results offer insights into a question that other studies of wage determination in transition economies do not directly address – namely, how has the transition to a market economy affected the relative wages and productivity of older workers, educated workers, and women. We investigate several possible explanations for the observed trends, including changes in the value of labor market experience acquired during the previous regime and shifts in relative labor supply.

The results indicate that the transition to a market economy dramatically altered the relative productivity differentials associated with education and age, but not gender. The increases in productivity changes by education were dramatic, with the largest increases among the most educated. The marginal productivity of older workers fell considerably, with the largest decreases among the oldest groups of workers. We interpret this as evidence of a decrease in the marginal product of firm- or industry- specific human capital driven by increased job and worker flows and by a decreased relevance of experience obtained under socialism in a market economy. Relative labor supply shifts that could have reversed the observed trends – decreases in labor force participation rates among the oldest workers and increases in the share of educated workers – were insufficiently large to counteract these other factors.

Interestingly, the large changes in the marginal productivity differentials were accompanied by smaller changes in the relative wage differentials, thus yielding little convergence between relative wages and marginal productivity. How can this finding be explained, given that studies for developed market economies indicate that the ratio of the two generally falls within a few percentage points of parity, as we would expect in a stylized steady-*state* equilibrium? First, the sheer size of some of the changes in the marginal productivity differentials associated with education and age was tremendous, making it difficult for wages to adjust. For example, for workers with at least a 4-year college degree, marginal productivity differentials grew at an annualized rate of 4.3 percent over the 1992-2001 period. Second, collective bargaining agreements appear to exert a considerable influence on wages, thus preventing necessary adjustments from taking place. The effects seem particularly visible in

the wages of older workers, who are guaranteed pay increases in line with the number of years they have paid social security contributions, and who in 2001 continued to command a wage premium over workers under 30 despite their lower marginal productivity. Interestingly, the 18 percent wage differential for workers aged 50 and over coincides with the mandated experience related premium in the private sector for a worker with 36 years of work experience.[13]

The most salient policy recommendation that emerges from these findings is that regulations that increase labor costs in lockstep with work experience need to be reformed. Previous studies have shown that in Slovenia, older workers have a lower probability of exit from unemployment (for a recent study, see Van Ours and Vodopivec, 2006) even after taking into account their generally longer potential unemployment benefit durations. More generally, a cross-country analysis by the OECD (2006) shows that seniority wages have a statistically significant negative impact on both older workers' employment rates and their five-year retention rates. The results of this study point to a simple underlying explanation for why older workers have more difficulty finding employment in Slovenia: their marginal productivity is lower. In fact, in addition to mandated pay raises for work experience, older workers are more relatively expensive to employ for several other reasons. A common stipulation in collective bargaining agreements is that workers are entitled to an additional day of vacation for every 5 years of labor market experience, an additional 5 days of vacation once they are 50 years of age, progressively higher bonuses for every ten years of labor market experience (the so-called "jubilee rewards"), and an

[13] The general collective bargaining agreement for the private sector stipulates a 0.5% increase in base wages for every year of work experience, although this requirement may not *de facto* be binding for firms who pay wages high enough to command a significant wage cushion.

additional three months of wages upon their retirement. All of these serve to increase the effective relative labor costs of older workers. A recent development indicates that some steps have been taken in the right direction: for public sector workers, the premium associated with labor market experience was decreased in 2007 from 0.5 percent per year of work experience to 0.33 percent. As Slovenia continues to increase the retirement age in response to its growing pension burden and aging population, however, more radical changes will be needed to ensure that employers are willing to hire older workers.[14]

The results have several other important policy implications. Second, although education continues to be undervalued to a similar proportion as it was during socialism, the surge in undergraduate education enrollment suggests this has not necessarily led to allocative inefficiencies from an undersupply of skilled labor. Indeed, the generous benefits afforded to Slovenian students may compensate for their lower future wages.

Compared to other transition economies, Slovenia had among the most liberal price, wage and foreign-trade regimes at the onset of transition, and it also exhibited the smallest degree of liberalization during the course of transition (World Bank, 2002). We know that wage liberalization brought about dramatic changes in other transition economies, and the results of this study clearly illustrate the complex nature of the relationship between wages and productivity. For countries that adopted a faster pace of reform and operated under a more regulated system under socialism, the changes of relative productivity differentials may have been even more dramatic.

[14] After a 1999 pension reform, employment rates of older persons increased significantly over the past decade (Koske, 2009): for example, between 1997 and 2008, the employment rate for persons aged 55-59 increased by 17 percentage points, to 45 percent. However, despite this increase, the employment rate is for this age group is still the third-lowest in the OECD. Moreover, the effective retirement age in Slovenia lags behind the OECD average by about three years for men and 5 years for women.

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Table 1: Selected real macroeconomic indicators for Slovenia, 1991-2008 (1991=100)

Year	GDP (1)	Employment (2)	Labor productivity (3) = (1)/(2)	Average gross wage (4)	Unit wage costs (5) = (4)/(3)
1990	100.0	100.0	100.0	100.0	100.0
1991	91.1	94.9	96.0	77.0	80.2
1992	86.1	91.0	94.6	76.0	80.3
1993	88.5	89.4	99.1	84.5	85.3
1994	93.3	89.0	104.8	87.6	83.6
1995	97.1	89.9	108.0	91.5	84.7
1996	100.6	88.1	114.1	95.9	84.0
1997	105.5	86.5	122.0	98.9	81.1
1998	109.3	86.3	126.6	101.1	79.8
1999	115.1	87.5	131.6	104.9	79.7
2000	120.2	88.6	135.6	107.6	79.3
2001	123.6	89.0	138.8	111.9	80.6
2002	128.5	88.7	144.8	114.9	79.3
2003	132.2	88.4	149.5	116.8	78.1
2004	137.8	88.7	155.4	118.0	75.9
2005	144.0	88.5	162.7	120.9	74.3
2006	152.4	89.8	169.6	123.6	72.9
2007	162.7	92.5	175.9	126.0	71.6
2008	168.4	95.1	177.1	129.5	73.1

Source: Statistical Yearbook of Slovenia, various issues.

Table 2: Summary Statistics for Firm-Level Variables

Summary Statistics for Continuous Variables	Mean	St. Deviation
Basic Production Function Variables		
Value-Added	87,932	530,581
Workers	36	192
Capital	178,083	1,995,958
Employment Shares		
Gender		
Women	0.389	0.370
Education		
Unfinished elementary school	0.028	0.091
Completed elementary school	0.117	0.223
Vocational school	0.279	0.333
High school	0.372	0.363
2-year college	0.094	0.228
4-year college	0.109	0.255
Age		
Age under 30	0.293	0.332
Age 30-39	0.335	0.340
Age 40-49	0.279	0.330
Age 50+	0.093	0.213

Table 2: Summary Statistics for Firm-Level Variables
(cont.)

Summary Statistics for Dummy Variables	Count	Percent of Total
Industry		
Manufacturing	23,834	22.39
Utilities	725	0.68
Construction	7,501	7.05
Trade	39,112	36.74
Tourism	3,304	3.1
Transport	6,778	6.37
FIRE	1,654	1.55
Other services	23,547	22.12
Number of Workers Employed		
under 20	87,342	82.05
20-49	6,962	6.54
50-99	4,303	4.04
100-499	6,581	6.18
500+	1,267	1.19
Year		
1992	4,859	4.56
1993	7,034	6.61
1994	8,376	7.87
1995	11,293	10.61
1996	12,367	11.62
1997	13,404	12.59
1998	13,839	13
1999	14,106	13.25
2000	12,255	11.51
2001	8,922	8.38

Table 3: Worker-level Wage Regressions, 1992-2001

Dependent variable is Log(Wages)	Standard Wage Regression (1)	Firm Fixed Effects (2)
Age		
30-39 years old	0.148	0.147
	(0.001)	(0.001)
40-49 years old	0.260	0.249
	(0.001)	(0.001)
50+	0.319	0.304
	(0.002)	(0.001)
Education		
Completed elementary school	0.088	0.075
	(0.001)	(0.001)
Vocational school	0.203	0.185
	(0.001)	(0.001)
High school	0.449	0.411
	(0.002)	(0.001)
2-year college	0.839	0.809
	(0.003)	(0.002)
4-year college	1.123	1.059
	(0.004)	(0.002)
Gender		
Women	-0.210	-0.143
	(0.001)	(0.001)
R^2	0.473	...
N	654,630	654,630

Notes: Robust standard errors of the estimates are reported in parentheses. Estimates of the intercept are not reported. The base category comprises of men less than 30 years old with unfinished elementary education. Other control variables included in specification (1) are controls for ownership type, rural location, firm size, and industry and year dummies. Specification (2) excludes the time-invariant control variables.

Table 4: Firm-level Production Function and Wage Equations Estimates, using complete data from 1992-2001

	Production Function (1)	Wage Equation (2)	Wald P-value (3)
log(Labor)	1.229		
	(0.001)		
log(Capital)	0.031		
	(0.007)		
log(Labor^2)	0.014		
	(0.002)		
log(Capital^2)	0.017		
	(0.001)		
log(Capital·Labor)	-0.05		
	(0.002)		
Age			
30-39 years old	0.998	1.071	0.000
	(0.009)	(0.007)	
40-49 years old	0.986	1.152	0.000
	(0.009)	(0.008)	
50+	0.992	1.302	0.000
	(0.013)	(0.013)	
Education			
Completed elementary school	1.078	1.049	0.357
	(0.037)	(0.026)	
Vocational school	1.210	1.203	0.837
	(0.042)	(0.028)	
High school	1.636	1.392	0.000
	(0.053)	(0.032)	
2-year college	1.957	1.593	0.000
	(0.066)	(0.038)	
4-year college	2.269	1.750	0.000
	(0.075)	(0.041)	
Gender			
Women	0.935	1.015	0.000
	(0.007)	(0.005)	
R^2	0.8270	0.864	
N	106,455	106,455	

Notes: The results are estimated using non-linear least squares. Standard errors of the estimates are reported in parentheses. The third column presents p-values for the Wald test for the equality of the corresponding coefficients in that row. Estimates of the intercept are not reported. The base category comprises of men less than 30 years old with unfinished elementary education. Other control variables included in both equations are controls for ownership type, rural location, and industry and year dummies.

Table 5: Empirical evidence from firm-level estimates of productivity (φ) and wage (λ) differentials

	Country	Coefficients on Female dummies	Coefficients on Education/Skill dummies	Coefficients on other dummies	N
Hellerstein, Neumark and Troske (1999)	USA	$\varphi = 0.84, \lambda = 0.55$	…	Aged 35-54: $\varphi = 1.15,\ \lambda = 1.19$ Aged 50+: $\varphi = 1.19,\ \lambda = 1.18$ (Base group: under 35 years of age)	3,102
Hellerstein and Neumark (1999)	Israel	$\varphi = 0.8, \lambda = 0.75$	Technical engineers: $\varphi = 2.0,\ \lambda = 1.7$ Engineers: $\varphi = 4.0,\ \lambda = 2.25$ (Base group: unskilled workers)	…	998
Haegeland and Klette (1999)	Norway	$\varphi = 0.83,\ \lambda = 0.82$	Low Education: $\varphi = 1.10, \lambda = 1.20$ Medium Education: $\varphi = 1.55,\ \lambda = 1.50$ High Education: $\varphi = 1.80,\ \lambda = 1.82$ (Base group: less than 11 years of education)	8-15 years of experience: $\varphi = 1.62,\ \lambda = 1.39$ 15 + years of experience: $\varphi = 1.33,\ \lambda = 1.38$ (Base group: less than 8 years of experience)	7,122
Jones (2001)	Ghana	$\varphi = 0.45, \lambda = 0.86$	Primary schooling: $\varphi = 1.08,\ \lambda = 1.3$ Secondary schooling: $\varphi = 1.54, \lambda = 1.56$ Tertiary schooling: $\varphi = 1.79,\ \lambda = 1.56$ (Base group: no primary school)	…	278 for φ's, 1211 for λ's
Crepon, Deniau, and Perez-Duarte (2002)	France	$\varphi = .89, \lambda = 0.86$	Skilled: $\varphi = 1.20,\ \lambda = 1.17$ Highly skilled: $\varphi = 1.88,\ \lambda = 1.73$ (Base group: unskilled workers)	Aged 25-35: $\varphi = 1.22,\ \lambda = 1.23$ Aged 35-50: $\varphi = 1.10,\ \lambda = 1.27$ Aged 50+: $\varphi = 1.11,\ \lambda = 1.41$ (Base group: less than 25 years old)	23,292
Illmakunnas, Maliranta and Vainiomaki (2004)	Finland	…	…	2-5 years tenure: $\varphi = 1.04,\ \lambda = 1.03$ 5-10 years tenure: $\varphi = 1.0,\ \lambda = 1.05$ 11-20 years tenure: $\varphi = .95,\ \lambda = 1.07$ (Base group: 1-2 years tenure)	28,737

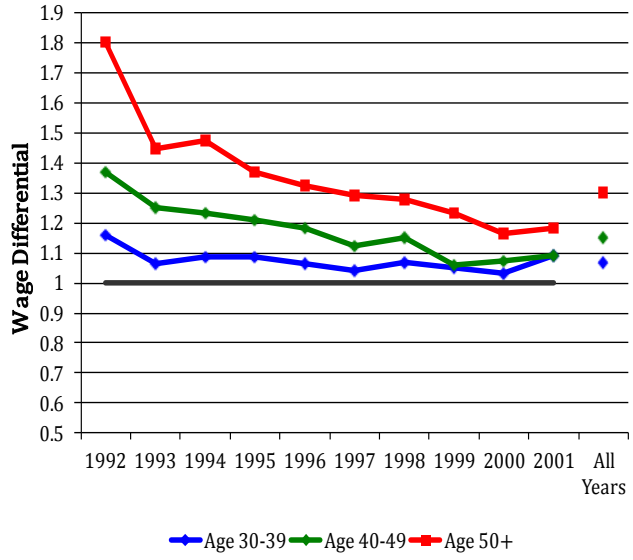
(see notes on next page)

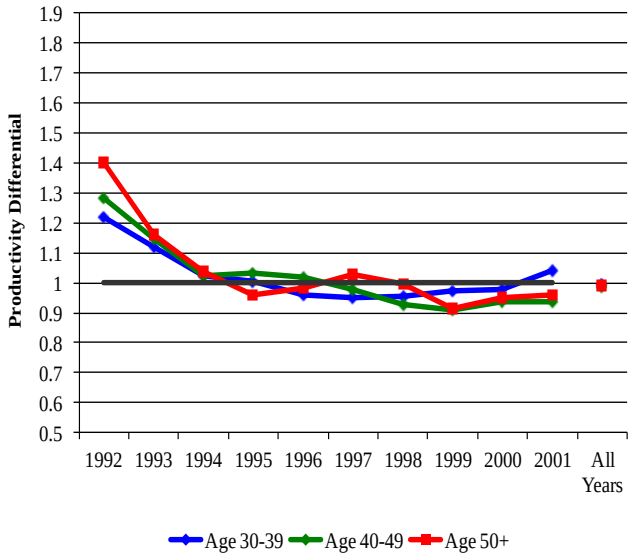
Table 5: Empirical evidence from firm-level estimates of productivity (φ) and wage (λ) differentials (continued)

	Country	Coefficients on Female dummies	Coefficients on Education/Skill dummies	Coefficients on other dummies	N
Lopez-Acevedo, Tinajero and Rubio (2005)	Mexico	$\varphi = 0.49, \lambda = 0.66$	Upper secondary: $\varphi = 1.84$ $\lambda = 1.44$ University or more: $\varphi = 3.82$ $\lambda = 2.37$ (Base group: lower secondary or less)	3-10 years tenure: $\varphi = 1.12$ $\lambda = 1.19$ 10 years+ tenure: $\varphi = 0.76$ $\lambda = 0.97$	6,866
Van Biesebroeck (2007)	Tanzania	…	High level of schooling: $\varphi = 1.84$ $\lambda = 1.19$	Above average experience: $\varphi = 0.59$, $\lambda = 1.30$ Above average tenure: $\varphi = 0.76$, $\lambda = 0.97$	316
Van Biesebroeck (2007)	Kenya	…	High level of schooling: $\varphi = 1.19$ $\lambda = 1.96$	Above average experience: $\varphi = 0.81$, $\lambda = 1.36$ Above average tenure: $\varphi = 1.52$, $\lambda = 1.31$	375
Van Biesebroeck (2007)	Zimbabwe	…	High level of schooling: $\varphi = 3.33$ $\lambda = 3.13$	Above average experience: $\varphi = 1.42$, $\lambda = 1.27$ Above average tenure: $\varphi = 2.03$, $\lambda = 1.78$	213

Notes: Figures from Illmakunnas, Maliranta and Vainiomaki (2004), Crepon, Deniau, and Perez-Duarte (2002) and Van Biesebroeck (2007) refer to imputed values based on author's calculations. The coefficients should be interpreted based on whether they are different from 1. For example, estimates of $\varphi = 1.25$ and $\lambda = 1.35$ for women would indicate that the MP_L of women is 25 percent greater than that of men, while their wages are 35 percent greater.

Figure 1a: Differences in Relative Wages and Marginal Productivity by Age, 1992-2001





Omitted group: Individuals less than 30 years old.

Figure 1b: Ratio of Relative Productivity Differential to Relative Wage Differential by Age, 1992-2001

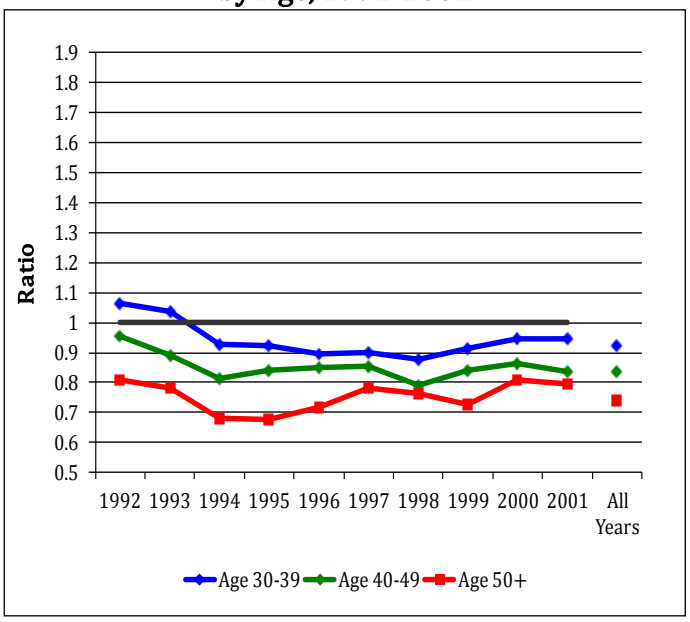
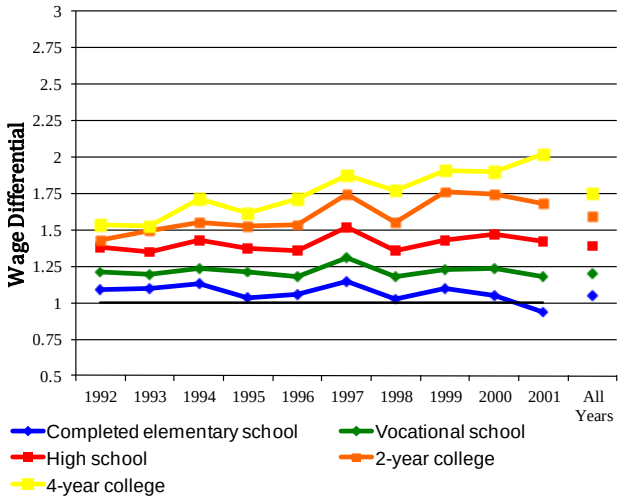
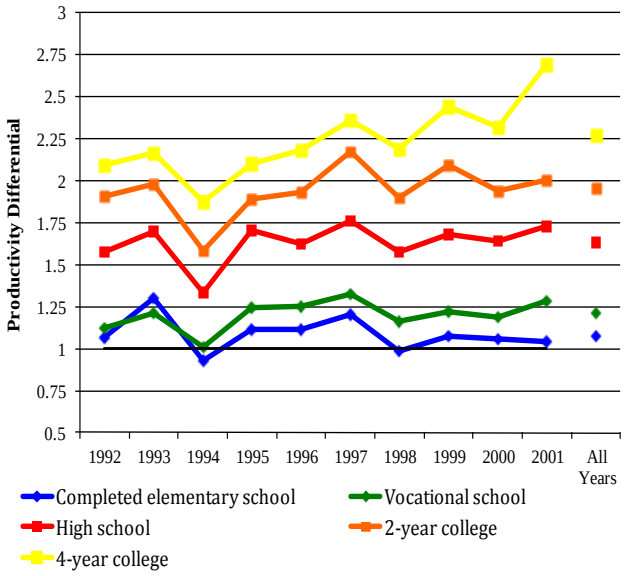


Figure 2a: Differences in Relative Wages and Marginal Productivity by Education, 1992-2001





Omitted group: Individuals with uncompleted elementary school.

Figure 2b: Ratio of Relative Productivity Differential to Relative Wage Differential by Education, 1992-2001

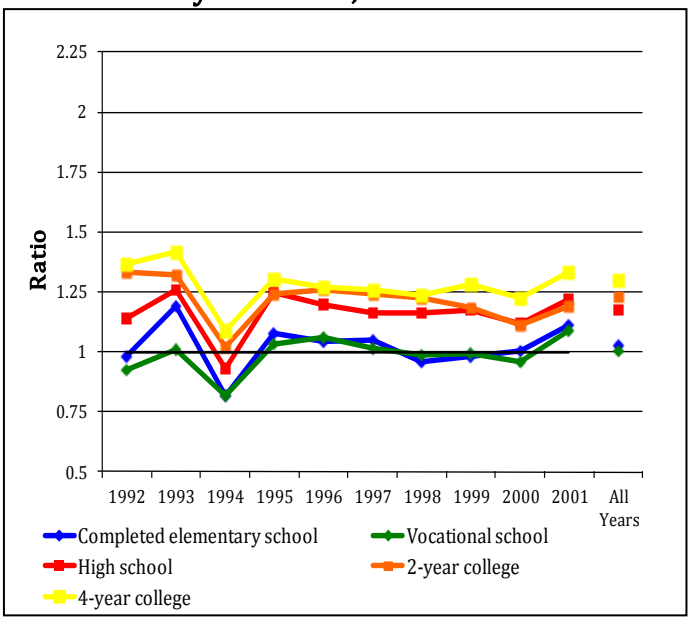
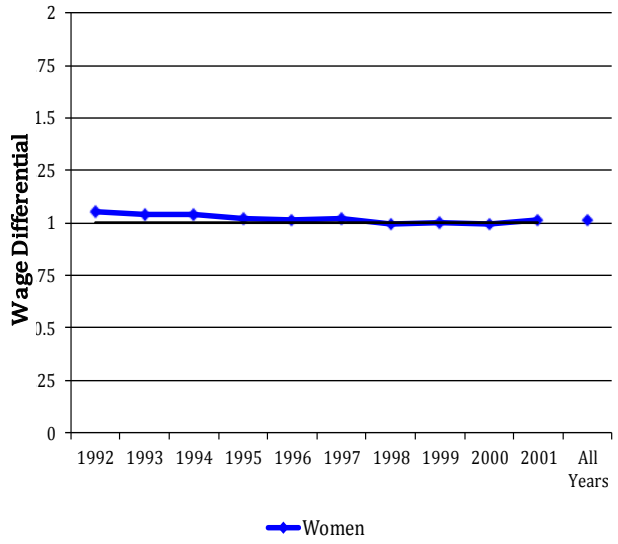
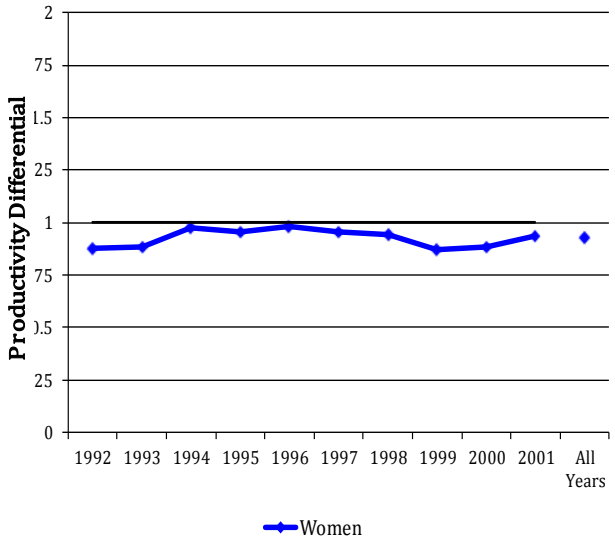


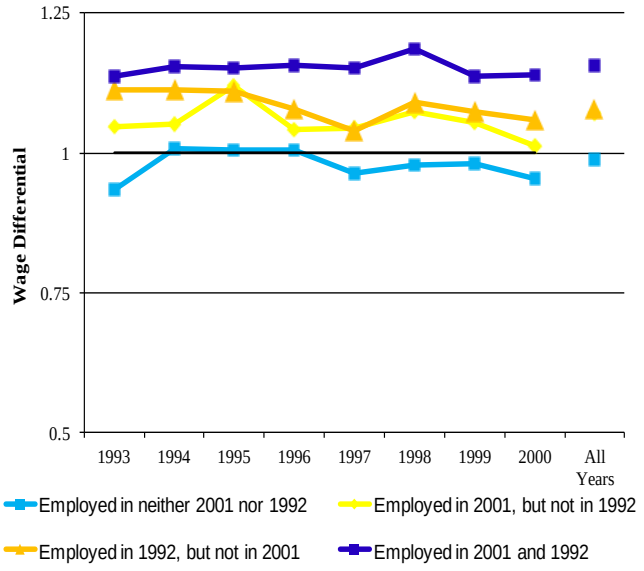
Figure 3: Differences in Relative Productivity and Wages by Gender, 1992-2001

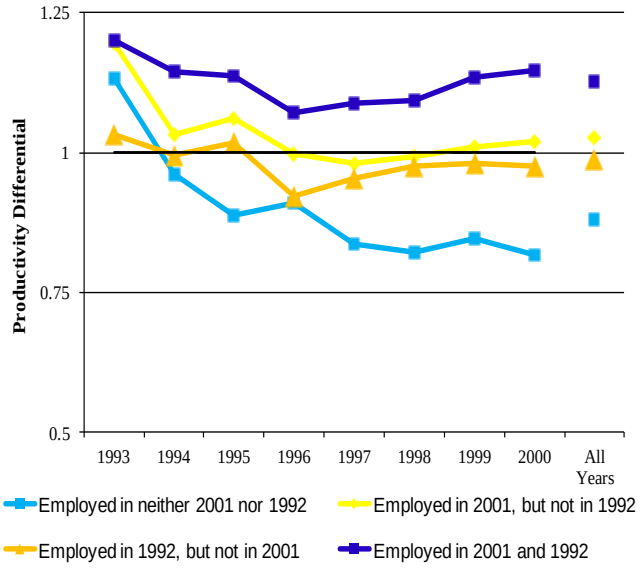




Omitted group: Men.

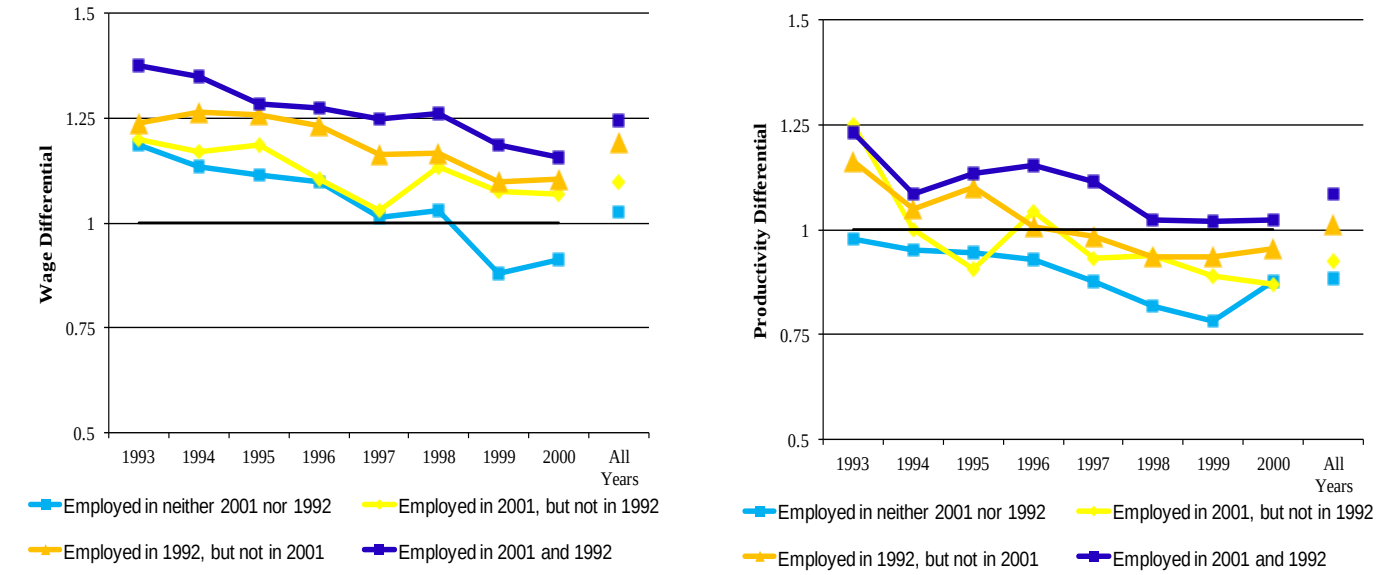
Figure 4: Differences in Relative Productivity and Wages across Individuals with Different Work Histories Individuals Aged 30-39





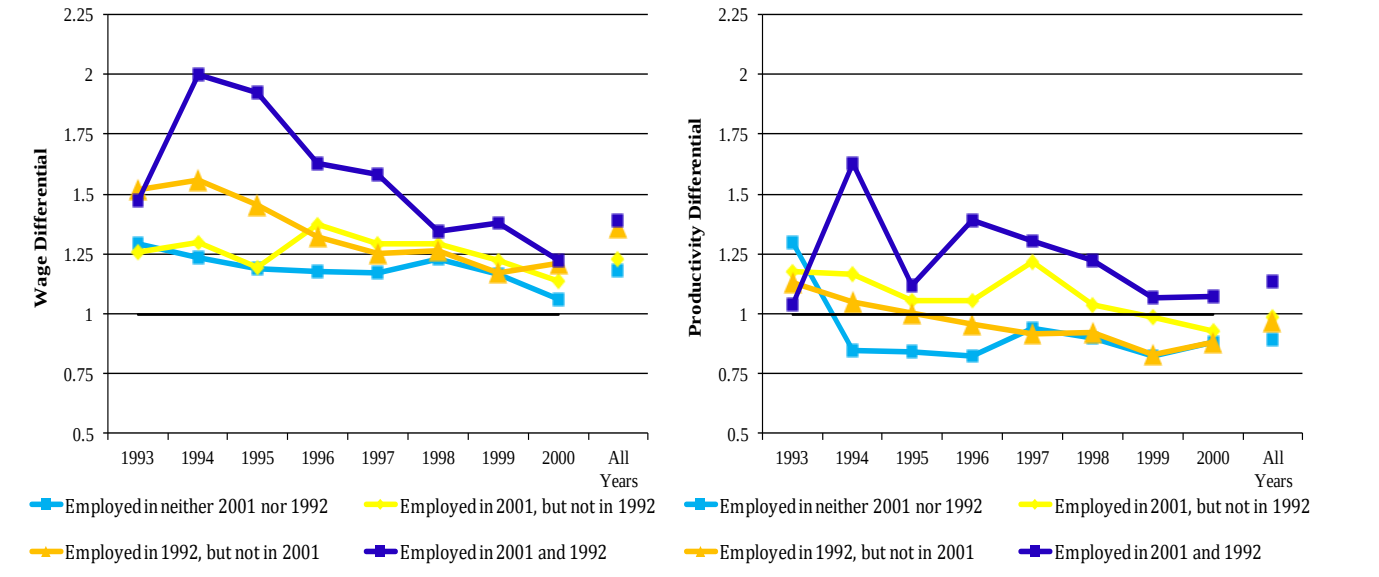
Base group: Individuals aged 18-29.

Figure 5: Differences in Relative Productivity and Wages across Individuals with Different Work Histories Individuals Aged 40-49



Base group: Individuals aged 18-29.

Figure 6: Differences in Relative Productivity and Wages across Individuals with Different Work Histories Individuals Aged 50+



Base group: Individuals aged 18-29.