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Wage and Productivity Differentials across Privatized, State-Owned and De Novo Firms: Matched Employer-Employee Evidence from Slovenia

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Honors Thesis

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Abstract

How has the transition to a market economy affected the relationship between wages and productivity across different types of workers and firms? This paper examines this question using unusually rich matched employer-employee data from Slovenia over the 1992-2001 period. The findings include strong evidence that 1.) state-owned firms overpaid their employees at the onset of transition, a finding consistent with theoretical predictions on self-managed firms, 2.) older workers have become relatively less productive, indicating a difficulty in acquiring the skills demanded in a market economy, 3.) the relative wages of workers across demographic characteristics such as gender, age and education generally reflect their relative marginal productivity differentials.

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Preface and Acknowledgements

This honors thesis is the end product of a collective effort involving a number of people whose contributions have proven invaluable. I would first like to thank my advisor, Prof. Gary Krueger, for his support and guidance throughout this project, and his insightful and prompt feedback. He has been a wonderful mentor as well as a great teacher –his courses in econometrics and transition economics were what got me excited about the subject of this paper to begin with. I would also like to offer my gratitude to my second reader, Prof. Pete Ferderer, who has done an incredible task of not only guiding me through the process of writing the honors thesis, but who has also done a truly phenomenal job in his capacity as my academic advisor. My acknowledgements also extend to Prof. Peter Orazem from Iowa State University, as well as other participants at the Midwest Economics Association Conference, for their constructive suggestions. In addition, special thanks also go to Duoduo Cai, Andrew Goodman-Bacon, and Linh To for help with various aspects of this thesis. Lastly, I would also I would also like to thank my father, Milan Vodopivec, for providing me with the inspirational support, helpful comments and suggestions, as well as this rather ideal dataset without which I would have rather little to discuss! I am truly indebted to all of these people. The responsibility for any remaining errors remains solely my own.

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This paper is divided into three chapters. The first chapter discusses the theory and previous empirical research on privatization and workers' self-management, while the second chapter discusses the same aspects of the wage determination literature. These two chapters set the basis and motivation for the final chapter, in which I present my results. Note that the scope of the paper is rather broad by necessity: in order to obtain unbiased estimates of relative wage and productivity differentials across different types of firms (i.e. state-owned, privatized, newly created, foreign owned), we need to account for differences in worker quality across these different types of firms, which involves calculating the relative wage and productivity differentials for different types of workers in the process. Conversely, in order to obtain unbiased estimates of relative wage and productivity differentials across workers with differing demographic characteristics, w need to account for differences in firm ownership. The result is the proceeding analysis of wage and productivity differentials across different types of workers *and* firms.

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Chapter I: Effects of Transition on Productivity and Wage Differentials across Different Types of Firms

1.) Introduction

A defining part of the transition from a socialist to a market economy has been the process of factor and product market liberalization (Krueger, 2004). During this process, government intervention in what had previously been highly regulated spheres of economic activity has been greatly curtailed, and market based allocation mechanisms have increasingly been given free reign to govern economic activity. In the process, governments have privatized previously state-owned firms, eliminated soft-budget constraints, liberalized capital flows from abroad, abolished guaranteed job security, and deregulated the wage determination process. The fundamental underlying belief behind these reforms has been that market-based incentives will ultimately lead to long-term economic growth and will correct the severe distortions inflicted by socialist planners.

A decade and a half after the onset of transition, it is clear that most countries have overcome the initial difficulties inherent in the transition process. However, many fundamental questions about the effects of market liberalization remain unresolved. For example, how has privatization – a key ingredient in transition reforms – affected the wages of workers working in different types of firms (e.g. private, *de novo*, foreign-owned)? Are workers in state-owned firms, which presumably have less efficient corporate governance structures and managerial oversight, able to inflate their wages above what their marginal revenue product would warrant? Have the different wage policies across these different types of firms affected the composition of their workforces? If so, how does the total factor productivity of different types of firms differ after we account for differences in labor quality

across dimensions such as education, experience, and age? In other words, to what extent has the transition process succeeded in reforming the previously dysfunctional incentive regimes?

In this paper, I explore these questions empirically for a particular transition economy: Slovenia. Using matched employer-employee data spanning the first ten years of the transition period, I examine several aspects of the dynamic wage determination process. I directly test a longstanding hypothesis regarding the behavior of workers in (formerly) self-managed firms which was first formulated by Ward (1958) – namely, that workers in self-managed firms appropriate a portion of the firms profit through wages that are higher, *ceteris paribus,* than they would be in a profit-maximizing capitalist firm. I find strong support for this hypothesis, as workers in state-owned firms early in transition are paid markedly higher wages than workers in privately-owned firms even though they are considerably less productive. I also find that as transition has progressed, competitive pressures have forced the wage policies of state-owned firms to converge with those of private firms, as the wage-productivity gap decreases significantly between 1992 and 2001. Moreover, the performance of privately-owned firms has consistently proven superior to state-owned ones: estimates of labor-quality augmented production functions indicate that privatized, foreign-owned and newly created firms are 14, 24, and 7 percent more productive than state-owned ones, respectively.

The structure of the chapter is as follows. In Section 2, I describe the theoretical background which motivates the empirical analysis and outline the previous empirical research on the subject. Section 3 discusses the country-specific considerations of the study, focusing first on the theory and empirical evidence on workers' self-management and then describing the institutional background in Slovenia since the collapse of socialism. (Note

that the discussion of the methodology, actual data used and empirical results is relegated to Chapter 3.)

2.) Theoretical background

Privatization, when accompanied by the appropriate institutional reforms, is a critical aspect of the transition process because it addresses a fundamental source of inefficiency in socialist economies: the state's inability to institute the proper incentives for the economy's managers and workers. By assigning ownership rights to specific groups of people, privatization is seen as a way of addressing the dysfunctional incentive regimes that lead to the principal-agent problem, as the new owners are in a superior position to carry out the planning, monitoring, and disciplinary functions the principal ought to perform. Because the new owners/shareholders have a profit-maximizing motive, the firm's decisions will presumably be guided by efficiency considerations, and not political ones. The productivity gains arising from improved governance can be categorized along three lines (Filer *et* al, 2001): 1.) reductions in slack (moving closer to the production possibilities frontier), 2.) improved allocative efficiency (reallocating productive resources along the production possibility frontier to more efficient uses), or 3.) greater organizational efficiency (inducing outward shifts of the production function through better management or the adoption of new production methods).

Privatization can only be successful, however, when accompanied by institutional reforms which promote efficient, competitive markets. One crucial goal in the reform process must be to eliminate the soft-budget constraint that had allowed unprofitable firms to survive under socialism through mechanisms such as distorted factor and product prices

or transfer payments from the government.[1] Since the soft-budget constraint allowed unprofitable and unviable firms to remain solvent indefinitely, bankruptcies were virtually nonexistent under socialism, and bankruptcy laws were commensurately ill-defined (World Bank, 2004). Thus, transition reforms must also introduce laws which enable bankruptcy to occur and, conversely, lower barriers to entry to facilitate the creation of new firms. Facilitating firm exit is important because it enables unviable firms to exit and free up scarce resources – land, labor, capital – for other firms. Stimulating firm entry is important because newly created (*de novo)* firms presumably enter the market with a more efficient mix of capital and labor, newer production technologies, and a more resourceful management.[2] Functional factor markets are a crucial link in this process, as they provide nascent firms with the necessary resources to facilitate their growth. This study can be viewed as an empirical test of the overall efficiency of these factor markets, as the relationship between wages and productivity provide a unique metric for gauging the degree to which these markets are reallocating resources in an efficient manner.

We should note that entry and exit plays an important role even in developed market economies – according to a 2002 OECD study, the net contribution to aggregate productivity growth from the entry and exit of firms typically accounts for between 20 and 40 percent of total productivity growth in these economies (Scarpetta *et al*, 2002). We may expect these effects to be especially important in transition economies: since entering firms are typically smaller in size than incumbents (Richter and Schaffer, 1996), they can correct the size imbalance of existing firms and shift economic activity from sectors which had been

[1] For example, during the 1980's, the Yugoslav government granted massive soft-budget subsidies in the form of negative real interest rate loans (Kraft and Vodopivec, 1992).
[2] *De novo* firms are also presumably less likely to engage in dysfunctional behavior such as asset stripping or tunneling resources for personal gain (World Bank, 2002, p. 27).

favored by central planners, such as heavy industry, to more viable and previously neglected ones, such as the service industry.[3]

3.) Evidence on the effects of privatization

Research on transition economies in Central and Eastern Europe (CEE) has generally confirmed the expected productivity effects associated with privatization (Djankov and Murrell, 2002).[4] Studies have found the positive effects of privatization across a wide range of countries, including the Czech Republic (Zemplinerova *et al*, 1995; Claessens and Djankov, 1998), Hungary (Campbell, 2002), Estonia (Jones and Mygind, 2001), Romania (Earle and Telgedy, 2001), Slovenia (Smith *et al,* 1997; Konings and Xavier, 2003, Orazem and Vodopivec, 2003), and various cross country comparisons (Claessens *et al.*, 1997; Frydman *et al*, 1998; Carlin *et al*, 2001). For example, in their survey of seven CEE countries, Claessens *et al* (1997) find that total factor productivity growth following privatization increases by about 5 percent per year. Earle and Telgedy (2001) find that privatized firms in Romania had an average growth rate that was 16% higher than state-owned ones, and Jones and Mygind (2001) find this figure to be on the order of 18% in their study of Estonian firms.

Empirical results from studies of *de novo* firms offer inconclusive results on the productivity effects of these firms. In their survey of firms in 25 transition countries, Carlin et al (2001) find that average firm productivity growth was negative in *de novo* firms while it

[3] For example, comparing the sectoral distribution of employment across countries shows that Slovenia, like other Eastern European countries, placed excessive emphasis on industry: the fraction of the labor force employed in manufacturing and mining in 1981 was 42.6 percent in Slovenia, compared to 43.5 percent in Hungary, 43.2 percent in Poland, and 30.7 percent in Western Europe ("Yearbook of Labor Statistics," ILO Geneva 1981, in Mencinger, 1989).

[4] Djankov and Murrell (2002), in their extensive survey of the literature on the topic, also find that the "privatization effect is statistically insignificant in the Commonwealth of Independent States… these results are robust" (p. 4).

was positive in SOE's and privatized firms. However, they find clear size effects, with positive productivity growth recorded for *de novo* firms in the largest size class.[5] In their study of Russian manufacturing firms, Richter and Schaffer (1996) find stronger evidence of positive performance among *de novo* firms. They find that while real output declined by 19 percent among privatized firms in the 1993/94 period, it grew by 4 percent *de novo* firms, a result that was robust regardless of size. This result is confirmed by Berkowitz and DeJong (2001), who find a strong positive relationship between regional entrepreneurial activity and regional economic growth in Russia.[6]

One significant bias inherent in the many of the above studies stems from the endogeneity of the decision to privatize a firm. Particularly in countries which adopted a gradualist privatization strategy, the likelihood that a firm would be privatized was not independent of its general viability: viable firms were more likely to be privatized, which means that studies which do not account for this endogeneity will tend to overestimate the effects of privatization. This is certainly a concern for Slovenia, where the decision to privatize a firm was strongly influenced by its employees and management (who could purchase its shares at a 50% discount); employees in firms with poor prospects would be unlikely to support privatization in an attempt to preserve the firm's soft budget constraint (World Bank, 1999).

Another significant problem with studies on the productivity of firms in transition economies is that none have, to the author's knowledge, included detailed measures of labor quality in their production function. That is, in estimating firm level production functions and examining how efficiently firms produce output given their labor and capital inputs, they

[5] They mention that this may be the result of endogeneity: "Larger firms may be larger at the time of survey because they grew faster" (p. 11).
[6] They use the regional registry of small private enterprises per thousand inhabitants as a proxy for the presence of *de novo* firms, a rather imperfect measure.

have failed to account for the multiple qualitative dimensions along which workers may differ – for example, by education, experience, and seniority.[7] As Griliches (1970) contends, this may introduce potentially serious bias in the estimated coefficients. It is particularly problematic in the context of transition economies, where firms of different ownership types (privatized, state-owned) and vintage (newly created vs. state-owned or formerly state-owned) are likely to employ workers with differing demographic characteristics. Studies which fail to account for worker quality are likely to overstate the productivity of privately owned firms relative to state-owned ones, since the higher prevailing wages in the private sector are likely to induce more qualified workers to exit the public sector.

4.) Workers' self-management

In this section, I discuss the ways in which the Slovenian transition experience may be influenced by factors specific to its institutional environment under the socialist regime and the particular decentralized style of socialist planning that the government adopted after abolishing central planning in 1965. The legacy of workers' self-management may imply specific labor market outcomes in which workers' wages are inflated relative to their productivity. This section first examines the theoretical considerations, and then turns to the previous empirical research. Finally, I also briefly discuss the Slovenian transition experience to date, focusing especially on how we might expect it to impact the wage determination process.

[7] Alternatively, one could argue that such studies do allow for worker heterogeneity within individual firms, but assume that the proportions of these workers along various qualitative dimensions – for example, gender, education and seniority -- are equal across all firms, thus effectively rendering the labor quality terms irrelevant. Such an assumption is arguably similarly unrealistic.

4.1) Theory of workers' self-management

Workers' self-management, the particular form of socialism Slovenia adopted as a constituent republic of Yugoslavia, deserves particular attention in the context of a discussion on firm productivity in Slovenia. Given the nature of the wage determination process in Slovenia, with the strong role of unions and long-term bargaining agreements, we might expect the salient features of self-managed firms to persist into early transition, thus contributing to their inefficiency and posing a barrier to restructuring. And, as I outline below, we might expect that a self-managed firm would tend to operate at a lower level of employment, output and investment than the profit-maximizing capitalist firm.

In the purest form of workers' self-management, initially adopted in Yugoslavia in the 1950's and 1960's, the self-managed firm vested virtually complete control in its workers.[8] Thus these workers, "in a one-man-one-vote basis, were the ultimate repository of economic decision making" (Granick, 1975, p. 336). Workers elected the members of the workers' council, which played the role of a capitalist firm's board of directors – they designated the general director and the management board (which was charged with managing the firm's daily operations). The firm operated as an individual cooperative – net receipts, after deducting expenses other than wages, were divided between net investments and a wage fund distributed to the membership. Thus, firms could choose to invest heavily at the expense of the current wage fund, hoping that they would increase future productivity – and thus the workers' wages – through current sacrifices, or they could decide to disburse

[8] After 1972, state intervention in the firms' operations increased, and restrictions were imposed upon firms' ability to disburse profits through workers' wages (Granick, 1975, and World Bank, 2004). Moreover, because bankruptcy was socially-undesirable and essentially non-existent (World Bank, 2004), firms operated under a soft-budget constraint (Kornai, 1980). In-effect, the profits of efficient firms were thus used to subsidize the losses of inefficient ones (Kraft and Vodopivec, 1992).

their entire profits to workers in the form of higher wages, allocating nothing to investment (Granick, 1975).

Despite their great social appeal and democratic, egalitarian nature, worker managed firms may tend to have a propensity for allocative inefficiency and perverse economic behavior. As first outlined by Ward (1958), we may expect the self-managed firm to pursue a set of incentives particular to its specific situation – instead of maximizing total profit, as a capitalist firm will in the long-run, a self-managed firm may attempt to maximize its profit per worker. Assuming the self-managed firm has N types of labor which are perfectly substitutable inputs with potentially differing marginal products, we can formally express the objective function workers will attempt to maximize as

$$\frac{\Pi}{L} = \frac{P\,Q(L_1, L_2, L_3, \ldots L_N, K) - rK}{L}$$

Taking the derivative with respect to L_i yields

$$\frac{\partial \frac{\Pi}{L}}{\partial L_i} = \frac{P}{L}\frac{\partial Q}{\partial L_i} - \frac{rK - PQ}{L^2}$$

First order conditions require that

$$P\frac{\partial Q}{\partial L_i} = \frac{PQ - rK}{L}$$

or equivalently, that

$$VMP_{L_i} = \frac{\Pi}{L}$$

This outcome differs markedly from the outcome one expects from the capitalist firm. Consider again the standard profit function with N labor types

$$\Pi = P\ Q(L_1, L_2, L_3, \ldots L_N, K) - \sum_{i=1}^{N} w_i L_i - rK$$

Denoting the total wage bill as WB, we have

$$\Pi = P\ Q(L_1, L_2, L_3, \ldots L_N, K) - WB - rK$$

Profit maximization requires that

$$\frac{\partial \Pi}{\partial L_i} = P \frac{\partial Q}{\partial L_i} - \frac{\partial WB}{\partial L_i} = 0$$

Rearranging yields

$$P \frac{\partial Q}{\partial L_i} = \frac{\partial WB}{\partial L_i}$$

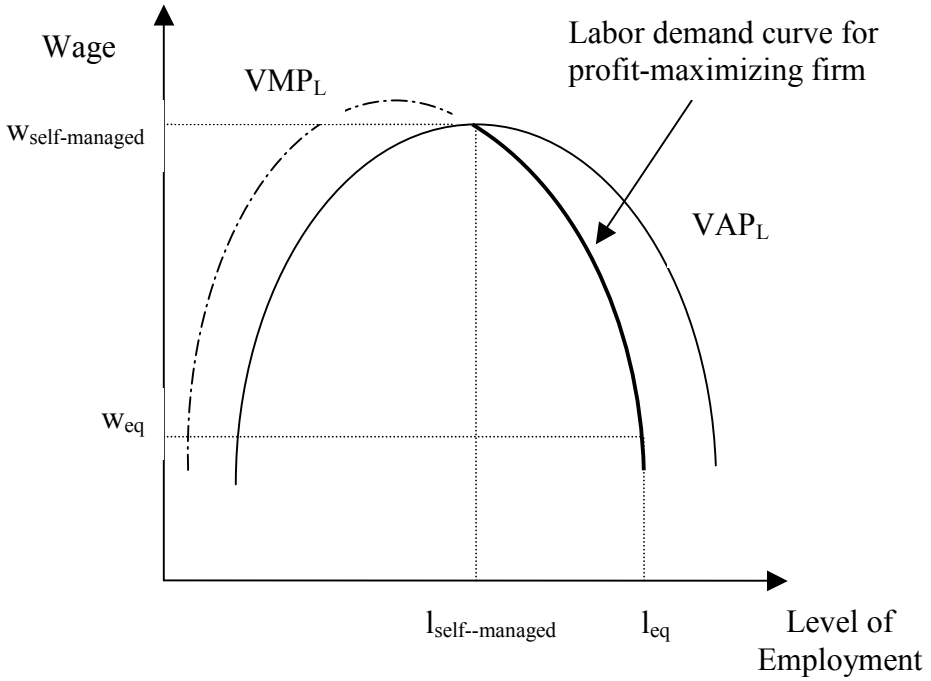
or equivalently, that

$$VMP_{L_i} = w_i$$

and thus economic efficiency requires that the marginal revenue product equals the marginal cost of hiring each type of labor, given by the derivative of the wage bill with respect to L_i.

These outcomes are clearly illustrated in Figure 1 below. We see that whenever the Value Marginal Product of Labor (VMP_L) is less than the Value Average Product of Labor (VAP_L), the self-managed firm can increase VAP_L by decreasing the number of workers employed. Conversely, whenever $VMP_L > VAP_L$, VAP_L can be increased by increasing employment. Thus, the self-managed firm will tend to operate at $w = w_{self\text{-}managed}$ and $l = l_{self\text{-}managed}$. A profit-maximizing firm, by contrast, will continue to hire labor as long as VMP_L is greater than the equilibrium wage rate, w_{eq}, but not past l_{eq} since this would decrease total profits. Thus, as is evident from Figure 1, $w_{self\text{-}managed} > w_{eq}$ and $l_{self\text{-}managed} < l_{eq}$.

Figure 1: Wage-employment outcomes under workers' self-management



Moreover, a firm's incentive to distribute its surplus in the form of wages is even stronger given that part of the firm's surplus is retained by the government. Many economists have argued that this led to the so-called "underinvestment problem" in Yugoslavia, whereby firms did not reinvest profits they otherwise may have due to short time-horizons and the exacerbating effects of government intervention (Bonin and Putterman, 1987). Thus, we would expect that self-managed firms will be inefficient both in the short- and the long-run: in the short-run, because they do not operate at the efficient frontier, and efficiency gains could be reaped through reductions in slack and increasing employment; and in the long-run, because sub-optimal levels of investment lead to antiquated technology and equipment and insufficient capital.[9] Also, we would expect that VMP$_L$ would tend to be higher in the self-managed firm than in its capitalist counterpart.

[9] In addition, there are many other theoretical predictions on the perverse behavior of self-managed firms– for example, "increases in the relative scarcity of a commodity actually signal suppliers to reduce their production of it, generating allocative inefficiency" (Estrin, 1983, p. 21).

4.2) Research on self-managed firms and formerly self-managed firms in transition

Competing views on of workers' self-management have spawned an abundance of empirical research on the subject, with authors attempting to attribute firm inefficiencies and the large wage dispersion found in workers' self-managed economies to various factors (Bonin and Putterman, 1987; Prašnikar and Svejnar, 1991). While the majority of this research focuses on the pre-1991 period when Slovenia was still a part of Yugoslavia, the extremely slow pace of reform in Slovenia suggests that many of its characteristics are likely to persist in the early transition period.

A large number of studies on productivity under workers' self-management focus on the under-investment problem, attributing variations in earnings and efficiency to the capital allocation process and the fact that firms were not required to pay the full opportunity cost for capital previously allocated to them by planners. Thus, for example, Vanek and Jovcic (1975) contend that differing levels of investment between firms, evidenced by significant variation in capital to labor ratio across otherwise similar firms, are the most important factor in explaining wage dispersions, while factors such as concentration ratios have little impact on them. Other researchers focus more on the endogeneity of worker earnings and use differences in labor productivity to explain wage dispersion. Wachtel (1973), for example, using industry level productivity data from 1956 to 1968, finds that average earnings are closely related to labor productivity at the industry level.[10] In fact, he finds that two variables – labor productivity and industry concentration – explain as much as 81 percent of the variation in mean earnings in certain years. Still other authors offering competing views, contending that theoretical models of workers' self-management have

[10] Estrin (1983) finds similar results.

been rendered useless since the 1970's because of increased government intervention in firm behavior – Prašnikar and Svejnar (1991), for example, find that "there is evidence that, in the past two decades, income determination in Yugoslav firms has reflected political rather than self-management forces" (p. 35).[11]

The empirical literature on the behavior of formerly self-managed firms during the transition period is comparatively sparse. Prašnikar and Svejnar (2003), analyzing a panel of Slovenian firms over the 1991-1995 period, find that many firms – particularly those eventually privatized to insiders – tended to exhibit a tradeoff between investment and wages (as the Ward model would predict). Moreover, workers in (frequently loss-making) firms which were not headed by elite, powerful managers and which were privatized to outsiders also appeared to engage in some surplus sharing (which they infer from the higher wages of workers in these firms). Overall, Prašnikar and Svejnar (2003) thus find that many of the salient features of workers' self-management were still observable in certain groups of firms in early transition.

It is important to note that, due mainly to a lack of suitable data, the above studies tend to focus on corollaries that do not directly address the central propositions outlined by Ward (1958) – that the wages of workers in self-managed firms will tend to be inflated relative to what their marginal revenue product would warrant. That is, while questions such as sub-optimal levels of investment are, to a certain degree, important in their own right, they are ultimately relevant insomuch as they affect total factor productivity (and wages) in the long run. For example, the so-called "underinvestment problem" is deemed problematic because, in the long-run, sub-optimal levels of investment lead to an antiquated capital stock

[11] Estrin and Svejnar (1993) as well as Prašnikar, Svejnar *et al* (1994) corroborate this view, finding that the appropriation of capital rents by workers does not account for high interindustry earnings differentials during the same period.

that translates into lower total factor productivity.[12] Studies that analyze the underinvestment productivity, in effect, use current investment as a proxy for future productivity, but do not yield conclusions that are directly translatable into tangible economic effects. By contrast, the approach used in this study, which directly compares wage and productivity differentials across different types of firms, overcomes these shortcomings.

5.) Institutional considerations

As discussed above, the Slovenian economy operated under a particular style of socialism that differed from the Soviet-type command economy in that it maintained a quasi-market economy with flexible prices and open unemployment (World Bank, 2004). Although the theory section described above assumed a relatively pure system of workers self-management, the reality is that by the late 1980's, there was extensive political interference in firm decisions regarding investment, employment and wages. Firms operated with soft-budget constraints in which a massive system of discretionary taxes and transfers taxed away net revenue from profitable enterprises in order to subsidize failing firms. As such, inefficient firms could lose money indefinitely, while efficient firms could not build up reserves that could allow expansion (Orazem and Vodopivec, 2003).

Since seceding from Yugoslavia and beginning the transition to a market economy in 1991, the Slovenian government adopted a gradualist approach to reform relative to other transition economies (World Bank, 2002). The legal process for privatizing large state enterprises began in 1993; privatization itself was initiated in 1994 and continues today despite several waves of privatization, with almost 50 percent of output still controlled by

[12] Similarly, the sub-optimal levels of employment predicted by the Ward hypothesis would also translate into lower levels of total factor productivity.

the state (World Bank, 2004). Although the reform process was expedited by Slovenia's accession to the European Union in May 2004, many pressing reforms still need to be carried out, particularly in the banking and financial services sectors (IMAD, 2005).

Chapter II: Effects of Transition on Productivity and Wage Differentials across Different Types of Workers

1.) Introduction

For workers in economies undergoing the transition from a plan to market, the past decade and a half has been a turbulent period. Under the previous regimes, they had enjoyed generous benefits such as guaranteed employment and job security, socially-mandated minimum wages, and numerous fringe benefits, such as extended vacations in company-owned vacation houses. Moreover, their governments had been – at least nominally – committed to wage equality for all workers. Since the onset of transition, however, governments have been progressively abandoning their previously paternalistic roles and granting firms greater freedom with their employment policies, allowing them discretion in the process of hiring and laying off workers, creating and destroying jobs, and deciding on their wage regimes. In the process, some workers have suffered long unemployment spells or sharp earnings declines; some have retired early or temporarily left the labor force to work at home or upgrade skills; and some have switched occupation, industry, or residency; all with considerable disruption to the lives and jobs of family members.

Of course, these changes have come as part of a larger set of liberalization and marketization reforms aimed at improving the competitiveness of the economy. One underlying premise has been that such reforms will lead to outcomes consistent with what we would expect to see in a developed market economy – with higher levels of labor productivity and wages which roughly correspond to the marginal revenue product posited by economic theory. Despite a voluminous body of literature examining a variety of labor market issues – ranging from analyses of wage differentials to studies on worker and job

flows – this fundamental relationship between wages and productivity remains untested empirically.

In this paper, I use a novel approach proposed by Hellerstein, Neumark and Troske (1999) to conduct a direct empirical test of the relationship between relative wages and the marginal productivity of workers. This allows us to examine several pressing questions regarding the impact of transition on the labor market. For example, to what extent have the increased returns to education during transition reflected growth in labor productivity, and to what extent do they reflect a liberalization of the forced wage compression under the previous regime?[13] How can we explain the narrowing wage gap in transition economies – has the marginal productivity of women increased relative to men?[14] Finally, how have older workers coped with the changing skills and knowledge required in a modern market economy – have they been able to adjust their skills, judging by the productivity differentials of older workers relative to younger ones?

Using an unusually rich administrative database containing employer-employee matched data spanning a ten-year period, this study examines the wage and productivity differentials among different types of workers in Slovenia.[15] The results offer unprecedented empirical insight into the dynamic relationship between relative wages and marginal productivity throughout the transition process. The results indicate that wage and productivity differentials have been progressively converging over the transition period,

[13] For example, Vodopivec (1993) finds that in a Yugoslav firm with several thousand workers, the pay of the highest manager was only 4.54 times that of the lowest paid worker.
[14] In a survey on the topic, Brainerd (2000) finds that, with the exception of Russia and the Ukraine, women's relative wages have consistently increased across Eastern Europe during the transition process.
[15] Having abolished central planning in 1965 in favor of workers' self-management, a quasi-market type economy with flexible prices, the problems that the former Yugoslav republics faced at the onset of transition were arguably less severe than in other transition economies (where central planning was not abolished until the collapse of socialism). However, most of the salient features of socialist economies – for example, guaranteed job security, state ownership of the means of production, soft-budget constraints – were also present in Slovenia.

indicating that market liberalization is in fact becoming a reality. They also show that older workers have lagged considerably behind younger workers in acquiring the skills that the new economic conditions demand of them, as witnessed by the precipitous fall in their marginal productivities over the past decade. Moreover, the increased returns to education over the transition period reflect genuine productivity growth and not simply a liberalization of the previously forced wage compression, and we can thus be expect that the returns to education may continue to increase in the future.

In what follows, I first present an overview of several wage determination theories in Section 2. This provides a theoretical framework for a discussion of the measurement problems inherent in empirical tests of the relationship between wages and productivity, which is the subject of Section 3. Section 4 briefly discusses the institutional considerations specific to the Slovenia. (Methodological issues, a description of the data used in the analysis, and a presentation of the results are the subject of the concluding chapter, Chapter III.)

2.) Wage Determination Theories

There are many competing theories on how an individual's characteristics affect their productivity and determine their wages (see Hutchens, 1989, for a survey). Generally speaking, the most established theory of wage determination – the human capital theory – posits that worker productivity closely corresponds to the degree of education, training and experience that person has accumulated (Becker, 1962). When an individual is acquiring firm-specific capital, human capital theory predicts a wage which exceeds marginal productivity because the firm will incur the costs of training the individual firm-specific

skills.[16] In order to recoup these costs, the productivity profile of the individual is steeper than the wage profile, and thus productivity exceeds wages as seniority increases. If the skills gained through experience are not firm specific but general, then the wage and productivity profiles should be more similar. In both cases, human capital theory implies that wages grow with seniority *because* productivity grows with seniority.

Alternative theories of job tenure dispute this contention. Implicit contract theory (Lazear, 1979) maintains that wage determination should also be understood in terms of the agency problems facing an employer. It argues that employers and employees may enter implicit contracts whereby at the beginning of employment, workers are paid less than the value of the marginal of labor, whereas the opposite is true after employees have stayed with the employer for a long period of time. Such wage policy discourages shirking in situations where employee effort is difficult to monitor, because honest and hard-working employees – who are less likely to be fired in the long run – will be rewarded with a wage premium in the years leading up to their retirement. This theory predicts that wages may grow with job tenure even when productivity decreases with seniority.

Theories of job matching also offer alternative predictions on wage determination (Jovanovic, 1979). These theories are based on the idea that imperfect information exists on both sides of the market about the exact location of one's optimal job assignment. After an initial job assignment, new information is available about an individual's skills and preferences, and a job separation may be mutually beneficial for the employer and employee. Thus, matches that turn out *ex post* to be good survive longer and lead to longer tenure at a

[16] Various alternative flavors of this general approach have been proposed. Lazear(2003), for example, proposes a "skill-weights" human capital theory whereby virtually all skills acquired on the job are general, but firms vary in their weighting of these skills. Returns to tenure are explained as the result of the value firms place on the particular *set* of more specific skills and knowledge individuals develop with longer tenure, and wage losses upon employment with another firm are explained as a result of an inferior job match.

firm. Employers may use steep earnings profiles to sort out workers and accelerate the process of job matching.

The wage determination process may be viewed in light of market imperfections which result from either discrimination or imperfect labor market competition (e.g. collective bargaining agreements). In the case of the first, if employers exhibit a distaste for employing workers with certain demographic characteristics (for example, women), the equilibrium outcome will be one in which such workers are paid less than the marginal revenue product of their labor (Becker, 1971) – that is, a wage differential will arise large enough to induce employers to hire workers from this demographic group. In the case of imperfectly competitive labor markets, labor unions may negotiate collective bargaining agreements which mandate minimum wages based on a worker's characteristics such as age, seniority, education, and so forth. In both cases, a workers' wage may be unrelated to his or her productivity within the firm.

The impact of an individual's education on productivity can be explained by two theories, human capital theory and signaling theory. Human capital theory posits that additional education increases the productive capacity of the individual through the acquisition of knowledge and skills required to perform more complex jobs. It thus predicts a causal relationship between education and productivity which is reflected in higher wages. In the context of transition, human capital theory predicts that older workers may possess human capital that is obsolete, and thus that *ceteris paribus,* older, well-educated workers will be less productive than their younger counterparts. Signaling theory (Spence, 1973), by contrast, views education merely as a screening process through which individuals can signal their skills to potential employers. Employers use education as a proxy for ability with which they detect the best candidates in a heterogeneous applicant pool and overcome the

informational asymmetry inherent in the labor market. Hence, signaling theory predicts that educated individuals will be more productive not because of the skills and knowledge they have acquired during the course of their education, but because of their superior abilities. In the context of transition, signaling theory implies that even educated older workers will be able to adapt to the changing skills and knowledge demanded in a market economy since their education is a sign of latent abilities or intellectual capacities.

3) Measurement issues and Empirical Evidence

The empirical evidence examining the relationship between wages and productivity has largely yielded inconclusive results (Hutchens, 1989). While a large number of studies have been conducted on the topic, the validity of many of them has been questioned because of the measurement issues that most fail to fully address. Ideally, modeling the relationship between wages and productivity would entail relating an individual workers' wage with that worker's effect, at the margin, on the firm's total output. The most significant problem facing studies which attempt to link these two factors is that, while measuring an individual workers' wage is relatively straightforward, obtaining a meaningful estimate of his or her marginal productivity is usually not.

This problem can be most easily overcome by studying situations where the nature of the production process is such that an individual's output is easily measured (Lazear, 2003). The results of such studies generally confirm the hypotheses of the human capital model and theories of job matching. Thus, for example, in his study of glass installers in an auto glass manufacturing plant, Lazear (2000) finds significant tenure effects, with strong evidence of both on-the-job learning and sorting, with high separation rates amongst

unproductive workers.[17] Paarsch and Shearer (1997), as well as Fernie and Metcalf (1996), find similar results. In general, however, researchers have resorted to rather imperfect proxies for marginal productivity.

However, quantifying the marginal productivity of workers with differing demographic characteristics is much more difficult for the majority of jobs in an advanced industrial society, where heterogeneous workers are often complementary inputs in the production process, and several different approaches have been proposed. One proxy for productivity is employee performance evaluations. Medoff and Abraham (1980), in their study of two large U.S. manufacturing corporations, find that increased wages that came about with longer tenure were not associated with improved performance ratings. They interpret this as evidence discrediting the human capital model, as the wage and productivity models appear to differ. However, their results are suspect for two reasons. Firstly, psychologists have long pointed to the numerous biases of job performance ratings which arise from factors such as halo error, positive leniency, and random response error (Viswesveran *et al,* 2005), making them suspect from a measurement point of view. Secondly, such studies may yield different, but equally valid, interpretations. For example, Dohman (2004), who replicates the methodology in Medoff and Abraham (1980), using personnel data from a Dutch aircraft manufacturer and finds similar results, contends that such results can arise even when wage and productivity profiles are similar, arguing that as workers are promoted, their relative performance ratings fall, but increase with tenure in a given position – a result that finds empirical support in his data. Thus, performance evaluations appear to be a generally inaccurate proxy for productivity.

[17] The estimated effects are on the order of 34% per year, a figure that can be explained by the high worker turnover rate – the average tenure length is 8 months.

A relatively new framework for analyzing the relationship between marginal productivity of workers and their relative wages – and the one used in this study – is the one proposed by Hellerstein, Neumark and Troske (1999). Using plant-level data which includes detailed data on the demographic characteristics of the labor force, they jointly estimate an augmented production function with a quality of labor term and with a plant-level wage bill equation. (Since their methodology is also used in this paper, the details of their exposition are relegated to the methodology discussion in Section 3). Their results enable them to directly compare wage and productivity differentials (although the nature of their data does not permit them to classify workers into very specific groups). They find that, ceteris paribus, the marginal productivity of workers aged 35-54 is 15 percent greater than that of their counterparts who are younger than 35, and that the older workers' wages are 19 percent greater (the four percent difference is statistically insignificant). This result is in line with human capital theory's predictions. Another of their findings, however, supports the discrimination hypothesis, as the gender wage gap – whereby, according to their estimates, women earn 45 percent less than men – is not justified by women's 16 percent lower marginal productivity (a statistically significant difference).

Similar studies have been carried out by Hellerstein and Neumark (1999), Haegeland and Klette (1999), Jones (2001), Crepon, Deniau, and Perez-Duarte (2002), and Illmakunnas et al (2004). Their results are summarized in Table 1 below for comparison (note that φ and λ respectively refer to the productivity and wage differentials of the specified group relative to the omitted group):

Table 1: Empirical evidence from joint 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	φ = 0.84, λ = 0.55 (difference is statistically significant)	…	Aged 35-54: φ = 1.15, λ = 1.19 Aged 50+: φ = 1.19, λ = 1.18 (Base group: under 35 years of age)	3,102
Hellerstein and Neumark (1999)	Israel	φ =0.8, λ = 0.75 (difference between λ and φ not statistically significant)	Technical engineers: φ = 2.0, λ = 1.7 Engineers: φ = 4.0, λ = 2.25 (Base group: unskilled workers)	…	998
Haegeland and Klette (1999)	Norway	φ =0.83, λ = 0.82 (difference between λ and φ not statistically significant)	Low Education: φ = 1.10, λ = 1.20 Medium Education: φ = 1.55, λ = 1.50 High Education: φ = 1.80, λ = 1.82 (Base group: less than 11 years of education)	8-15 years of experience: φ = 1.62, λ = 1.39 15 + years of experience: φ = 1.33, λ = 1.38 (Base group: less than 8 years of experience)	7,122
Jones (2001)	Ghana	φ = 0.45, λ = 0.86 (difference between λ and φ not statistically significant)	Primary schooling: φ = 1.08, λ = 1.3 Secondary schooling: φ = 1.54, λ = 1.56 Tertiary schooling: φ = 1.79, λ = 1.56 (Base group: no primary school)	…	278 for φ's, 1211 for λ's
Crepon, Deniau, and Perez-Duarte (2002)*	France	φ = .89, λ = 0.86 (difference between λ and φ not statistically significant)	Skilled: φ = 1.20, λ = 1.17 Highly skilled: φ = 1.88, λ = 1.73 (Base group: unskilled workers)	Aged 25-35: φ = 1.22, λ = 1.23 Aged 35-50: φ = 1.10, λ = 1.27 Aged 50+: φ = 1.11, λ = 1.41 (Base group: less than 25 years old)	23,292
Illmakunnas, Maliranta and Vainiomaki (2004)*	Finland	…	…	2-5 years tenure: φ = 1.04, λ = 1.03 5-10 years tenure: φ = 1.0, λ = 1.05 11-20 years tenure: φ = .95, λ = 1.07 (Base group: 1-2 years tenure)	28,737

Notes: (*) indicates statistics which 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 φ = 1.25 and λ = 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.

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 we cannot conclude this with certainty because the difference tends to be statistically insignificant (and thus we cannot interpret the disparity as conclusive 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. Thirdly, the evidence on the effects of job tenure and age are inconclusive, but we may tentatively say that the marginal productivity with respect to age or tenure appears to be negative past a certain point in workers' careers.

Although much of the empirical evidence discussed above appears to favor the human capital model, we should recognize that this model is nevertheless quite incomplete in that it still fails to explain a large portion of the variation in wages. In standard earnings equations for individuals of the same race and sex in the United States, for example, between two-thirds and four-fifths of the variance of the natural logarithm of wages is unexplained after accounting for the factors which are included in these models – factors such as age, years of schooling, labor market experience, and parental characteristics (Bowles, Gintis, and Osborne, 2001). Studies have found that many seemingly irrelevant factors – including personal characteristics such as beauty, height, obesity and even whether one keeps a clean house – can often be robust predictors of wages (Bowles *et al*, 2001). We should thus bear in mind that although the methodology used in joint estimations of productivity and wage differentials may offer the best estimates on the relationship between wages and productivity to date, the data used in these studies appear to exclude some intangible, unobservable factors we have yet to fully understand.

4.) Institutional Considerations

Under socialism, the wage determination process in Yugoslavia was highly regulated by the government, which set each firms' total wage bill. A firm's wage scale was determined by a referendum of its employees, and the resulting distribution of wages was highly compressed in comparison to capitalist firms (Haltiwanger and Vodopivec, 2003). In 1991, the government passed legislation formally removing these governmental administrative constraints, and since then collective bargaining agreements – which are legally binding for all firms – have played a major role in the wage determination process. These collective bargaining agreements mandate minimum pay scales based on an individual's education (for example, those with a Ph.D must be paid at least 3 times the minimum wage), seniority (they specify that an individual must receive at least a 0.5 percent wage increase for each additional year of tenure), and hours which must count as overtime. 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 a worker-specific basis, since the collective bargaining agreement generally only sets a wage floor. Empirical results indicate that the system still allows for considerable flexibility in the wage determination process in practice (Haltiwanger and Vodopivec, 2003), and thus we may expect to find evidence of sizable competitive forces acting in the labor market.

Chapter III – Methodology, Actual Data, and Results

1) General methodological approach

In this section, I outline the methodology used in this study and contrast it with conventional approaches used in studies on wage determination and firm productivity. Note that, generally speaking, the literature on these two topics has previously been confined to separate studies in the spheres of labor and industrial economics, respectively, due mainly to a limited availability of data which would link them together. I also discuss the limitations of these studies in obtaining accurate estimates of productivity.

Typical studies on wage determination focus on wage regressions of individual level data. Using the log-linear model with wages as the dependent variable, these models examine the wage differentials attributed to various worker characteristics such as gender, age, seniority, and so forth. Thus, such models follow the functional form introduced by Mincer (1974), which can be written as

$$\ln w = \beta_0 + \text{SUM}(i=0, n)\ \beta_i D_i + \varepsilon$$

where $\ln w$ is the logarithm of wages, β_0 is the constant term and D is a vector of individual characteristics such as gender, education, work experience, seniority, and so forth.

The problem with using this approach to test theories on wage determination is that, without independent measures of productivity differentials, it is difficult to determine whether wage differentials associated with worker characteristics actually reflect differences in productivity or whether they arise from other factors, such as market imperfections in the form of sticky wages or discrimination. Also, in the absence of corresponding information of productivity, it is difficult to verify which theory of wage determination (e.g. human capital theory, implicit contract theory) has the most empirical support in the data.

The approach used in this study draws heavily on the model pioneered by Hellerstein, Neumark, and Troske (1999), in which production functions and wage equations are estimated jointly, allowing for direct comparisons of the wage and productivity differentials. I briefly review their methodology, and examine how the availability of additional control variables for ownership type can add to this framework.

1.1) Actual model for estimating productivity differentials

Consider a simple production function in which value-added output Y is a function of capital inputs K and a quality of labor aggregate QL. Using a translog production function, the model can be described as

$$\ln Y=\ln(A) + \alpha \ln(K) + \beta \ln(QL) + g(K,QL) + \gamma_i X_i + \mu \quad (1)$$

where g(K,QL) represent the second order terms of the translog production function (Jorgensen et al, 1973), $\gamma_i X_i$ is a vector of dummy variables capturing firm characteristics such as ownership type and industry, and μ is the stochastic error term.

For each plant, assume for simplicity that we can differentiate workers based on a single characteristic, their gender. Assuming the workers are perfectly substitutable inputs with potentially different marginal products, we can define QL as

$$QL=L(1+ (\varphi_F-1) F/L) \quad (2)$$

were L is the total number of workers in the plant, F is the number of women in the plant, and φ_F is the marginal productivity of women relative to men. Substituting equation (2) into equation (1) yields a plant level production from which φ_F can be estimated.

The actual data permit us to distinguish the each plants workforce not only based on gender, but also by education, job tenure, 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), three categories of tenure length (less than 2 years, 2-5 years, more than 5 years), 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 144 possible combinations that these multiple dimensions can capture, and obtaining exact estimates for each of these groups would require including 144 terms for the productivity differentials (φ's) in the production function.

In order to reduce the dimensionality of the problem, a simplifying restriction on the model is imposed. I restrict the productivity differentials of workers in one demographic category to be equal for those same types of workers in another demographic category. Thus, for example, I assume that the productivity differentials of young women (those in the first age category, less than 30 years old) relative to young men is 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

$$\begin{aligned} QL = [L + (1+(\varphi_F - 1)\, F] \cdot [1 + (\varphi_{EDU2}-1)\, EDU2 + (\varphi_{EDU3}-1)\, EDU3 + (\varphi_{EDU4}-1)\, EDU4 \\ + (\varphi_{EDU5}-1)\, EDU5 + (\varphi_{EDU6}-1)\, EDU6] \cdot [1 + (\varphi_{AGE2}-1)\, AGE2 + (\varphi_{AGE3}-1)\, AGE3 + \\ (\varphi_{AGE4}-1)\, AGE4] \cdot [1 + (\varphi_{TENURE2}-1)\, TENURE2 + (\varphi_{TENURE3}-1)\, TENURE3] \end{aligned} \quad (3)$$

where EDU2-EDU6 reflect the number of workers with completed elementary school, vocational school, high school, 2-year college, and at least 4-year college, respectively; AGE2, AGE3 and AGE4 reflect the number of workers aged 30-39, 40-49, and over 50 years, respectively; and TENURE2 and TENURE3 reflect the number of workers with 2-5 and more than 5 years of tenure at the present firm, 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 zero. Thus, a finding that $\varphi_F = 1.25$ would imply that women are 25% more productive than men.

1.2) Actual model for estimating wage differentials

In order for the wage differentials to be directly comparable to the productivity differentials in the model described above, the model used in this study deviates from those typically used in studies analyzing the determinants of wages. Again, this study emulates the model used by Hellerstein, Neumark, and Troske (1999), and is briefly outlined below.

For the purposes of explaining the model, assume again that workers can be differentiated based on only one demographic characteristic, their gender. Since we have matched employer-employee data containing information on each person's earnings in a given year, we can come up with a total wage bill for employers if we sum up the individual level earnings. That is, we begin by considering the individual level-wage equations in levels

$$w_{i,j} = w_M M_{i,j} + w_F F_{i,j} \quad (3)$$

where M_i and F_i are dummy variables for men and women, respectively, for the i-th worker in plant j, and w_M and w_F are the individual wages of men and women. Summing this equation over all workers yields plant level wage bills, which can be expressed as

$$w = w_M (L - F) + w_F F \quad (4)$$

Defining λ_F as the relative wage of women to men ($\lambda_F = w_M/w_F$), we have

$$w = w_M (L - F) + \lambda_F \; w_M F = w_M (L + (\lambda_F - 1) F) \quad (4)$$

or, equivalently,

$$\ln(w) = \ln(w_M (L + (\lambda_F - 1) F)) \quad (5)$$

Equation (5) thus yields estimates of wage differentials that are directly comparable to the marginal productivity differentials obtained from (1).

Since I have data on workers' wages based not only on their gender but also based on the other characteristics described above, the actual equation that I estimate is

$$\ln(w) = \ln(w_{base}) + \ln[(1+(\lambda_F - 1)F] \cdot [1 + (\lambda_{EDU2}-1)EDU2 + (\lambda_{EDU3}-1)EDU3 + (\lambda_{EDU4}-1)EDU4 + (\lambda_{EDU5}-1)EDU5 + (\lambda_{EDU6}-1)EDU6] \cdot [1 + (\lambda_{AGE2}-1)AGE2 + (\lambda_{AGE3}-1)AGE3 + (\lambda_{AGE4}-1)AGE4] \cdot [1 + (\lambda_{TENURE2}-1)TENURE2 + (\lambda_{TENURE3}-1)TENURE3] + \gamma_i X_i + \mu \quad (6)$$

where w_{base} is the wage of individuals in the omitted group, the wage differential coefficients λ correspond to their respective definitions for equation (3), $\gamma_i X_i$ is a vector of dummy variables capturing firm characteristics such as ownership type and industry, and μ is the stochastic error term.

Estimating the equation in (5) along with the augmented production function in (1) then yields directly comparable measures of marginal productivity (φ) and wage differentials (λ). Note that 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.

2.) The Data

The actual data used in this study are from a comprehensive panel of Slovenian firms from 1992 until 2001 and comprehensive matching individual level data for these firms (see Table 2 below for data sources). The data include all registered legal businesses in the business sector from 1992 until 2001; thus, for each year, the firm level data contains between 21,046 and 38,454 observations (see Appendix 1 for details). 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. Because the firm-level data contained information on the number of workers employed in the firm, it was possible

to ensure that a sufficient number of workers were matched to a firm so that the sample could be used to make reliable inferences about the demographic characteristics of the firm's workforce. Due to errors in the identifiers and lapses in the data, a considerable number of observations were lost in the process; after merging the worker and firm level data, the resulting matched employer-employee database contained information on the firms which employed between 73.8 and 53.4 percent of the workforce.

For each firm and year it was in operation, the resulting data include the following variables:

Table 2: Data Sources and Variables Used in the Empirical Model

Variable	Basis for calculation	Values taken by variable	Data source
Output	revenues plus net change in inventories, where applicable	Positive integers	Agency of the Republic of Slovenia for Public Statistics and Services Accounting Register
number of workers employed[a]	Number of hours worked based on yearly number	Positive integers	
Capital[a]	value of tangible fixed assets based on historical cost accounting	Positive values	
Materials	cost of goods sold, where applicable	Positive integers	
Location	Urban or Rural location	Dummy if rural	
Ownership type	State or Private (includes foreign and domestic ownership)	Dummy if majority private-owned	Statistical Office of Slovenia Business Register
Foreign ownership	Capital origin	Dummy if majority foreign- owned	
Firm wage bill	Worker-level data	Positive values	Statistical Office of Slovenia Working Population Register
Share of women	Worker-level data	Ratio between 0 and 1	
Employment shares by education	Worker-level data	Ratio between 0 and 1	
Employment shares by age	Worker-level data	Ratio between 0 and 1	
Employment shares by job tenure	Worker-level data	Ratio between 0 and 1	
Entry	Firm data (7-digit firm identifiers)	Dummy if firm exits between 1992 and 2001	Own calculations
Exit	Firm data (7-digit firm identifiers)	Dummy if firm enters between 1992 and 2001	
Herfindahl index[b]	Slovenian activity codes and data on output	0 (perfect competition) to 1(monopoly)	
Overall firm turnover rate[c]	Slovenian activity codes and data on entry, exit	0 (no entry or exit) to 2 (all firms enter and exit)	

Note: Because not all firms were in operation for entire year, output and materials were adjusted for the number of months firm was in operation (data thus represent simulated yearly data). Data on output, materials and capital were deflated based on the respective deflators from the Statistical Office of Slovenia price index reports (1991-2001). The identifying variables used to merge data from different sources were a universal 7-digit firm identifier and the relevant year.

[a] A large number of companies with no employees or capital existed in the early 1990's as more liberal legislation made it easy to establish a new company (Hrovatin and Uršič,, 2002). These companies were fictitious; they never *de facto* performed business operations, but rather were established for tax-avoidance purposes. As such, they were excluded from the data.

[b] The Herfindahl index measures the degree of competition based on the output shares of firms. It is defined as

$$\text{Herfindahl} = \sum_{j=1}^{n} S_j^2$$

where S_j is the share of firm j in sectoral output in the sample of n firms in the sector. Two-digit sectors are used to define the respective market (they are based on the Slovenian classification, but are roughly analogous to the SIC classifications).

[c] Following Scarpetta *et al* (2002), the overall firm turnover rate is defined as the sum of the entry and exit rate, where the entry rate is the number of new firms divided by the total number of incumbent and entrant firms in a given year, and the exit rate is the number of firms exiting the market in a given year divided by the incumbents in the previous year.

The data suffer from several shortcomings. The capital stock is measured by historical cost instead of its market value, which is problematic given Slovenia's socialist legacy. Like many studies using statistical records, no distinction can be made "between new-startups and small firms that emerge from restitution, spinoffs from state-owned enterprises, or other forms of privatization" (Brada, 1996, p. 75). Finally, the valuations of output and material inputs originate from markets where monopoly power is likely to exist – as a transition market economy that still needs to further liberalize its markets, significant (although decreasing) monopolistic markups are likely to exist throughout the Slovenian economy. As a result, interpreting estimates of productivity differentials can be problematic because they may reflect markups due to imperfect competition instead of actual productivity levels (Basu and Fernald, 1995). We may thus mistakenly attribute to productivity increases what is in fact caused by increases in market power.

Fortunately, at least the latter problem can be partially corrected. If we include measures of sector-level competition in the model, we can control for increases in revenues that result from imperfect competition and thus attempt to capture the real resource costs of production. Two indices are used for this purpose. The first – the Herfindahl index – is widely used (see Earle and Estrin, 1996, for example) and captures the degree of firm market power by measuring output shares in respective 2-digit industries. However, this measure does not address an important problem – that is, that similar levels of sectoral concentration may be associated with differing levels of competition because defining the relevant geographic market can be problematic (for example, a grocery store's market is much more restricted than that of a manufacturing plant). For this reason, a second measure of competition – the overall firm turnover rate – is used. This measures the fraction of firms which exit and enter a certain sector in a given year, and as such proxies the degree to which

markups from imperfect competition induce market entry. Since the Yugoslav economy was, by Western standards, characterized by low levels of competition,[18] a lack of entry indicates high barriers to entry (e.g. high sunk costs or continued government subsidies to incumbents). In the absence of entry, firms can thus be posited to possess market power. Moreover, firm exit can also be seen to be strongly tied to competition because a competitive environment is more hostile and likely to produce bankrupt firms. However, even with these modifications, the data do not allow us to consider competition from imports, which may be an important factor in determining competition given the openness of Slovenia's economy.

3.) Results

Tables 3a and 3b presents the results of joint estimations of equations (1) and (6) on the entire panel of plant-level data spanning the 1992-2001 period. Due to the way the parameters enter the model, the regressions are estimated using nonlinear least squares. When examining these results, we should bear in mind that these results describe the average wage-productivity profiles over the first 10 years of Slovenia's transition, a turbulent period during which we would expect significant changes in the wage and productivity profiles of various demographic groups. (For this reason, I present estimates of these regressions on the annual, cross-sectional data in the next section.)

[18] A 1990 OECD economic report on Yugoslavia notes that "the institutional set-up has encouraged vertical integration and oligopolistic behaviour in the context of regional autarky" (p. 41). "Barriers to entry applied not only to private business but also to socialized companies if this threatened the regional or local monopoly of large conglomerates" (p. 42).

Table 3a: Joint Estimates of Nonlinear Least Squares Production Function and Wage Equations, using complete data from 1992-2001 (table is continued on next page)

		Log(Value Added) (1)	Log(Wages) (2)	p-value, (1) = (2)
Productive inputs and competition control variables	log(Labor)	1.21	1.10	...
		(0.010)	(0.002)	
	log(Capital)	0.04	…	...
		(0.007)		
	$(\log(\text{Labor}))^2$	0.01	…	...
		(0.002)		
	$(\log(\text{Capital}))^2$	0.02	…	...
		(0.001)		
	log(Labor · Capital)	-0.05	…	...
		(0.002)		
	Overall firm turnover rate	0.27	-0.08	...
		(0.059)	(0.055)	
	Herfindahl Index	-0.11	0.00	...
		(0.042)	(0.039)	
Firm Characteristics	De novo (private)	1.07	0.75	0.00
		(0.009)	(0.008)	
	Formerly state owned (private)	1.14	0.82	0.00
		(0.009)	(0.008)	
	Foreign-owned	1.24	1.24	0.99
		(0.009)	(0.009)	
	Dummy for entry within current year	1.04	1.04	0.91
		(0.029)	(0.027)	
	Dummy for exit after current year	0.52	0.71	0.00
		(0.019)	(0.017)	
	Rural firm dummy	0.90	0.96	0.00
		(0.006)	(0.005)	
	R^2	0.8185	0.8625	
	Adjusted R^2	0.8184	0.8624	
	F-statistic	13279.24	20710.42	
	N	109,023	109,023	

Notes: 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 excluded age category comprises of workers less than 30 years old, the excluded education category comprises of workers with unfinished elementary education, and the excluded firm type are cooperatives and firms with mixed or state ownership. Other control variables included in both equations are industry and year dummies.

Table 3b: Joint Estimates of Nonlinear Least Squares Production Function and Wage Equations, using complete data from 1992-2001 (cont.)

		Log(Value Added) (1)	Log(Wages) (2)	p-value, (1) = (2)
Demographic characteristics	Women	0.93	1.01	0.00
		(0.007)	(0.005)	
	30-39 years old	1.00	1.06	0.00
		(0.010)	(0.007)	
	40-49 years old	0.99	1.14	0.00
		(0.010)	(0.008)	
	50+	1.01	1.29	0.00
		(0.015)	(0.013)	
	2-5 years tenure	0.97	1.04	0.00
		(0.007)	(0.006)	
	5+ years tenure	0.87	1.00	0.00
		(0.013)	(0.010)	
	Completed elementary school	1.14	1.08	0.27
		(0.042)	(0.027)	
	Vocational school	1.27	1.24	0.49
		(0.045)	(0.029)	
	High school	1.79	1.44	0.00
		(0.062)	(0.033)	
	2-year college	2.11	1.63	0.00
		(0.075)	(0.039)	
	4-year college	2.39	1.79	0.00
		(0.084)	(0.042)	
	R^2	0.8185	0.8625	
	Adjusted R^2	0.8184	0.8624	
	F-statistic	13279.24	20710.42	
	N	109,023	109,023	

Notes: See notes on previous page.

The regressions yield several interesting results. Most noticeable is the stark discrepancy in the wage and productivity differentials in both privatized and newly created firms. While newly created (private) firms are 7 percent more productive than their state-owned counterparts (with $\varphi = 1.07$ in the left column), their wages are 25 percent lower ($\lambda=0.75$ in the right column); similarly, formerly state-owned firms are 14 percent more productive yet pay 18 percent lower wages. The results thus appear to be in line with Ward's (1958) theoretical model on firm behavior under workers self-management, which predicts that workers in self-managed firms will appropriate some of the firm's profits and thus earn more than their MP_L would warrant. However, this finding is complicated by the

productivity and wage differentials in foreign-owned firms which – assuming foreign owned firms exhibit behavior consistent with profit-maximization – appear to indicate that the wage/productivity differentials in state-owned firms are justified: foreign owned firms are 24 percent more productive than state-owned ones, and their productivity differentials are also not statistically significantly different from this 24 percent.

The coefficients for the demographic characteristics are also interesting. Contrary to previous empirical findings, neither of the coefficients for women deviate considerably from 1 – although the estimates of $\varphi_F = 0.93$ and $\lambda_F = 1.01$ are both statistically distinguishable from 1, this difference is not practically meaningful. These plant level results conflict with individual-level wage regressions (reported in Appendix 2) on the same data, which indicate a statistically significant wage gap of 13 percent. How can we reconcile these findings? It appears that while women's wages do reflect their marginal productivities – and thus, little evidence of plant-level gender discrimination exists – women tend to be segregated in firms and industries with lower wages in general. Narrowing the gender wage gap would thus require women to enter occupations (and firms) that pay higher wages.

I next turn to the estimates of age-productivity and age-wage differentials. The results indicate that older workers are neither more nor less productive than the base group, individuals under 30 years of age – the estimates for φ are not statistically distinguishable from 1.[19] These age-productivity profiles appear to differ from empirical findings from other studies, which find evidence of concave profiles in which worker productivity peaks at around 40 years of age (Ilmakunnas *et al*, 2002; Hellerstein *et al*, 1999). Their relative wages, by contrast, yield a starkly different conclusion – older workers earn a wage premium that

[19] These results are particularly striking in light of Slovenia's early retirement schemes, which we would expect to have decreased the number of the relatively lower paid – and, presumably, less productive – older workers in the workforce (see preceding discussion).

ranges from 6 percent for those between 30 and 39 years old to 29 percent for those older than 50. The wage determination process appears to be most strongly influenced by the collective bargaining agreements, which mandate minimum wage levels for older workers.

Examining the wage and productivity differentials regarding job tenure yields similarly puzzling findings as those regarding age. The estimates imply that productivity tends to decrease with tenure, averaging 3 percent less after 2-5 years at a firm and 13 percent thereafter. These results are in stark contrast with theoretical predictions, which predict that productivity should, at the very least, increase with tenure as workers acquire firm-specific knowledge and skills. The wage profiles indicate a weakly concave profile in which individuals with 2-5 years of tenure earn a 4 percent wage premium that disappears for those with longer tenure.

The wage and productivity differentials for various educational groups are largely in accord with our theoretical predictions and previous empirical evidence. Examining the productivity profiles shows a steep increase in productivity with increased education, indicating that those with completed elementary education are 14 percent more productive than those with uncompleted elementary education, while those with at least four year college degrees are 139 percent more productive. Comparing these figures with the wage differentials shows continuing evidence of wage compression, as individuals are consistently paid about a third less than their MP_L would warrant in every educational group with the exception of those who completed vocational school.

The other coefficients are also of some interest. Most of the second order coefficients of the translog production function are significant, providing evidence against a Cobb-Douglas specification of the model. It thus appears that the marginal rate of substitution between capital and labor is not constant, and underscoring the complexity of

the production processes. Rural firms appear less productive than firms in urban locales; similarly, they pay slightly lower wages than urban firms. Both coefficients appear to reflect the fact that urban firms operate in environments with more developed factor and product markets, while rural firms operate in environments where the prices that should serve as signaling devices for gauging opportunity costs are distorted by informational asymmetry in the market.

It is also interesting to note that the standard errors of the coefficient estimates are consistently higher in the production function estimates. This indicates a higher degree of heterogeneity amongst firms in their productivity than in their wage policies, and is possibly indicative of the rigidities that collective bargaining agreements continue to impose on a firm's wage policy. Alternatively, it could indicate that a functional labor market exists, as firms have to match the market wage irrespective of their productivity.

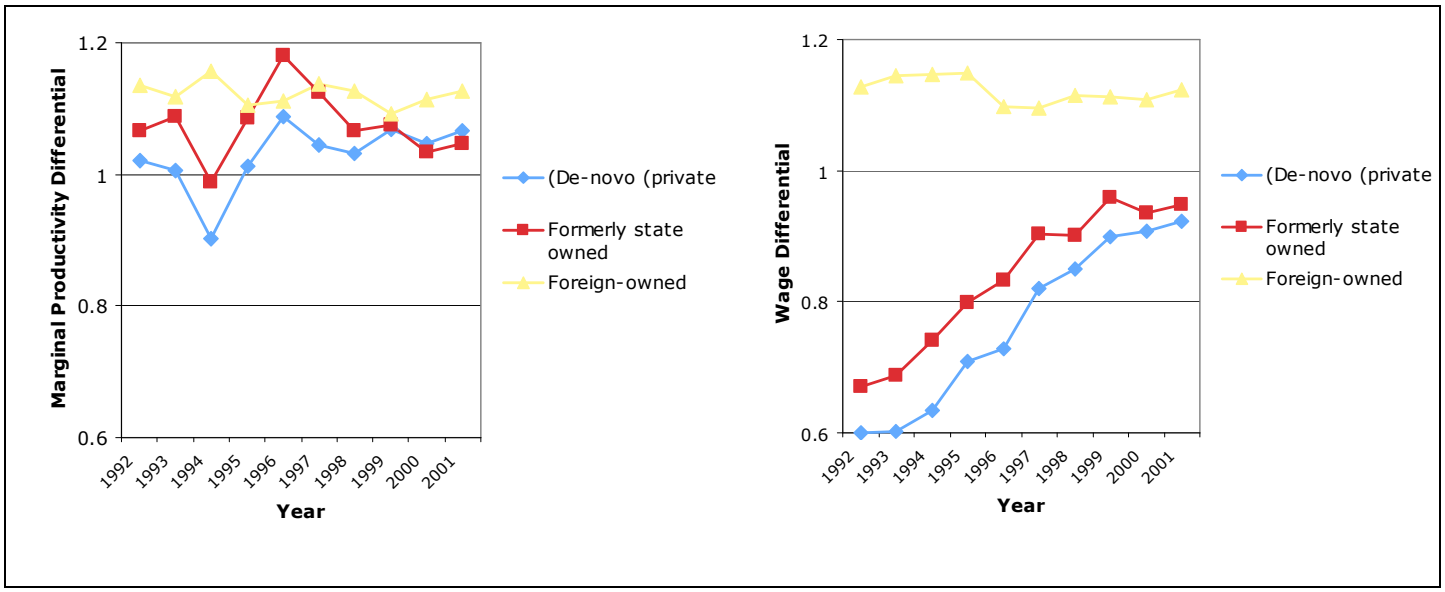
Finally, it is instructive to examine the bias that would have arisen had we failed to account for differences in labor quality in the plant level production functions.[20] To this end, the joint estimation of two such equations is presented in Appendix 3. Interestingly enough, the bias that arises in the production function generally appears statistically insignificant. The sole exception is the coefficient for foreign-owned firms, where the difference is statistically significant according to the Wald test. In this case, the simple production function predicts a 6 percentage point higher marginal productivity than the labor-quality augmented one. This upward bias in the simple production function is consistent with what we would expect given that foreign owned firms tend to employ relatively more skilled workers than other firms – the failure to account for the superior

[20] The magnitude of this bias is particularly informative given that, to the author's knowledge, no empirical studies on productivity in transition economies have estimated labor-quality augmented production functions.

workforce means that the simple production function overestimates the productivity of foreign owned firms. The fact that the other coefficients are similar for both production functions possibly reflects a much more similar demographic labor force composition between privatized, *de novo* and state owned firms. If the workforces are similarly homogeneous across firms of differing ownership types in other countries as well, we can cautiously conclude that the majority of existing studies on firm productivity in transition economies have not been severely biased by the omission of labor quality controls in their empirical models.

Since the data allow us to track the evolution of wage and productivity differentials from 1992 to 2001, I now present results from cross-sectional regressions identical to the ones presented in Table 2 that have been estimated for each individual year. Due to the large number of coefficients estimated, the results are presented in the figures below.

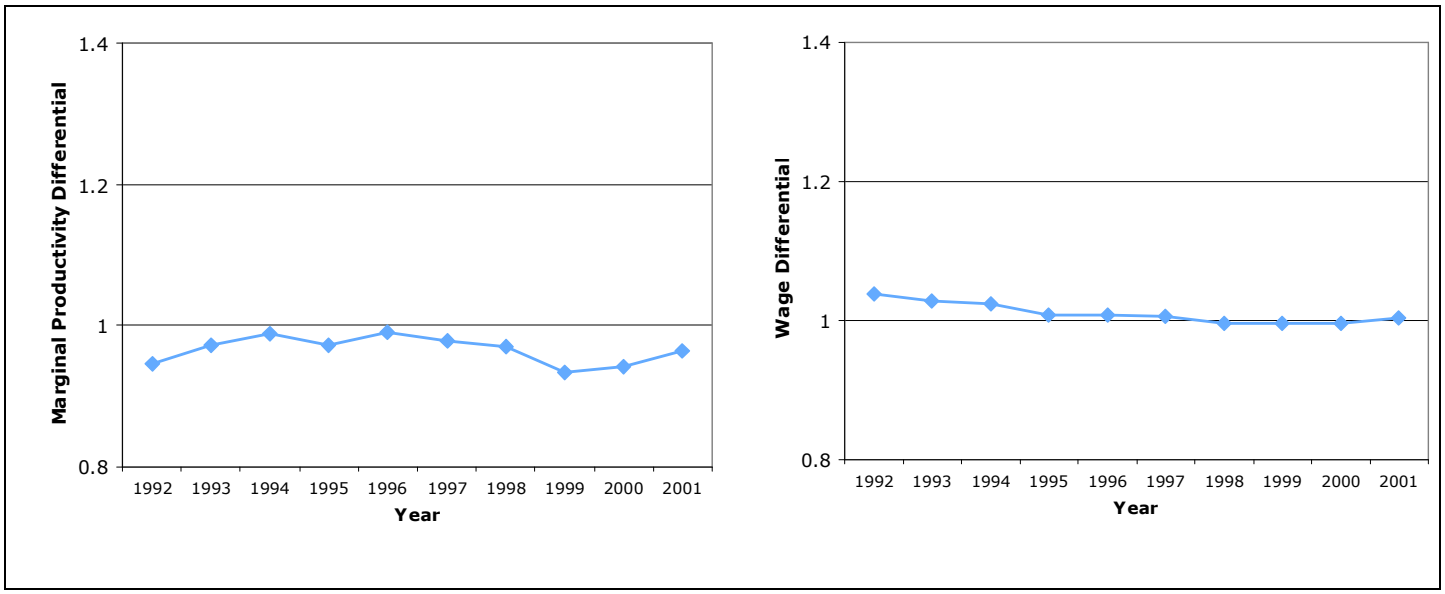
Figure 2: Estimates of productivity and wage differentials by firm ownership type, 1992 - 2001



Base group: Cooperatives and firms with mixed or state ownership.

Figure 1 indicates that, apart from a dip in 1994, private and foreign owned firms have indeed been more productive than state-owned ones, and that foreign-owned firms have exhibited less variable performance than non-foreign owned firms. The data appear to support the hypothesis first postulated by Ward (1958) that workers in a worker-managed firm will engage in rent sharing, thus garnering wages that are higher than their marginal productivity would warrant. This can be seen by noting that all types of private firms – *de novo*, privatized, and foreign-owned – are more productive than the omitted group, state-owned firms, for every year except 1994. Examining the corresponding wage profiles shows that state-owned firms paid a premium wage relative to privatized and *de novo* firms, and this difference posts a sharp decrease as transition progresses. It is also interesting to note that foreign owned firms are *both* more productive and tend to pay higher wages; thus, Slovenian's traditional mistrust for relinquishing control of their firms to non-Slovenians appears completely unwarranted.

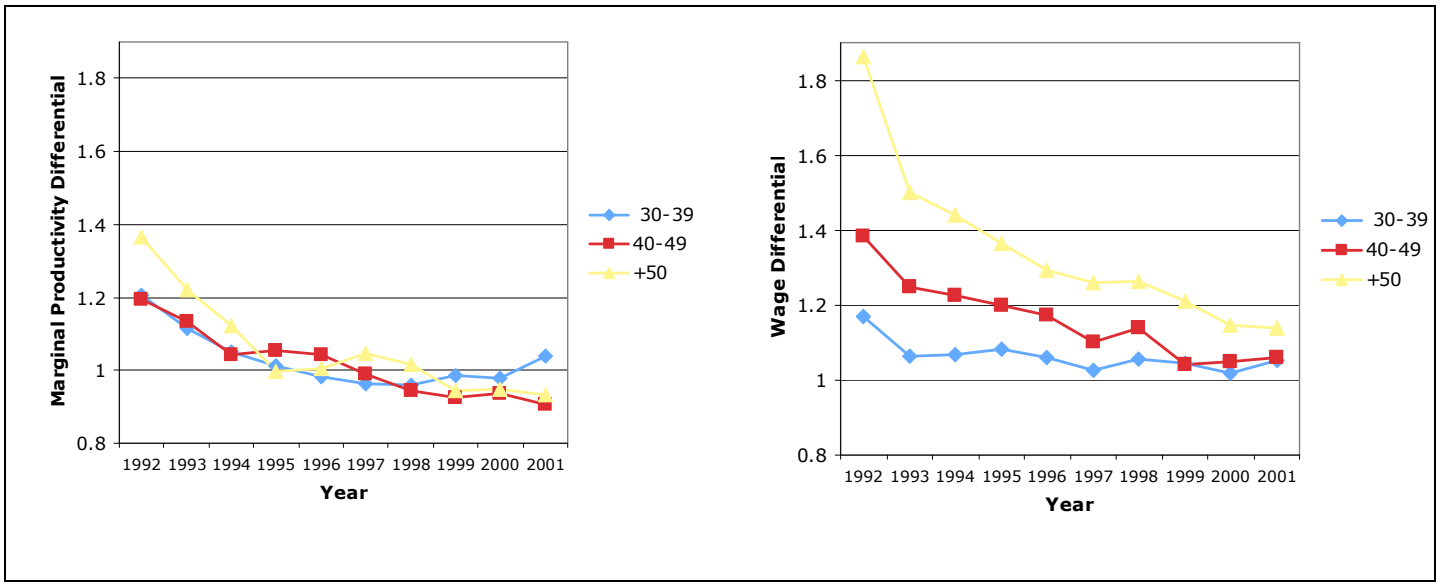
Figure 3: Estimates of productivity and wage differentials of women relative to men, 1992 - 2001



Base group: Men.

The wage and productivity profiles of women underscores the fact that the transition period had little effect on women – both profiles appear to remain rather constant relative to men. Furthermore, although the labor market was highly regulated under socialism, it nevertheless appeared to operate efficiently.

Figure 4: Estimates of productivity and wage differentials by age, 1992 - 2001



Base group: Individuals less than 30 years old.

Examining the wage and productivity differentials of workers of various ages reveals a fascinating dynamic that has evolved during the process of transition: both the relative wages and marginal productivities of older workers have been consistently decreasing over this ten year period. Thus, while the oldest group of workers were 37 percent more productive than the youngest group at the onset of transition, their marginal productivity was 7 percent lower by 2001; for the second oldest group, their marginal productivity fell from 19 percent above the youngest group to 10 percent below them by 2001. The drop in relative wages has been even more dramatic: for the oldest workers, relative wages have declined from λ=1.86 to λ=1.13; for the second oldest group, relative wages have fallen from λ=1.38 to λ=1.05.[21] This dramatic drop in both productivity and wages may be indicative of a larger, more long-term problem facing transition economies. The drop in the productivity of older workers may be due to their inability to acquire the knowledge or skills demanded

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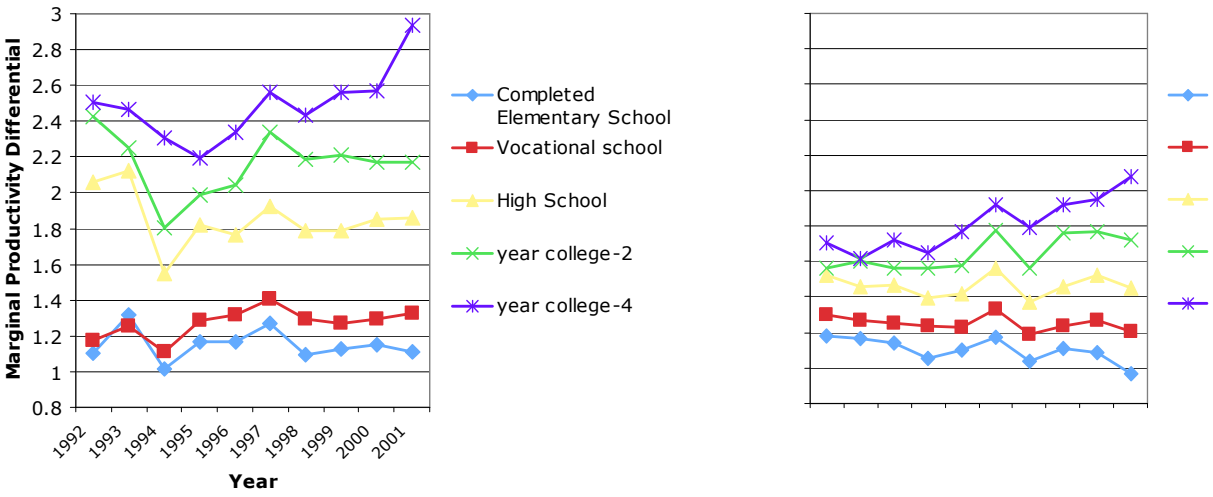
of workers in a market economy – in other words, just as transition economies have suffered from obsolete physical capital, they may face the challenge of a workforce whose human capital has been rendered useless in a market economy.

Figure 7: Estimates of productivity and wage differentials by education, 1992 - 2001



4.) Conclusion

Traditional empirical tests of wage determination theories typically fail to include direct measures of an individual's marginal productivity, making it difficult to make robust conclusions about the wage determination process. Similarly, traditional approaches to estimating firm productivity across different types of firms typically fail to account for differences in the quality of a firm's labor-force, making it difficult to calculate unbiased productivity measures. The proceeding study overcomes both of these shortcomings by using matched employer-employee data to jointly estimate plant level production functions and wage equations. This allows us to make a direct comparison of wage and productivity differentials across various demographic groups and firm ownership types.

In general, the results indicate that wage and productivity differentials have been progressively converging over the transition period, indicating that market liberalization is in fact becoming a reality in Slovenia. Moreover, the results of this study strongly support the theory that worker appropriation of capital rents in state-owned firms was occurring under workers' self-management, and that this phenomenon persisted into the early phase of transition, as indicated by the discrepancy between the marginal products and the wage differentials of workers in state-owned firms *vis-à-vis* their counterparts in privately owned firms. Foreign owned firms appear to be highly beneficial for the Slovenian economy, as they are not only significantly more productive than the average firm, but they consistently pay higher wages as well. The relative productivity of older workers has witnessed a dramatic fall during the first decade of transition, indicating that older workers are experiencing difficulty acquiring the skills necessary in a modern capitalist economy. This

problem may have significant consequences for unwary governments even several decades down the road, and may prove especially difficult for governments who may need to increase the retirement age to counter the effects of a generally aging population. Furthermore, although the discrepancy in the wage and productivity differentials for older workers has decreased considerably over the first decade of transition, the persisting wage premium indicates that overly restrictive labor laws and mandated seniority wages may be hindering productivity growth and weakening the employment prospects of older workers who are unemployed. In general, however, the regression results indicate that the wage and productivity profiles in Slovenia across different types of workers and firms are increasingly approaching a competitive market structure, a development that is especially interesting in light of Slovenia's relatively slow pace of structural reform.

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Appendix 1: Comparison of sample employment with actual employment

Year	Number of firms in initial firm sample	Number of firms in matched employer employee data	Total employment in initial firm sample	Total employment in matched employer-employee data	Official employment in formal sector	Percentage of official employment in matched employer-employee data
1992	21046	5973	525600	468717	658922	71.1%
1993	28,975	8,565	484,350	440,983	629,016	70.1%
1994	32,723	10,411	475,880	431,446	605,496	71.3%
1995	34,997	12,742	485,841	431,407	594,394	72.6%
1996	36,939	13,867	467,851	428,611	581,106	73.8%
1997	37,800	14,956	457,919	423,233	593,086	71.4%
1998	38,454	15,464	455,278	411,712	591,653	69.6%
1999	38,427	15,819	455,594	405,237	606,982	66.8%
2000	38,056	13,850	454,897	365,424	615,493	59.4%
2001	37,210	10,032	457,455	334,928	626,444	53.5%

Source: Statistical Yearbook of the Republic of Slovenia, various years; own tabulations.

Appendix 2: Results from standard log-linear wage regression on individual-level data

	Dependent variable: Log(wages)
Women	-0.13
	(0.01)
Completed Elementary School	0.10
	(0.002)
Vocational school	0.25
	(0.002)
High School	0.54
	(0.002)
2-year college	0.89
	(0.003)
4-year college	1.22
	(0.003)
30-39	0.27
	(0.059)
40-49	-0.11
	(0.042)
50+	1.07
	(0.009)
2-5 years tenure	1.14
	(0.009)
5+ years tenure	1.24
	(0.009)
Constant	1.04
	(0.029)
F-stat	30,621.92
R^2	0.3634
N	1,019,759

Notes: White-consistent standard errors are in parenthesis. All the coefficients are significant at the 5 percent level. Variables included in the regression but excluded from the table include year dummies, industry dummies, and ownership type dummies.

Appendix 3: Joint Estimates of Nonlinear Least Squares Production Function and Wage Equations, using complete data from 1992-2001 and omitting labor quality terms

		Log(Value Added) (1)	Log(Wages) (2)	p-value, (1) = (2)
Productive inputs and competition control variables	log(Labor)	1.15	1.08	...
		(0.010)	(0.002)	
	log(Capital)	0.01	...	...
		(0.008)		
	$(\log(\text{Labor}))^2$	0.00	...	...
		(0.002)		
	$(\log(\text{Capital}))^2$	0.02	...	...
		(0.001)		
	log(Labor · Capital)	-0.04	...	...
		(0.002)		
	Overall firm turnover rate	0.37	-0.07	...
		(0.060)	(0.057)	
	Herfindahl Index	-0.20	-0.03	...
		0.04	(0.039)	
Firm Characteristics	De novo (private)	1.05	0.66	0.00
		(0.009)	(0.008)	
	Formerly state owned (private)	1.13	0.77	0.00
		(0.009)	(0.008)	
	Foreign-owned	1.30	1.30	0.88
		(0.009)	(0.009)	
	Dummy for entry within current year	1.05	1.02	0.43
		(0.030)	(0.027)	
	Dummy for exit after current year	0.50	0.67	0.00
		(0.019)	(0.017)	
	Rural firm dummy	0.87	0.93	0.00
		(0.006)	(0.006)	
	R^2	0.8107	0.8391	
	Adjusted R^2	0.8106	0.8391	
	F-statistic	17,949	27,465	
	N	109,023	109,023	

Notes: 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 excluded firm type comprises of are cooperatives and firms with mixed or state ownership. Control variables included in both equations are industry and year dummies.