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法定勞動成本、薪資與企業資本投資:
三項應用個體計量的實證研究

Mandated labor costs, wages and capital investments:
Essays in Applied Microeconometrics

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中文摘要

第二章

本論文中第一項實證研究探討近幾年來台灣勞工保險費率提高對台灣私部門勞工工資的影響，用以針對補償性工資差異理論 (compensating wage differentials) 進行驗證。本研究係針對台灣現行體制下，除了國民健保與退休金外之第三種主要法定員工福利金的提高，對工資所造成影響之首篇實證研究。由於過去分析兩項法定員工福利金對勞工薪資相關實證結果並不一致，因此，本文將奠基於過去有關之研究成果，更進一步釐清其相關性，以填補文獻空缺。因此，我們以近期勞工保險費率提高期間的前一個年度爲基礎，採用差異中之差異法 (difference-in-differences) 以及 2010 至 2012 年的人力運用調查資料分析此議題。根據本文之實證研究發現，台灣私部門勞工保險費率提高，對勞工工資確實有造成衝擊，而受到該政策的影響之台灣勞工的工資在費率調整期間有顯著下降。

第三章

本論文中第二項研究，則細究台灣企業面臨法定員工福利支出提高，對其固定資本投資意願之影響。近年來，台灣法定員工福利支出明顯增加，而這是否會透過勞動成本上升造成企業投資意願下降，已成爲重要政策議題。爰此，本文特以 2002 至 2012 年國內上市櫃公司財報資料，針對此議題進行驗證。爲避免個別企業不可觀測差異 (unmeasurable heterogeneity) 以及自變數的內生性對估計結果造成偏誤，本文採縱橫資料固定效果模型 (fixed-effects panel data) 以及動態縱橫資料模型 (GMM dynamic panel data) 進行估計。此外，本文亦運用工具變數法，處理法定員工福利支出與薪資之內生關連性問題。本文實證結果發現，提高法定員工福利支出的確會使得企業之實際投資減少，且不論是採用靜態的固定效果模型或動態的縱橫資料模型，法定員工福利支出對企業投資的估計係數皆爲顯著負值。

第四章

本論文中第三項實證研究探討中國的基本工資的調漲，對企業固定資本與人力資本投資之影響。本文利用中國縣級基本工資數據，並採用中國工業企業數據庫，以 2004 年基本工資相關新規定通過及其前後時段爲研究期間進行分析。就研究方法而言，本章節採用動態縱橫資料模型 (GMM dynamic panel data) 估計固定資本投資模型，並採用杜賓模型 (Tobit model) 估計人力資本投資迴歸。根據本文實證結果顯示，中國基本工資對企業固定資本投資呈現顯著的正向影響，對於人力資本投資則呈現顯著的負向影響。進而，本文以樣本中的企業之不同所有權做爲區隔，發現所有受到基本工資調整影響的企業，包含國營企業與外資企業，皆有降低人力資本投資率之趨向，但惟有中國的私營企業呈現替代效果，顯著增加其固定資本投資。

English Abstract

Chapter 2

In this chapter, we employ manpower utilization data to test the theory of equalizing differences for the most recent amendments to the labor insurance contribution rates in Taiwan. Our empirical research fills a gap in the literature by providing evidence on compensating wage differentials for the third major type of mandated benefits after contrasting evidence has been provided for the effects of health insurance and pension fund contribution rates in previous research. We thus employ manpower utilization survey data over the period from 2010 until 2012 and estimate several difference-in-differences models comparing the development of the gap between private and public sector wages to the one in our base year. Our results broadly confirm the theoretical prediction of the theory of equalizing differences by demonstrating that private sector wages in Taiwan have indeed decreased in response to the reforms.

Chapter 3

In recent years, mandated benefits in Taiwan have increased significantly due to several policy reforms pertaining to social insurance and labor welfare. An important policy issue is the question whether the resulting increase in total labor costs has in turn caused a decrease in capital investments. This chapter therefore employs data from Taiwanese stock market companies over the period from 2002 to 2012 to analyze the effect of mandated benefits on fixed capital investments. In order to shed light on both short-term and longer term processes and to control for potential bias due to unmeasurable heterogeneity and endogeneity between mandated benefits and other forms of labor compensation, we estimate error-correction models using a GMM estimation strategy. The control variables employed are motivated by the literature on capital investments based on accelerator model, cash flow model, neoclassical model and Tobin's Q. According to our empirical research results, an increase in

mandated benefits causes a reduction in company capital investments. This finding is robust across different estimation techniques and various instruments employed to measure the development of mandated benefits.

Chapter 4

This chapter empirically analyzes the impact of Chinese minimum wage regulations on the firm decision to invest in physical and human capital. We exploit the geographical and inter-temporal variations of county-level minimum wages in a large panel data set of Chinese firms covering the introduction of the new Chinese minimum wage regulations in 2004 and estimate dynamic panel data GMM models for our fixed capital investment regressions, as well as tobit models for our human capital investment regressions. In our basic regressions including all Chinese firms, we find significant negative effects of the minimum wage on human capital investment and significant positive effects on fixed capital investment. When grouping firms by their ownership structure, we find that all company groups - including state-owned and foreign-owned firms - have reduced their human capital investments, whereas only Chinese privately owned firms have increased their fixed capital investment rates, hence exhibiting a substitution effect between the two factors of production.

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1 Introduction

Governments around the globe mandate elements of the labor compensation system in order to achieve socially desirable outcomes where the market has failed to do so. The International Labour Organization (ILO) encourages its member states to implement minimum wages and to provide minimum social protection in terms of health care, insurance benefits and pension funds (ILO, 2009; ILO, 2013).[1] The latter are typically paid as mandated benefits and constitute the majority of non-wage labor compensation paid by companies to their employees.[2] While such labor market institutions have been instrumental in achieving social policy objectives, their effect on the labor costs incurred by firms also affects company behaviour. This effect is of importance not only for economic development, but also from a labor economics perspective since production costs affect company development which in turn feeds back to labor market indicators in the longer term. Taiwan and China - the two economies in our study - have both increased their standards for mandated labor compensation during the past two decades. In this dissertation, we focus on two elements of the labor cost system which have substantially increased in the two economies by analyzing the effects of reforms of the mandated benefit system in Taiwan and minimum wage regulations in China.

In Taiwan, policy makers have introduced several reforms pertaining to social insurance and labor welfare during the past two decades. As a result of these reforms, company mandated benefit expenditures have increased significantly. In particular, three policy shifts have had an immediate impact on the development of company expenditures for mandated benefits. The first one is the introduction of the National Health Insurance in 1995. The unified national scheme replaced thirteen workplace-

[1] No ILO instrument officially defines the term "minimum wage" and it is generally understood to be "the minimum sum payable to a worker for work performed or services rendered [...] which is guaranteed by law and which may be fixed in such a way as to cover the minimum needs of the worker and his or her family, in the light of national economic and social conditions"(ILO, 1992; ILO, 2014).

[2] According to the ILO definition total labor compensation costs include (1) direct pay, (2) employer social insurance expenditures and (3) labor-related taxes (ILO, 2013). We analyze the effects of government mandates regarding the second element.

related public health insurance plans previously in place and extended coverage to the whole population by also covering dependants of employees. The insurance scheme is financed by premium payments shared between employers and employees. While the changes in NHI premium rates over time have been smaller than for the other two kinds of mandated benefits discussed below, the employer premium rates for NHI have been recently increased from 2.73% to 3.10% of employee wages in 2010.[3] The second policy reform pertaining to the mandated benefit system is the enactment of the Labor Pension Act in 2004. According to the regulations, companies are required to make payments to a pension fund according to the defined contribution principle for new labor market entrants, while previous labor market entrants may chose between the new system and a defined benefit system which had been previously introduced as part of the Labor Standards Act. The Labor Pension Act requires companies to contribute 6% of an insured person's monthly salary to the Labor Pension Fund and have induced a rise in non-wage labor costs during the transition years after the introduction of the new law. As the third policy shift, premium rates for labor insurance have been successively raised since 2011. With previous rates at 7.5% of an insured person's salary, in July 2008 the authorities decided to increase the insurance premiums from 2011 onwards by 0.5% annually until a 10% threshold rate will be reached in 2015.[4] As a result of the policy shifts, the current level of company mandated benefit expenditures, which also include severence pay and employee welfare expenditures, amounts to more than 15% of company wage expenditures.

While the reforms have improved the well-being of Taiwanese workers, at the same time they have also increased labor costs for Taiwanese companies. As a result of the reforms, total company expenditures for insurance premiums and pension contributions have risen by 28.9% between 2002 and 2012. According to previous

[3] The complete English versions of the related legal documents are provided on the website of the Bureau for Health Insurance (http://www.nhi.gov.tw).

[4] See Article 3, Article 13 of the Labor Insurance Act. English versions of the regulations are provided by the Ministry of Labor on its Law Source Retrieving System of Labor Laws and Regulations (http://laws.mol.gov.tw/).

research findings for the Taiwanese economy, increases in labor costs due to mandated benefit and payroll tax system reforms exert adverse affects on company labor input levels (Lai and Masters, 2005; Kan and Lin, 2009) and wages (Yang and Luoh, 2009). An analysis of labor market effects of the third type of mandated benefits mentioned above has not been conducted thus far. More importantly, an analysis of the effect of mandated benefits on the other main factor of production - capital - via the fixed asset investment decision is missing to date. This effect is of particular importance for the Taiwanese economy, since low levels of domestic capital investment in combination with a net outflow of international investments have become critical issues in recent years.[5] While wage growth has been notoriously stagnant in the Taiwanese economy, the mandated part of labor compensation has increased significantly during the recent social security system reforms and the resulting increase in labor costs may be one reason behind the low levels of capital investments in the Taiwanese economy.

In China, minimum wages have been a key driving factor behind labor cost developments during the past two decades. China first recognized the ILO Minimum Wage Fixing Convention in 1984 and introduced its first 'Enterprises Minimum Wage Regulations' in 1993. In 2004, the government passed new minimum wage regulations, requiring each province to increase its minimum wage at least biannually and increasing the fines for non-compliant companies. The frequency and scale of minimum wage adjustments across the Chinese economy has subsequently increased significantly. While the average increase in the minimum wage per county was 34.98% between 1993 and 2004, this was followed by an increase of 174.61% in the subsequent years until 2012. According to data from the Urban Household Survey used in Fang and Lin (2013), 8.91% of urban workers and 57.01% of urban female

[5] Growth in domestic investment has been surpassed significantly by outward investment into other economies. Most notably, investment to mainland China has risen from US$ 4.5 billion to 12.2 billion between 2003 and 2010, while investment to ASEAN economies has risen from US$ 1.05 to 2.13 billion over the same period. Moreover, despite being ranked favorable on various investment climate indexes, Taiwan has been unable to attract foreign capital at a significant scale and inward foreign investment currently amounts to about one fifth of outward direct investment.

workers were earning the minimum wage or less between 2004 and 2009. While data on non-urban workers are scarce, the number of affected workers amongst rural migrants is estimated to be much higher than in the urban worker group.

At the same time, the controversy regarding the suitability of the policy for the Chinese economy has increased. Proponents argue that it is a necessary means to warrant sufficient living standards for vulnerable workers and introduces incentives for companies to upgrade excessively labor intensive production technology, while its opponents argue that the policy interferes with the transition to a market economy and that it raises production costs, in turn harming the international competitiveness of Chinese companies (Cooke, 2005; Wang and Gunderson, 2011). Empirical research on minimum wages in the Chinese economy has found some negative effects on working hours (Jia, 2014) and employment (Fang and Lin, 2013) for some labor groups. However, the effect on company investment behaviour in the Chinese economy has not been investigated thus far and we therefore aim to scrutinize the effect of the policy on company capital investments and the willingness to invest in staff training. As explained below, the empirical literature on the effect of minimum wages on firm investment in both physical and human capital investments in other economies currently remains inconclusive.

In this research we thus analyze the effect of changes in labor cost mandates on wages and company investments by focusing on the recent reforms of the mandated labor cost system in Taiwan and China. We first investigate a topic that has already received some amount of attention in the literature by analyzing whether the most recent government mandated increase in labor insurance payments in Taiwan has caused a reduction in worker's wages. After mixed evidence from two previous academic contributions, this chapter closes a gap in the literature by analyzing whether compensating differentials have occured after adjustments of the premium rates of the third type of mandated benefits described above.[6] Second, we then construct a panel data set of Taiwanese companies and analyze whether the increase

[6] Kan and Lin (2009) reject this hypothesis for the NHI reform, while Yang and Luoh (2009) confirm it for the recent pension system reform.

in total mandated benefit payments during the past decade has depressed company capital investments Taiwan. In the third essay of this dissertation we adopt a similar methodological approach for the case of minimum wages and exploit the changes introduced by Chinese policy makers in recent years to analyze the effect of the policy on company investments in both physical and human capital for a panel of Chinese companies.

The outline of this dissertation is therefore as follows. Chapter 2 employs Manpower Utilization Survey data to test the theory of equalizing differences by analyzing whether the recent increase in labor insurance contribution rates in Taiwan has caused compensating wage differentials. Chapter 3 employs data from Taiwanese listed companies to analyze whether the overall increase in social security contribution rates has affected company fixed capital investment rates. Chapter 4 uses China Annual Survey of Industrial Firms (CASIF) data to analyze whether the recent Chinese minimum wage hikes have affected the fixed and human capital investment rates of Chinese firms. In each of these chapters we introduce our data set and methodology and present our research findings and engage in a discussion thereof. Chapter 5 summarizes the overall findings and concludes this dissertation.

2 Has raising labor insurance contribution rates caused compensating wage differentials in Taiwan?

2.1 Review of the empirical literature: compensating wage differentials

The theoretical effect of an increase in labor costs through a higher minimum wage or a higher level of mandated benefits is a reduction in labor demand due to negative output and substitution effects. This implies layoffs or a reduction in labor utilization rates. Yet, for the case of an increase in non-wage labor costs an alternative channel for adjustment exists. According to the theory of equalizing differences, an increase in non-wage labor costs can be offset through a reduction in wages (Rosen, 1974, 1986). As a result, total labor costs remain constant and labor demand as well as investment levels are not affected. It is important to bear in mind that the overall effect of the policy shift on labor input levels and the ability of companies to compensate changes in non-wage labor costs with wage adjustments also bears an impact on capital investments through output and substitution effect.

After the seminal contributions by Rosen, researchers began to empirically analyze the incidence of compensating differentials due to mandated benefits in the US economy during the late 1970s.[7] Schiller and Weiss (1980) were amongst the first to conclude that an increase in mandated benefits had been offset by lower wages. Their conclusion for the case of pension benefits was that the compensating differentials *partially* (but not *fully*) offset the change in benefit levels. This finding has been confirmed in the majority of later studies. In particular, the compensating dif-

[7] Before applying the theory of equalizing differences to mandated benefits, earlier research has more generally focused on the wage differential due to job characteristics. See Duncan (1976) and Brown (1980) who analyze the effects of factors such as freedom to choose work time, workplace safety, degree of task repetitiveness and other characteristics. This type of research has provided very limited support for the compensating differentials hypothesis (Brown, 1980).

ferentials hypothesis in its partial or full version has been confirmed for total fringe benefit payments (Woodbury, 1983), pension benefits (Montgomery et al., 1992; Montgomery and Shaw, 1997), health insurance (Miller, 2004) and unemployment insurance (Anderson and Meyer, 2000; Murphy, 2007). Baicker and Chandra (2005, 2006) jointly analyze the effect of health insurance premiums on employment and wages and find that both are adversely affected. Adopting a model with sticky nominal wages, Sommers (2005) confirms the adverse employment effect due to health insurance payroll taxes.

In the first notable contribution from other economies, Holmlund (1983) also concluded that payroll tax increases were partly shifted backwards onto wages in Sweden during the 1970s. Gruber (1997) finds that the incidence of a reduction in the payroll tax rate during a period of social security system privatisation in Chile has raised wages without an effect on employment. Cruces et al. (2010) conclude for partial backward shifting of payroll taxes without an effect on employment in their analysis of different regions in Argentina. The absence of an effect on employment is again confirmed for the case of Germany in Bauer and Riphahn (2002). Using the Columbian health and pension social security reform from 1993 as a natural experiment, Vargas (2011) shows that gender and family structure affect the labor market outcomes of the reform with negative effects on single women but positive wage effects for male workers. In a model allowing for entry and exit of firms, Bennmarker et al. (2009) is amongst the few studies finding a positive effect on the number of firms and employment levels for the case of the 10% payroll tax reduction implemented in Sweden in 2002. The positive effect of a payroll tax reduction on wages and unemployment has also been found in a recent study by Cervini-Plá et al. (2014) using Spanish data. As one of the few studies from Asian economies, Lai and Masters (2005) show that maternity and pregnancy benefits have reduced wages and employment of young women in Taiwan. Kan and Lin (2009) analyze the effects of national health insurance in Taiwan and find that married men faced adverse work hour effects and those in high wage groups also witnessed a negative impact on their wage. On the contrary, Yang and Luoh (2009) conclude that an increase in pension premiums is almost fully shifted back through lower wages. In sum, the most widespread finding in the literature on the labor market effects of mandated benefits are adverse effects on employee wages, while mixed evidence has been provided for the employment effects of payroll taxes.

2.2 Methodology

2.2.1 Difference-in-differences estimation

For our empirical analysis of compensating wage differentials in response to the recent labor insurance rate reforms in Taiwan, we derive a difference-in-difference regression specification to scrutinize the effects of the policy. The derivation of the model to be estimated in this chapter is based on a standard human capital earnings function developed in Mincer (1974) and previously used in several empirical papers (Schiller and Weiss, 1980; Smith and Ehrenberg, 1983; Montgomery et al., 1992; Yang and Luoh, 2009). The earnings function takes the following form:

$$Y_i = A\, exp\left(\boldsymbol{\alpha}'\boldsymbol{x_i} + \varepsilon_i\right) \tag{1}$$

where Y is total labor compensation, $\boldsymbol{x}$ contains personal characteristics affecting productivity, ε is an independent and identically distributed error term, and A reflects the technology level. In addition to wages W, workers are compensated by benefit payments which are mandated as a fraction p of wage payments. Total labor compensation can therefore be decomposed into the two elements as:

$$W_i\left(1 + bp_i\right) = A\, exp\left(\boldsymbol{\alpha}'\boldsymbol{x_i} + \varepsilon_i\right) \tag{2}$$

If wage payment and benefit compensation is valued equally, the value of b amounts to one. After taking logarithms, assuming that $ln\left(1 + p\right) = p$ for small values of p and incorporating the technology level as the constant in our vector $\boldsymbol{x}$ brings about our basic estimation equation as:

$$ln\, W_i = \boldsymbol{\alpha' x_i} - bp_i + \varepsilon_i \tag{3}$$

This equation is the starting point for the difference-in-difference (DID) models implemented in this chapter.

The basic idea of a two-period DID model is a comparison between two groups which are both not subjected to a policy change in the first period. In the second period, the treatment group is subjected to the new policy, while the control group remains exempt from it. Algebraically, we can write:

$$\Delta^{POLICY} = (Y_{t=1}^{treat} - Y_{t=0}^{treat}) - (Y_{t=1}^{control} - Y_{t=0}^{control}) \tag{4}$$

Where Δ^{POLICY} is the effect of the policy and *treat* and *control* signify treatment and control group, respectively. When implemented in a regression framework with pooled data for the pre-policy (t=0) and post-policy (t=1) periods, this yields the following general regression equation:

$$ln\, W_{it} = \beta_1\, treat_{it} + \beta_2\, post_i + \beta_3\, impact_t + \boldsymbol{\alpha' x_{it}} + \varepsilon_{it} \tag{5}$$

where *post* is a dummy variable equal to 1 in the post-policy period and 0 otherwise, *treat* is a dummy variable equal to 1 for the treatment group and 0 otherwise and *impact* is the product of the two dummy variables which measures the impact of the policy.

2.2.2 Policy background and regression specification

The policy shift we aim to analyze in this chapter is an amendment of the Labor Insurance Act, which was passed in July 2008. Following the new regulations, which apply to all Taiwanese private companies employing at least five employees, a successive increase in labor insurance premium rates was required starting from

Table 2.1: Public and private sector labor insurance contribution rates

Year	Private	Public	$\Delta_{Private-Public,t}$	$\Delta_{Private-Public,t} - \Delta_{Private-Public,2010}$
2010	4.55%	4.65%	−0.10%	0.00%
2011	4.90%	4.65%	0.25%	0.35%
2012	5.25%	4.65%	0.60%	0.70%

Notes: Private sector insurance contribution rates were obtained from the website of the Ministry of Labor (http://www.mol.gov.tw). Public sector insurance contribution rates can be found on the website of the Ministry of Civil service (http://www.mocs.gov.tw).

2011. As displayed in table 2.1, employer contribution rates for labor insurance in the private sector were at a level of 4.55% of employee wages in 2010. Subsequently, the contribution rates were raised by 0.35% until a premium rate of 5.25% was reached in 2013.[8] Public sector companies, however, pay premiums according to the Civil Servant and Teacher Insurance Act and were not exposed to the above regulations.[9] The premium rates for public sector companies had not been raised in more than a decade and remained constant throughout our study period, hence providing a suitable control group.[10] The difference in the time paths of private and public sector contribution rates therefore enables us to disentangle the effect of the labor insurance rate policy on wages. In particular, the increase in the private-public sector contribution rate gap in the first year, followed by an equal increase in the following year motivates a regression setting with a stepwise measure for the intensity of the policy treatment. We therefore set up our regression model as follows. The variable *treat* identifies our treatment group as all private sector employees in our sample. For our treatment group, the variable *impact* therefore takes on the value one in the first year of our analysis and the value two the final year

[8] The element of the private sector labor insurance rates that was affected are the contribution rates for ordinary accident insurance. These were raised by 0.5% annually. Because employers pay 70% of the insurance rates, this increase implies an impact of 0.35% on employers. The other element of the private sector labor insurance, the unemployment insurance, remained unchanged at 1% throughout our study period.

[9] A limitation of our data set is that we cannot identify workers that are employed in public enterprises but are not civil servants and are therefore not entitled to participate in public employee insurance. These workers, which include contracted workers, workers in government-owned businesses, as well as drivers and technicians in government institutions, pay labor insurance premiums according to the Labor Insurance Act.

[10] Because public sector companies were subjected to a premium rate increase of 0.71% in 2013, we only include the time periods during which the public sector contribution rate remained constant in our study.

of our analysis, when the difference in contribution rates between the two company groups was approximately twice the size of the first year.[11] The variable *post* takes on the value zero in 2010 and the value one in the two post-policy years.

$$ln\, W_{it} = \beta_1\, treat_{it} + \beta_2\, post_{it} + \beta_3\, impact_{it} + \boldsymbol{\alpha}' \boldsymbol{x_{it}} + \varepsilon_{it} \tag{6}$$

We implement four different estimation specifications for this regression model. We first estimate it with occupations grouped by type and employment grouped into secondary and tertiary sector (model 1). In the remaining models, we then employ occupational dummies (model 2), two-digit industry dummies (model 3), and dummies for both occupations and industries (model 4).

2.3 Data set and descriptive statistics

To investigate the impact of the recent labor insurance premium rate adjustments on affected workers, we construct a data set consisting of repeated cross-sections of individual labor data from the Manpower Utilization Survey (MUS). The survey is conducted by the Directorate General of Accounting, Budget and Statistics in Taiwan and contains representative information about Taiwan's labor force including monthly wages, working hours and a range of personal and workplace characteristics which will serve as control variables.

In order to address the effect of the recent labor insurance premium rate adjustments, the data included in this chapter cover the period from 2010 until 2012. To obtain reliable estimates, we select a relevant subset of the labor force that can be included in our analysis as follows. First, to avoid complications due to differences in the wage structure and movements between full-time and part-time employment, we focus on full-time employees working more than 35 hours per week. Second, we omit self-employed workers from our analysis since their wage rates cannot generally be compared to workers in an employment relationship. Third, in order to

[11] The difference-in-difference model with varying treatment intensity over time implemented in this chapter is similar in nature to the model employed by Waldinger (2010).

Table 2.2: Hourly wages of treatment and control group over time

	2010	2011	2012	$\Delta_{2011-2010}$	$\Delta_{2012-2010}$
Treatment group	195.945	193.635	191.930	−2.310	-4.015^{**}
	(101.820)	(102.797)	(104.404)	(1.423)	(1.435)
Control group	264.993	269.466	272.242	4.473	7.249^{*}
	(108.089)	(112.239)	(111.537)	(2.953)	(2.959)
$\Delta_{Treatment-Control}$	69.048^{***}	75.831^{***}	80.312^{***}	-6.782^{**}	-11.264^{***}
	(2.188)	(2.255)	(2.298)	(3.142)	(3.173)

Notes: Mean values are displayed in the first, third and fifth row. The rows below show standard deviations and standard errors in parentheses. The significance symbols indicate that a t-test was significant at the 10%-level (*), 5%-level (**) or the 1%-level (***).

ensure the accuracy of our wage variable, we only retain survey respondents who have answered the survey questions in person.[12] Our final data set includes a total of 31342 observations from our treatment group and 8219 observations from our control group.

We then proceed to the calculation of our dependent variable. As in Mincer (1974), we use the logarithm of hourly wages as our measure for wage compensation. Since the MUS survey asks for monthly wages as well as information on the hours worked by each worker per week, we calculate our dependent variable as monthly wages divided by monthly working hours. Monthly working hours are calculated as weekly working hours times $4\ ^1/_3$. We use consumer price inflation data obtained from the national statistical authority and deflate the wage data to the price level in 2010, i.e. the first year included in our analysis.

Table 2.2 presents the development of the hourly real wage rate over time for our treatment and control groups. Hourly real wages of our treatment group decrease by about NT$4.0 between 2010 and 2012. Hourly real wages of our control group increase by about NT$ 7.2 during the same time span. Two-tailed t-tests on the difference in hourly wages between the two groups point to large and persistent differences between the two groups. We then use 2010 as our base year and investigate the difference-in-differences for hourly wages over time. The raw differences point to

[12] Achieving a high response rate is a priority in the implementation of the survey used in this chapter. If a respondent is absent, other household members are therefore allowed to answer on his behalf. However, it is likely that these only possess inaccurate information regarding the salary of the absent person.

a differential of NT$6.8 in the second year of our analysis, followed by NT$11.3 in the third year. The development of these raw difference-in-differences values, which are statistically significant in every year included, therefore closely resembles the development of the theoretical difference-in-differences values of the contribution rates displayed in table 2.1.

Since there are persistent differences between our treatment and control group in terms of their personal and workplace characteristics, the control variables used in this chapter are of particular importance. We calculate a rage of control variables based on the initial work by Mincer (1974) and recently used by Yang and Luoh (2009) in their analysis of the Taiwanese pension system reform using the same database as in the current work. Our first set of control variables is employed in order to control for differences in personal characteristics. According to standard human capital theory, the educational attainment of a worker bears a positive impact on the resulting wage level (Becker, 1993). The years of schooling received by each worker therefore serve as our first control variable. Work experience is the second factor that contributes to higher wages. We include both the number of years a worker has been tenured by his or her current employer as well as the total number of potential years a worker has been in the labor market as additional control variables. Since both of these variables are expected to display decreasing marginal returns in terms of the wage outcome, we also include their squared values in our regressions. Motivated by the literature on marriage wage premiums (Korenman and Neumark, 1991; Loh, 1996) and gender wage differentials (Oaxaca, 1973; Weichselbaumer and Winter-Ebmer, 2005), we include marital status and gender of a worker as our final controls measuring worker characteristics. Our second set of controls is also included in the MUS data and aims to capture differences in the work environment of an employee. The variables include the occupation type, the geographical location and sector of the respective job undertaken. In order to maintain a high degree of freedom in our basic regressions, we group similar job types into managerial jobs, specialist jobs, assistant and clerk jobs as well as physical jobs. For the sectoral classification of jobs,

TABLE 2.3: Variable means for treatment and control group in each year

	Control group			Treatment group		
	Pre-reform 2010	Post-1 2011	Post-2 2012	Pre-reform 2010	Post-1 2011	Post-2 2012
Monthly wage	47997.583	48943.901	49372.658	37230.444	36917.836	36501.359
Weekly working hours	42.008	42.174	42.106	44.403	44.572	44.476
Education	14.879	15.049	15.141	14.111	14.074	14.119
Gender (male=1)	0.525	0.519	0.507	0.555	0.562	0.570
Age	42.580	42.626	43.107	37.159	37.284	37.731
Married	0.678	0.682	0.673	0.522	0.514	0.515
Experience	21.693	21.552	21.964	17.033	17.187	17.587
Tenure	11.120	11.158	11.606	6.765	6.839	7.032
Secondary sector	0.094	0.096	0.091	0.441	0.455	0.455
Tertiary sector	0.906	0.904	0.909	0.559	0.545	0.545
Medium-scale firm	0.000	0.000	0.000	0.252	0.242	0.249
Large-scale firm	0.000	0.000	0.000	0.238	0.238	0.237
Managerial staff	0.035	0.034	0.036	0.044	0.040	0.040
Specialist staff	0.509	0.528	0.541	0.411	0.390	0.381
Support staff	0.311	0.296	0.296	0.214	0.220	0.223
North	0.384	0.396	0.413	0.513	0.505	0.505
Central	0.224	0.227	0.222	0.219	0.223	0.217
South	0.321	0.301	0.294	0.252	0.254	0.261
Unemployment rate	5.193	4.391	4.240	5.194	4.381	4.235
Observations	2861	2707	2651	10040	10655	10647

Notes: All NT$ values have been deflated to the price level in year 2010. The variables *gender*, *married*, as well as the firm size variables, the job types (*support* and *physical*), sectoral and regional variables are all dummy variables. Support jobs include clerk, sales and general service positions. The reference group are physical jobs, which include the operation of equipment and other manual labor.

we distinguish between the secondary and the tertiary sector. In order to account for regional differences in the returns to personal and job characteristics, we distinguish between jobs in the Northern, Central, Southern and Eastern part of Taiwan.[13] As our third and final set of control variables, we obtain two measures of the overall economic environment in Taiwan. The first is the Taiwan Capitalization Weighted Stock Index (TAIEX) which measures the overall performance of the Taiwanese economy in each year. We calculate the index as the annual average of weekly data obtained from the website of the Taiwan Stock Exchange (TWSE). The second is the unemployment rate which is available annually for each city and county in Taiwan. Based on the predictions of the wage curve, a negative relationship is expected between the unemployment rate and the wage rate in each locality (Blanchflower and Oswald, 1994).

Mean values by time period for each variable in our data set are displayed in table 2.3. The differences in worker and workplace characteristics between treatment and control group are highly persistent during the four year period of our analysis. The public sector is characterized by higher monthly wages and lower working hours that amplify the wage differences in terms of hourly returns to labor input. Public sector workers are also characterised by higher educational attainment, labor market experience, and tenure as well as a higher likelihood of being married. Public sector jobs are predominantly in the tertiary sector, whereas the incidence of tertiary sector employment in the private sector is only approximately ten per cent higher than secondary sector employment. The balance between male and female workers is almost even in the public sector, while the ratio of male to female workers is about 1.28 in the private sector. The number of specialists and staff in clerical and support functions is higher in the public sector, hence implying a higher percentage of physical labor, which is our base category, in the private sector. We also identify a more even

[13] Northern Taiwan includes Taipei City, New Taipei City, Keelung City, Taoyuan County, Hsinchu City and County and Yilan County. Central Taiwan covers Miaoli County, Taichung City and County, Changhua County, Nantou County and Yunlin County. The South covers Chiayi City and County, Tainan City and County, Kaohsiung City and County, Pingtung County and Penghu County. The Eastern part includes Hualien County and Taitung County.

geographical distribution of public sector positions across Taiwan, while almost half of private sector employment is located in the Northern part of the island. As part of the recent recovery period after the global recession, the two variables measuring the economic environment in each year (stock market index and unemployment rate) and county (unemployment rate) have both developed favourably between the first and the final year included in this chapter.

2.4 Results

The regression results of equation 6 are displayed in table 2.4. Our key finding is a negative impact of the labor insurance regulations on the wage compensations paid to affected workers, which broadly confirms the prediction of the theory of compensating differentials. Our key result is robust acrossour four specifications, i.e. the model with occupation and industry groups (model 1), occupational dummy variables (model 2), industry dummy variables (model 3), and our final model with dummy variables for both occupations and two-digit industries (model 4). The size of the treatment effect we identify is approximately 1.1%. When controlling for a range of wage determinants, we find a conditional wage gap of about 18.7% between the public and the private sector and no significant differences in levels between the pre-policy year and the post-policy years.

The results regarding our control variables are largely in line with our predictions. We find a 4% salary gain to an additional year of education as well as positive returns to tenure and labor market experience with decreasing returns for both variables. We find positive wage differentials for married persons and males. Large firms pay the highest wages and medium-scale firms also pay wages significantly higher than small firms. Managers reap the highest salaries, followed by specialists and support staff position, which all earn more than employees in jobs with a physical nature that were used as our base group. After controlling for other factors, wages in the North are higher than in the centre of Taiwan, while wages in the South do not differ significantly from wages paid in the East. The coefficient of the Taiwan

Table 2.4: DID regression results

	(1)	(2)	(3)	(4)
Treatment effect	−0.010**	−0.013***	−0.009**	−0.011**
	(0.023)	(0.003)	(0.032)	(0.012)
Post-policy	0.008	0.013	−0.007	−0.011
	(0.719)	(0.543)	(0.756)	(0.592)
Treatment group	−0.198***	−0.200***	−0.182***	−0.180***
	(0.000)	(0.000)	(0.000)	(0.000)
Education	0.046***	0.041***	0.042***	0.040***
	(0.000)	(0.000)	(0.000)	(0.000)
Tenure	0.023***	0.020***	0.020***	0.018***
	(0.000)	(0.000)	(0.000)	(0.000)
Tenure sq.	−0.000***	−0.000***	−0.000***	−0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Experience	0.013***	0.013***	0.013***	0.013***
	(0.000)	(0.000)	(0.000)	(0.000)
Experience sq.	−0.000***	−0.000***	−0.000***	−0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Gender (male=1)	0.160***	0.154***	0.162***	0.149***
	(0.000)	(0.000)	(0.000)	(0.000)
Married	0.050***	0.048***	0.045***	0.043***
	(0.000)	(0.000)	(0.000)	(0.000)
Tertiary sector	0.071***	0.055***		
	(0.000)	(0.000)		
Managerial staff	0.500***		0.520***	
	(0.000)		(0.000)	
Specialist staff	0.216***		0.227***	
	(0.000)		(0.000)	
Support staff	−0.007		0.035***	
	(0.132)		(0.000)	
Medium-scale firm	0.050***	0.051***	0.052***	0.054***
	(0.000)	(0.000)	(0.000)	(0.000)
Large-scale firm	0.095***	0.094***	0.093***	0.093***
	(0.000)	(0.000)	(0.000)	(0.000)
North	0.083***	0.086***	0.073***	0.073***
	(0.000)	(0.000)	(0.000)	(0.000)
Central	0.028***	0.028***	0.022**	0.023**
	(0.003)	(0.002)	(0.018)	(0.012)
South	−0.001	−0.000	−0.008	−0.008
	(0.943)	(0.983)	(0.378)	(0.385)
Stock market Index	0.000	−0.000	0.000	0.000
	(0.648)	(0.834)	(0.439)	(0.744)
Unemployment rate	0.005	0.014	−0.009	−0.003
	(0.792)	(0.472)	(0.622)	(0.867)
Occupation dummy controls		✓		✓
Industry dummy controls			✓	✓
Observations	39496	39496	39496	39496
R^2	0.560	0.582	0.592	0.611

Notes: P-values are shown in parentheses. The significance symbols denote: * for $p < 0.10$, ** for $p < 0.05$, and *** for $p < 0.01$.

Capitalization Weighted Stock Index is positive and the coefficient of the county-level unemployment rate is negative, which is in line with our predictions, but both coefficients turn out insignificant.

2.5 Conclusion: compensating wage differentials

In this chapter, we have provided evidence of compensating wage differentials as a results of the recent labor insurance contribution rate amendments in Taiwan. In particular, we find a significant negative impact of approximately 1.1% on private sector worker wages during the two reform years. As in previous work by Yang and Luoh (2009) on the Taiwanese pension system reform, we confirm that employers are indeed able to shift the labor cost increase due to mandated benefits forward to their employees through a decrease in wages for the case of the recent labor insurance rate reform. However, our results differ from previous findings by Kan and Lin (2009), which suggests that an impact on firm behaviour and development can be expected as a result of different mandated benefit system reforms that have been implemented in Taiwan during the past two decades. A data limitation in this chapter is that the public sector control group employed also includes some workers under the private sector insurance scheme which we could not identify from our data.

3 What is the effect of raising mandated benefits on company fixed capital investments? Evidence from Taiwanese listed companies.[14]

3.1 The theoretical effects of mandated labor costs on firm-level fixed capital investment

The theoretical predictions regarding the effect of an exogenous change in the price of labor due to an increase in mandated benefits differs between standard neoclassical models and non-competitive models of the labor market.[15] Based on standard neoclassical theory, a mandated increase in the price of labor induces firms to substitute away from affected workers. The effect on capital thus depends on the degree of substitutability or complementarity between the two factors of production. If the two factors are complements, the decrease in labor input will be accompanied by a decrease in capital investment rates. If the two factors are substitutes, however, a decrease in labor input will go along with an increase in capital investment rates. Moreover, the cost burden imposed on companies through minimum wages potentially affects capital investments via a negative scale effect as product prices rise and the level of output drops. The overall effect of an increase in mandated labor costs on capital investment therefore depends on the direction and size of the substitution (or complementarity) effect and the size of the scale effect.

More recently, non-competitive models of the labor market have been developed in which labor market frictions and asymmetric information lead to a wedge between wages and marginal productivity (Acemoglu and Pischke, 1999). In these models,

[14] A preliminary version of this chapter has previously been presented at the *Singapore Economic Review Conference 2013.* A revised version is forthcoming in the *Taiwan Journal of Applied Economics* (TSSCI) as “Mandated benefits, labor costs and company fixed capital investments.”

[15] The theoretical predictions outlined in this section also apply to the effects of increases in the minimum wage on fixed capital investments analyzed in the next chapter. We therefore use the term “mandated labor costs” to jointly refer to mandated benefits and minimum wages in this section.

it can be profitable for a firm to retain a worker despite the increase in wage costs if it can increase worker productivity through investments in fixed capital and claim the resulting rents. Contrary to the results from traditional models, an increase in mandated labor costs without offsetting compensating differentials may thus induce an increase in fixed capital investments (Acemoglu and Pischke, 2003; Pischke, 2005). Hybrid models of the labor market that relax the general assumption of perfect competition generally predict that the incidence of an increase in labor cost mandates varies with the degree of competition and the amount of rents that can be allocated. The discrepancy between the theoretical predictions of neoclassical and non-competitive models of the labor market is therefore an additional factor facilitating an analysis of the effects of mandated benefits on company fixed capital investments.

3.2 Methodology

For our empirical analysis of the effect of mandated benefits on company fixed capital investments, we construct a panel dataset of Taiwanese companies covering the mandated benefit reform period during the past decade. The panel data structure of our dataset brings about the advantages of controlling for unobserved heterogeneity, reducing omitted variable bias and of providing a dynamic picture of what happens as companies adjust their mandated benefit rates to the requirements of policy makers over time. Within this basic framework, we then regress capital investment rates on mandated benefits and a set of control variables.

3.2.1 Dependent and explanatory variables

For our dependent variable we follow previous literature and calculate company fixed asset investment rates as the purchase value of fixed assets from the current period divided by the fixed capital stock of the previous period (Bond et al., 2003; Becker and Jagadeesh, 2010).[16] The level of fixed capital investment spending is obtained

[16] Fixed assets refers to physical assets such as machinery, equipment and buildings that can be used for productive purposes.

directly from company accounts of sources and uses of funds, which is more accurate than inferring it from balance sheet data using the perpetual inventory method.[17] Since capital investments in any period add to the capital stock which is recorded at the end of the year, the capital stock from the previous period is used as a normalization.

Regarding our explanatory variable, we pay attention to the fact that mandated benefit requirements in Taiwan are dictated by policy makers as a ratio of benefits to wages, which brings about a mathematical relationship between the levels of the two variables. This mathematical relationship would cause a multicollinearity problem for our regression coefficients if the variables were included simultaneously. In order to alleviate the multicollinearity problem, we focus on exogenous contribution rates and derive several instruments to measure the effect of the development in mandated benefit expenditures on fixed capital investments in the next subsection. As explained in the previous section, the influence of mandated benefits may be either positive or negative, depending on whether the sum of the scale effect and a potential complementarity effect (negative) or a possible substitution effect (positive) dominates.

3.2.2 Static factor demand: estimation strategy

The starting point for the construction of our explanatory variables measuring the development of the mandated benefit regulations during our study period is to obtain the mandated benefit contribution rates from the websites of Bureau of Labor Insurance and the National Health Insurance administration. The annual contribution rates are displayed in table 3.1 below. The development of the contribution rates for labor insurance, health insurance and pension fund contribution reflects the exogenous policy shifts explained in the introduction. We calculate the exogenous mandated benefit contribution rate (ER) as the sum of the three individual contribution rates and employ it as our first instrumental variable. In order to assess

[17] See Eberhardt and Helmers (2010) for a brief discussion of the two methods.

Table 3.1: Employer exogenous mandated benefit contribution rates

Year	Labor insurance premium	Health insurance premium	Pension fund contribution rate	Total exogenous mandated benefit contribution rate (ER)
2003	4.550	2.730	2.000	9.280
2004	4.550	2.730	2.000	9.280
2005	4.550	2.730	6.000	13.280
2006	4.550	2.730	6.000	13.280
2007	4.550	2.730	6.000	13.280
2008	4.550	2.730	6.000	13.280
2009	4.550	2.730	6.000	13.280
2010	4.550	3.102	6.000	13.652
2011	4.900	3.102	6.000	14.002
2012	5.250	3.102	6.000	14.352
2013	5.600	3.102	6.000	14.702

Notes: Labor insurance and pension fund contribution rates have been obtained from the Bureau of Labor Insurance website (www.bli.gov.tw). Health insurance rates have been obtained from the National Health Insurance administration website (www.nhi.gov.tw). The mandated range for pension fund contribution rates was between 2% and 15% prior to the reform in 2004. Since 2% was the strict lower limit, we consider this the exogenous part. Company insurance premium rates are calculated as the insurance premium rate multiplied by the share to be borne by employers, which is 70% for labor insurance premiums and 60% for health insurance premiums.

the effect of the exogenous mandated benefit rate as determined by policy makers on company capital investments, we then estimate the following regression:

$$I_{it} = \alpha_{0i} + \alpha_1 \; ER_t + \boldsymbol{\alpha_2'} \boldsymbol{x_{it}} + \varepsilon_{it} \tag{7}$$

where the subscript i identifies companies and t are the years covered. The variable I is the investment rate and the vector $\boldsymbol{x}$ contains other labor costs, determinants based on different theories for capital investment and our lagged dependent variable as will be explained below. The letter ε denotes a stochastic error term.

The model above will provide a first indication of the direction of the effect of mandated benefits on capital investments. However, the policy shifts which alter the exogenous mandated benefit rate employed above affect the company investment decision only through their impact on the actual expenditures incurred by companies. While ER differs only over time but not between companies, the realized mandated mandated benefit expenditures differ between companies due to factors such as the incidence of an upper limit on insurance salaries.[18] The actual mandated

[18] Current lower and upper bounds for insurance salaries are 18,780 NT$ and 43,900 NT$ for labor insurance, 18,780 NT$ and 182,000 NT$ for health insurance and 1,500 NT$ and 150,000 NT$ for pension fund contributions. The upper bound on insurance salary for labor insurance is most relevant for our dataset.

benefit ratio MR calculated as mandated benefit expenditures per worker divided by the average wage per worker is therefore the second instrument we employ. The estimation equation takes the following form:

$$I_{it} = \beta_{0i} + \beta_1 \; MR_{it} + \boldsymbol{\beta_2' x_{it}} + \zeta_{it} \tag{8}$$

While the above equation reflects the actual mandated benefit expenditure situation of the companies more accurately, this specification has introduced a multicollinearity problem due to the mathematical interrelation between mandated benefits and wages. In order to treat the multicollinearity problem in the above equation, we use the exogenous mandated benefit contribution rate to predict the actual mandated benefit ratio for each company in our next specification. In order to generate our final instrument, we thus regress the actual mandated benefit expenditure ratio MR on ER and a constant. The constant term accounts for company specific factors, such as heterogenous impacts of upper limits of insurance salaries mentioned because of differences in the company-level wage distribution. The regression is as follows:

$$MR_{it} = \gamma_{0i} + \gamma_1 \; ER_t + \eta_{it} \tag{9a}$$

We then employ the predicted value of the mandated benefit ratio from the above regression ($\widehat{MR}$) as instrumental variable in our capital investment regression as follows:

$$I_{it} = \delta_{0i} + \delta_1 \; \widehat{MR}_{it} + \boldsymbol{\delta_2' x_{it}} \; + \theta_{it} \tag{9b}$$

The final issue to be resolved is the fact that the above equations do not account for the endogenous interaction of wages and fringe benefits as predicted by the theory of equalizing differences. As discussed in the previous chapter, the theory of equalizing differences predicts that an increase in mandated benefits causes a decrease in non-mandated worker compensation (Rosen, 1974, 1986). We therefore estimate first-stage regressions with changes in the levels of wages and voluntary benefits as dependent variables and changes in each of our mandated benefit indicators as explanatory variables. We use this specification to predict the wage residuals ($\hat{W}$) and the voluntary benefit residuals ($\hat{V}$) as the part of each initial variable that cannot be explained by changes in our mandated benefit indicator used in each of our regression specifications. For those first-stage regressions where a negative impact can be identified, we then utilize these residuals as instruments to replace the wage level from company accounts. Regressions 10, 11 and 12 are therefore analogous to equations 7, 8 and 9b, respectively. In each of the former three estimations, wage and voluntary benefit expenditures from company income statements are replaced by their residuals accounting for the incidence of compensating differentials. A detailed derivation of our estimation procedure as well as the first-stage regression results are shown in appendix A.[19] The final stage estimations for our investment regressions accounting for compensating wage differentials take the following form:

$$I_{it} = \alpha_{0i} + \alpha_1 \; ER_t + \boldsymbol{\alpha_2'} \boldsymbol{\hat{x}_{it}} + \varepsilon_{it} \tag{10}$$

$$I_{it} = \beta_{0i} + \beta_1 \; MR_{it} + \boldsymbol{\beta_2'} \boldsymbol{\hat{x}_{it}} + \zeta_{it} \tag{11}$$

$$I_{it} = \delta_{0i} + \delta_1 \; \widehat{MR}_{it} + \boldsymbol{\delta_2'} \boldsymbol{\hat{x}_{it}} + \theta_{it} \tag{12}$$

where the matrix $\boldsymbol{\hat{x}_{it}}$ differs from $\boldsymbol{x_{it}}$ only in the wage or voluntary benefit column where income statement values have been replaced by their residuals.

Since companies differ markedly in their characteristics and their development over time, we introduce several control variables to be used in this chapter. First of all, we employ two other kinds of labor costs as our key control variables. The first one are company expenditures for voluntary staff benefits. This variable includes payments for items related to employee welfare and allowances for food and transport. It also includes expenditures for employee training, which can be considered human capital investments from the point of view of the employer and a benefit from the perspective of the employee. While mandated and voluntary benefits are

[19] The compensating differentials hypothesis is confirmed for voluntary benefits in regressions 10 and 12, whereas compensating wage differentials are found the first-stage regression of equation 11.

both non-wage labor costs from an accounting perspective, companies can exert significant leverage in adjusting the level of voluntary staff benefits without being restricted by government regulations such as the ones for mandated benefits. Since training expenditures reflect company investments in human capital, this variable may also correlate with company fixed capital investments based on evidence provided in the literature on capital-skill complementarity (Griliches, 1969; López-Bazo and Moreno, 2008). Due to the different nature of voluntary and mandated benefits, the inclusion of this voluntary benefit variable provides the most insightful unit of comparison to mandated benefits.

We then include the level of average wages in a company as our second labor related control variable. On the one hand, wages are a cost component in the production process and may therefore reduce funding available for other purposes, such as capital investments. On the other hand, the average wage level of a company also reflects the human capital endowment of the workforce and higher levels of human capital raise the return on investment in physical capital. Based on the theory of efficiency wages, companies may also pay higher wages in order to increase worker productivity (Shapiro and Stiglitz, 1984). Since the efficiency effect in combination with the human capital effect and the cost effect are potentially offsetting, the overall effect of changes in the wage level cannot be predicted on theoretical grounds.

The remaining control variables used in our investment analysis are based on different models for the determinants of capital investments.[20] We first include the change in the logarithm of company output as put forward in the accelerator model (Clark, 1917; Chenery, 1952). According to this theory, changes in investment respond to fluctuations in output since inputs are used in a fixed proportion and their level increases with company output. The second control variable is based on cash flow models of investment (Tinbergen, 1938; Kalecki, 1949). Cash flow levels are a source of internal finance for company capital investments. Moreover, higher cash flow levels also improve collateral firm value and therefore the ability to raise external

[20] See Blanchard et al. (1993) and Samuel (1998) for reviews of these theories.

financing (Carpenter and Guariglia, 2008). In the calculation of this variable, we pay attention to the endogeneity problem between cash flows and capital investments by only including cash flows from financing and operations. Since capital investments are a cash outflow within company cash flows from investment activities, we exclude this part of company cash flows. Third, according to the neoclassical model of company investments (Jorgenson, 1963; Hall and Jorgenson, 1967), investment levels are determined by the shadow price of capital, which is the sum of the price of money and the relative price of capital. We calculate the user cost of capital as the sum of company interest and depreciation expenditures.[21] As our final control variable based on investment theories, we include Tobin's Q (Tobin, 1969, 1982), which introduces the perspective of an investor into an analysis of the determinants of investments. According to the logic of the approach, managers rank investment projects according to their expected rate of return and execute those with higher returns first until the marginal rate of return of the remaining projects equals the market price of capital. Accordingly, the higher the expected rate of return of a company's assets, i.e. its market value, the more capital assets will be purchased by the company.[22] We follow the approach adopted in Bond et al. (2003) and include the lagged investment rate and its square as our final two control variables in order to capture the dynamics of the investment process over time. A positive coefficient is expected for the lagged value and a negative coefficient for its square. Our variable definitions and the predicted signs of the coefficients are summarized in table 3.2.

3.2.3 Dynamic factor demand: estimation strategy

The reduced form static models of company investment introduced in the previous subsection can generally be considered a simple empirical approximation of

[21] According to the theoretical models, changes in the real price of capital goods also add to the shadow price of capital. However, since no company level data are available for this variable, we exclude it from the analysis.

[22] We use the approximation method proposed by Chung and Pruitt (1994) and calculate the value of Tobin's Q as the sum of common stock market value, preferred stock market value and debts outstanding, divided by the value of a company's total assets. According to their research, this method explains at least 96.6% of the variability of complex calculation methods for Tobin's Q.

some more complex underlying process involving optimizing investment behaviour of firms.[23] Static models of firm investment behaviour maintain the assumptions that adjustments of factor input levels can be executed instantly and that these are costless. More recently, dynamic models of firm investments have been introduced into the literature. These relax the assumption of instantaneous and costless adjustment and attempt to model this optimizing firm behaviour in more detail. The error-correction model which was introduced into the investment literature by Bean (1981) motivates are more flexible regression model for the adjustment path of a firm towards its optimal capital stock.[24] The approach is appealing since it allows for a modelling of short-run and longer-term effects on firm-level investment rates within the same framework. The specific model we employ in this chapter is based on Bean (1981) and Bond et al. (2003). Assuming that the optimal capital stock (K^*) of firm i is a function of its output (Y), unobserved firm-specific effects (θ_i) and unobserved year-specific effects (ζ_t), a second-order autoregressive distributed lag model of the dynamic relationship between the realized (K) and the optimal capital stock can be written in error-correction form as:

$$\Delta k_{it} = \alpha_0 \Delta k_{i,t-1} + \alpha_1 \Delta y_{it} + \alpha_2 \Delta y_{i,t-1} + \alpha_3 (k_{i,t-2} - y_{i,t-2}) + \theta_i + \zeta_t + \varepsilon_{it} \quad (13)$$

where lower-case Latin letters denote the logarithms of upper-case variables. We extend this basic error-correction model by including our explanatory and control variables as introduced in the previous subsection. Based on the error-correction hypothesis, a negative coefficient is expected for our error-correction term, i.e. the variable measuring the gap between capital stock with a two period lag. Following the related literature (Bond et al., 2003; Chen and Zheng, 2008), we again perform

[23] While the introduction of static models into the literature on firm investments predates the dynamic models introduced in this subsection, the former are still widely used in empirical research. Recent labor economics research using these models has investigated the role of works councils on investment (Addison et al., 2007) and the impact of labor unions on investment (Cavanaugh, 1998) and investment cash-flow sensitivity (Chen and Chen, 2013).

[24] The use of error correction models for dynamic equations in economics dates back to the work by Davidson et al. (1978) on the relationship between consumer spending and disposable income. A general explanatory introduction is provided in Nickell (1985).

a normalization in dividing cash flows and the user cost of capital by the level of the capital stock at the end of the previous period.[25] After summarizing the above coefficients and variables ($\boldsymbol{z_{it}}$) in matrix notation, we obtain our regression equations as follows:[26]

$$I_{it} = \alpha_{0i} + \alpha_1 \; ER_t + \boldsymbol{\alpha_2'} \boldsymbol{z_{it}} + \varepsilon_{it} \tag{14}$$

$$I_{it} = \beta_{0i} + \beta_1 \; MR_{it} + \boldsymbol{\beta_2'} \boldsymbol{z_{it}} + \zeta_{it} \tag{15}$$

$$I_{it} = \delta_{0i} + \delta_1 \; \widehat{MR}_{it} + \boldsymbol{\delta_2'} \boldsymbol{z_{it}} + \theta_{it} \tag{16}$$

These equations are analogous to our static equations 7, 8 and 9b.

Special attention needs to be given to the appropriate estimation strategy for this equation. In particular, estimating this dynamic process via an OLS estimation of the levels or via estimating the within-group fixed-effect transformation of the above equation would both yield biased estimators due to the positive correlation of regressors with the error term (Nickell, 1981). An estimator that yields unbiased and consistent results for such an autoregressive process with endogenous regressors in a situation with a large number of cross-sectional units and few time periods as in our case is the Generalized Method of Moments (GMM) estimator developed by Arellano and Bond (1991) and Blundell and Bond (1998). Their estimation procedure first removes the time-invariant firm-specific effects through first differencing and then derives instruments to be used in the estimation from lagged values of the regressors and their first-differences. We treat all error-correction and financial variables as endogenous and adopt the most general specification by utilizing all of their lagged values as instruments. In addition, we also include year-dummies and two-digit industry dummy variables. To ameliorate the problem of instrument proliferation, we adopt the remedy proposed in Roodman (2009) and collapse our instrument

[25] In this subsection, we tackle the problem of endogenous regressors through a GMM methodology. Unlike in the previous subsection, we are thus able to include cash flows from all business areas for this part of our analysis.

[26] The GMM methodology employed in this subsection also accounts for the interaction between mandated benefits and other forms of labor compensation. Adjustments to the matrix $\boldsymbol{z_{it}}$ as in our static models are therefore not necessary.

Table 3.2: Variable definitions and expected signs of the coefficients

Variable (Notation)	Definition	Sign
Capital investment rate_t (I_t)	Fixed asset purchases_t / capital stock_{t-1}	
Mandated benefits (MR)	(Insurance + pension expenses) / wages	+/−
Voluntary benefits (VR)	Voluntary non-wage labor expenses / wages	+
Average wage (W)	Total wages / worker	+/−
Change in Output (ΔY)	Change in operating revenues	+
Cash flow (C)	Cash flow from operations and financing	+
User cost of capital (U)	Interest payments + depreciation	−
Tobin's Q (Q)	(Total stock value + debt) / nominal assets	+
Capital investment rate_{t-1} (I_{t-1})	Fixed asset purchases_{t-1} / capital stock_{t-2}	+
Error correction term (ECT)	Log capital stock_{t-2} - log output_{t-2}	−

Note: Displayed are our dependent variable followed by our static model regressors. The final two rows are additional variables included only in the dynamic models. The expected coefficients for cash flow and user cost, which are additional variables also included in the dynamic model as their respective ratios to the capital stock, are the same as those for their counterparts in the static model shown in this table.

matrix in order to reduce the instrument count. The consistency and unbiasedness of our GMM estimator relies on the assumptions that serial correlation in the error term is absent and the instruments are valid. We implement the autocorrelation tests proposed in Arellano and Bond (1991) to ascertain the absence of autocorrelation in the errors with one or more lags.[27] We also exploit the overidentifying restrictions in our model and test whether our instruments are uncorrelated with our error terms by implementing the test for joint instrument validity proposed by Hansen (1982).[28]

3.3 Data set and descriptive statistics

The dataset we employ in this chapter has been compiled by the Taiwan Economic Journal (TEJ) and consists of all manufacturing sector companies registered at the Taiwan stock exchange (TSE), the over-the-counter exchange (OTC) as well as the emerging stocks over-the counter exchange (ROTC).[29] Because the TEJ database contains all values disclosed in parent company balance sheets and income statements, it enables us to calculate the whole range of control variables based on

[27] First order autocorrelation of the differenced error terms is expected due to the common element of first-differenced error terms in adjacent periods.

[28] The Hansen J-statistic is preferred to the Sargan test because it does not impose the assumption of conditional heteroskedasticity; see, for example, Baum et al. (2003).

[29] Recent academic work using this database includes Yang et al. (2010), Tsou et al. (2013) and Liu et al. (2014).

Table 3.3: Summary statistics of key variables

Variable	Mean	Std. Dev.	Min.	Max.	Obs.
Capital investment rate	0.163	0.194	0	0.997	12955
Mandated benefits per worker	87.544	41.472	3.807	1083.604	12955
Voluntary benefits per worker	36.239	45.449	0	988.736	12955
Static model: regression variables					
Mandated benefits / wages	0.134	0.048	0.017	0.987	12955
Voluntary benefits / wages	0.058	0.074	0	0.997	12955
Average wage	694.212	387.176	38.984	9516.639	12955
Change in log company output	0.077	0.446	-6.959	7.217	12955
Cash flows (operations & financing)	876.917	7370.546	-41056.742	387558.625	12955
User cost of capital	478.213	3368.331	0.021	102096.461	12955
Log Tobin's Q	2.22	0.825	-2.978	6.495	12955
Dynamic model: additional regression variables					
Error term	-1.595	1.54	-11.842	7.655	12955
Cash flow per lagged capital	-0.001	0.52	-50.218	17.512	11748
User cost per lagged capital	0.002	0.117	0	8.556	11748

Note: Output, cash flows and the user cost of capital are measured in million NT$, benefits and average wages are denoted in thousand NT$.

theories of investment discussed in the preceding subsection.[30] Since labor cost data have been included in this database starting from 2002 and part of the companies have stopped disclosing their voluntary benefit data starting from 2013, we choose the time period from 2002 to 2012 as our study period. Our study period therefore covers amendments to all three mandated benefits included in our explanatory variable through the enactment of the Labor Pension Act in 2004, the adjustment of the National Health Insurance contribution rate in 2010, as well as the successive increase in labor insurance contribution rates starting from 2011.

To ensure the reliability of our results, we make some adjustments to our dataset by omitting outliers for our dependent and explanatory variables. First, we follow previous work in the investment literature and delete the company-year observations with investment rates greater than one.[31] Second, to warrant the feasibility of our explanatory variable, we also delete the company-year observations of companies

[30] We utilize parent company balance sheets in order to avoid complications that may arise due to the inclusion of subsidiary data. Since subsidiaries may also be located outside of Taiwan, the determinants of subsidiary investments may be different to their parent company, in particular with regard to the labor market environment.

[31] Such outliers are typically caused by data reporting errors or idiosyncratic events in a specific year, see for example International Study Group on Exports and Productivity (2008).

that have paid more benefits than wages during the time period.[32] Third, to make use of the whole data set, we make approximations for the value of Tobin's Q for some companies. Stock market values for the calculation of Tobin's Q are obtained from a supplementary database also provided by TEJ, but are unavailable for a few companies, especially from the OTC and ROTC markets in earlier years. To be able to make use of the information contained in the other variables for these company-year observations, we replace the values of Tobin's Q by making use of the information of Tobin's Q for the company in other years and the annual mean values for Tobin's Q in the whole market.[33] To account for the incidence of inflation in each year and industry, we deflate all data measured in monetary units with the most detailed deflators available from the Directorate-General of Budget, Accounting and Statistics.[34] Our final dataset consists of a total of 12,955 company-year observations. Summary statistics for our variables are displayed in table 3.3.

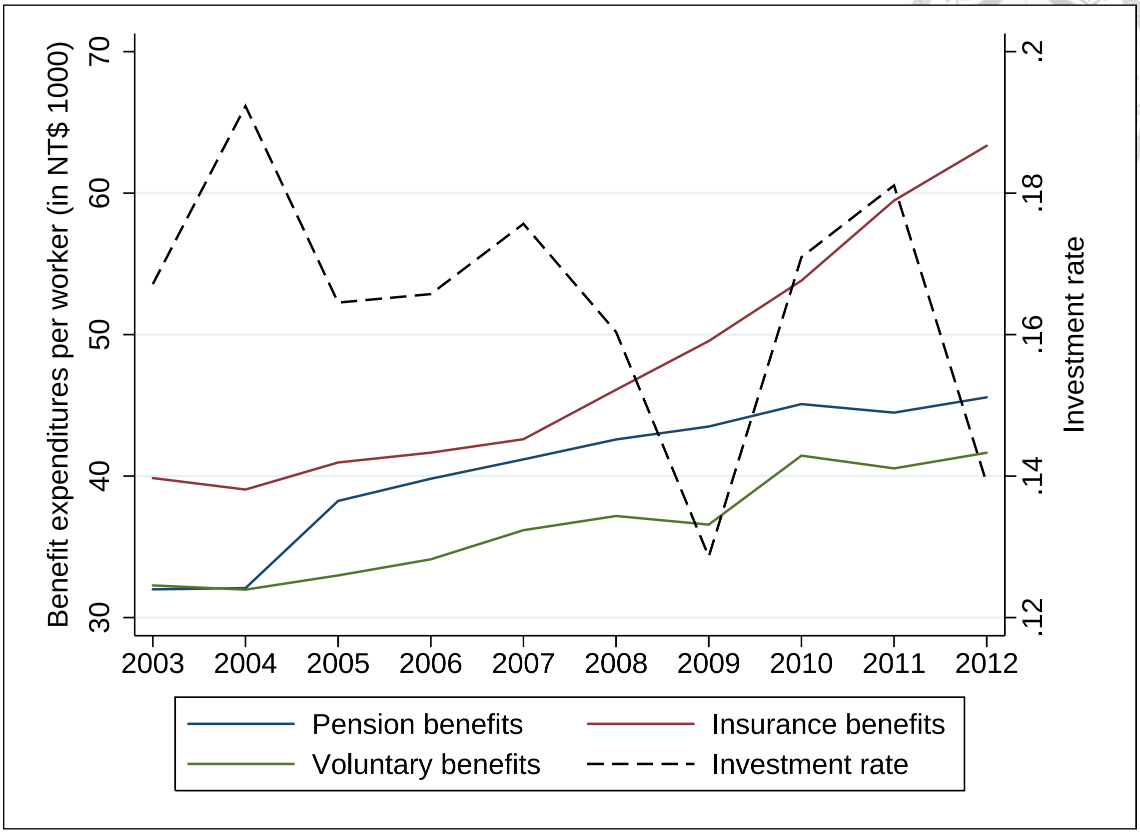
In addition to the summary statistics, the way our data evolve over time is of particular importance for the estimation of the effects of the policies discussed on the development of investment rates. Figure 3.1 traces the development of voluntary benefits and the two types of mandated benefits included in our study, as well as the time path of capital investment levels. The development of our company data on the two categories of mandated benefits reflects the two policy shifts discussed in the introduction. In response to the pension system reform in 2004 annual pension expenditures per worker rose from 32,083 to 38,245 NT$ in the subsequent year and have continued to rise at a moderate rate thereafter. After the implementation

[32] In our initial data set, 1573 company-year observations are investment rate outliers, 734 company-year observations report mandated benefit expenditures above their wage level and 15 company-year observations report voluntary benefit expenditures above their wage level. After accounting for overlap between the three groups, we drop a total of 1590 company-year observations through this procedure.

[33] We first calculate annual mean values for Tobin's Q and the overall mean value for Tobin's Q for each industry. We then use the available values for Tobin's Q for the companies with missing company-year observations and multiply them by the ratio of the industry mean value in the year to be replaced divided by the average industry mean value of the years with available values.

[34] Deflators for output and intermediate inputs are available at the two-digit (division) level, while deflators for the capital stock are available at the one-digit (section) level, see http://www.stat.gov.tw for details.

Figure 3.1: Time trends for investment rate and benefit expenditures



Note: All NT$ values have been deflated to the price level in year 2002.

of the new labor insurance premium rates in 2010, company insurance payments have subsequently been rising gradually from a level of 53,815 NT$ up to 63,349 NT$ annually per worker in 2012. For our regression analysis we construct our explanatory variable as the sum of mandated benefit expenditures through company labor and health insurance expenditures and pension plan expenditures as required by policy makers via the regulations outlined in the introduction. As a results of the three benefit rate adjustments implemented between 2003 and 2012, company-level average annual mandated benefit expenditures per worker have risen from 71,857 NT$ to 108,915 NT$, which is an overall increase of 51.6%.

In addition to the mandated benefit expenditures, we also obtain data on voluntary benefit expenditures which are not mandated by policy makers. Voluntary benefits were at an annual level of 32,274 NT$ per worker in 2003 and rose at a moderate rate in the following years, but then declined in response to the general contraction of economic activity during the recent recession. After dropping to 36,570 NT$ in 2009, voluntary benefit expenditures recovered back to a level of 41,649 NT$ in 2012. The change in voluntary worker benefit expenditures during the recession shows that managers decided to reduce the part of the non-wage labor costs that they could influence during the slowdown of overall economic activity. However, since the introduction of higher labor insurance premium rates after 2008 partly coincided with the economic recession, insurance premium expenditures increased even during the recession years.

The dashed line in figure 3.1 displays data on company fixed capital investment rates obtained from the fixed asset investment expenses section in company cash flow statements. Overall, company capital investment levels have displayed a downward trend since 2004, with the only notably positive trend in the two recovery years after the global recession. Starting from a level of 16.7% in 2004, investment dropped to 12.8% in 2009. During the recovery years in 2010 and 2011, investment rates rose to 17.1% and 18.1%, respectively, before dropping again to a rate of 13.9% in 2012. There is a notably similarity in the response of fixed capital investment rates to the global recession and the recovery thereafter and the time path followed by voluntary benefit expenditures during those two years.

3.4 Results

3.4.1 Static factor demand models

The results of our regression models making use of the exogenous mandated benefit rate, the realized mandated benefit ratio, and the predicted mandated benefit ratio as well as our final three models accounting for compensating differentials are presented in table 3.4.[35] Across all six models, our mandated benefit indicators are found significant with a negative coefficient.

Comparing model 7 and model 8, we should note that the average wage level

[35] The Hausman test rejects the null hypothesis that the coefficients estimated by the random effects (RE) model are the same as the ones based on a fixed effects (FE) model in all static specifications, and we therefore report the results of the consistent FE estimators.

Table 3.4: Capital investment results: static models

	(7)	(8)	(9b)	(10)	(11)	(12)
Exogenous mandated benefit contribution rate (ER)	−0.342***			−0.348***		
	(0.090)			(0.091)		
Mandated benefit ratio		−0.236***			−0.212***	
		(0.038)			(0.037)	
Exogenous mandated benefit ratio ($\widehat{MR}$)			−1.364***			−1.387***
			(0.361)			(0.361)
Voluntary benefit ratio	0.101**	0.114***	0.101**		0.114***	
	(0.040)	(0.040)	(0.040)		(0.040)	
Voluntary benefit ratio residual (Model 4)				0.101**		
				(0.040)		
Voluntary benefit ratio residual (Model 6)						0.101**
						(0.040)
Average wage	−0.000	−0.000**	−0.000	−0.000		−0.000
	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)
Average wage residual					−0.000**	
					(0.000)	
Change in log company output	0.038***	0.038***	0.038***	0.038***	0.038***	0.038***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Cash flows (operations & financing)	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
User cost of capital	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log Tobin's Q	0.046***	0.046***	0.046***	0.046***	0.046***	0.046***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Companies	1637	1637	1637	1637	1637	1637
Observations	12955	12955	12955	12955	12955	12955
R^2 (overall)	0.090	0.102	0.090	0.090	0.102	0.090
Hausman test (χ^2)	102.93	97.28	102.93	102.98	97.30	193.04
Model selected	FE	FE	FE	FE	FE	FE

Notes: Cluster-robust Huber/White standard errors are shown in parentheses. The significance symbols of the p-values denote: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The significant constant term has been omitted to save space.

is the denominator of the mandated benefit ratio and the two variables therefore correlate negatively. The second model has therefore introduced a multicollinearity problem between the mandated benefit and the wage variable employed and the wage variable captures part of the mandated benefit effect and turns significant. The correlation between wages and investment levels is negative. Since part of the wage effect is captured in our mandated benefit ratio coefficient, the multicollinearity hence results in a less negative regression coefficient for the mandated benefit ratio. This is resolved in model 9b which uses the mandated benefit ratio predicted by our exogenous instrument. In this model, wages are insignificant again, whereas our mandated benefit variable is found significant at the highest level.

Changes in the size of the mandated benefit coefficients can again be observed when we control the endogenous interaction between mandated benefits and other forms of labor compensation by focusing on residuals residuals rather than income statement data. Comparing each of the first three regressions to their counterparts amongst the final three regressions, the coefficient on our mandated benefit indicators turns more positive after removing the negative effect of wages on capital investments and more negative after removing the positive effect of voluntary benefits on capital investments when controlling for compensating differentials.

Contrary to the effect of mandated benefits, our voluntary benefit variable correlate positively with company investment rates and is found significant in all model specifications. The complementarity between investments in human and physical capital as previously found in the literature (López-Bazo and Moreno, 2008) may account for the positive coefficient. The essential difference between mandated and voluntary benefits is that profit-maximizing managers will only increase their voluntary benefit expenditures if this can be financially accommodated. The development of voluntary benefit expenditures therefore follows investment expenditures more closely, while the development of mandated benefits inevitable follows the time path of the requirements of government policy-makers. Our second labor cost control variable are company wage expenditures per worker. The coefficient of this variable

Table 3.5: Capital investment results: dynamic models, basic ECM

	(14)	(15)	(16)
Exogenous mandated benefit contribution rate (ER)	-9.215^{***}		
	(2.688)		
Mandated benefit ratio		-0.017	
		(0.243)	
Exogenous mandated benefit ratio ($\widehat{MR}$)			-36.769^{***}
			(10.724)
Voluntary benefits ratio	0.071	0.086	0.071
	(0.107)	(0.102)	(0.107)
Average wage	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Capital investment rate (lag)	0.305^{**}	0.300^{**}	0.305^{**}
	(0.145)	(0.147)	(0.145)
Δ Log company output	0.177^{*}	0.176^{*}	0.177^{*}
	(0.106)	(0.106)	(0.106)
Δ Log company output (lag)	-0.038	-0.037	-0.038
	(0.039)	(0.040)	(0.039)
Error correction term	-0.007	-0.003	-0.007
	(0.029)	(0.032)	(0.029)
Companies	1428	1428	1428
Observations	9088	9088	9088
AR(1) p-value	0.000	0.000	0.000
AR(2) p-value	0.660	0.719	0.660
Instruments	56	57	56
Hansen J-test (p-value)	0.411	0.391	0.411

Notes: Standard errors obtained through the Windmeijer (2005) correction are shown in parentheses. The significance symbols of the p-values denote: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

is negative across all models and it is only found significant in the models where the mandated benefit ratio and wage expenditures are included simultaneously. The negative coefficient of this variable reflects the fact that the cost factor of wage expenditures dominates the human capital or efficiency wage effects, hence yielding a negative correlation with investment rates.

The signs and significance of our other control variables largely confirm previous findings in the literature on the determinants of capital investments. An increase in output, cash flow and Tobin's Q correlates with an increase in capital investment. An increase in the user cost of capital lowers capital investment. After accounting for various contemporary determinants of capital investments, the lagged investment rate and its square are not found significant.

Table 3.6: Capital investment results: dynamic models, full ECM

	(14)	(15)	(16)
Exogenous mandated benefit contribution rate (ER)	−7.840***		
	(2.383)		
Mandated benefits ratio (MR)		−0.250***	
		(0.081)	
Exogenous mandated benefit ratio ($\widehat{MR}$)			−31.283***
			(9.508)
Voluntary benefit ratio	0.046	0.063	0.046
	(0.050)	(0.051)	(0.050)
Average wage	−0.000	−0.000*	−0.000
	(0.000)	(0.000)	(0.000)
Capital investment rate (lag)	−0.134	−0.147	−0.134
	(0.209)	(0.209)	(0.209)
Δ log company output	0.214***	0.211***	0.214***
	(0.076)	(0.075)	(0.076)
Δ log company output (lag)	−0.068**	−0.068**	−0.068**
	(0.029)	(0.029)	(0.029)
Error correction term	−0.037**	−0.037**	−0.037**
	(0.017)	(0.017)	(0.017)
Cash flow per lag capital	−0.234	−0.227	−0.234
	(0.167)	(0.158)	(0.167)
Cash flow per lag capital (lag)	−0.007	0.022	−0.007
	(0.364)	(0.351)	(0.364)
User cost per lag capital	−1.456	−1.502	−1.456
	(2.049)	(1.951)	(2.049)
User cost per lag capital (lag)	1.406	1.617	1.406
	(3.927)	(3.752)	(3.927)
Tobin's Q	0.001	0.000	0.001
	(0.003)	(0.003)	(0.003)
Tobin's Q (lag)	0.003	0.003	0.003
	(0.003)	(0.003)	(0.003)
Companies	1428	1428	1428
Observations	9088	9088	9088
AR(1) p-value	0.019	0.015	0.019
AR(2) p-value	0.132	0.120	0.132
Instruments	80	81	80
Hansen J-test (p-value)	0.340	0.341	0.340

Notes: Standard errors obtained through Windmeijer (2005) correction are shown in parentheses. The significance symbols of the p-values denote: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The voluntary benefit ratio residual results for different models are shown on the same line to save space.

3.4.2 Dynamic factor demand models

In this subsection we discuss the results of our dynamic panel data GMM models. We present results from two different models, first the basic error-correction model displayed in table 3.5 and then the results from our full error-correction model including the financial variables in addition to the basic error-correction model and our labor market variables displayed in table 3.6. All models reported in this part of our analysis pass the second-order autocorrelation tests as well as the Hansen J-test at conventional significance levels.

The key finding in this part of our analysis is that the sign and significance of our instruments for mandated benefits remains almost unchanged compared to our static models across all models. Moreover, the small changes in the coefficients for our instruments across our six specifications for labor cost variables are in line with the changes observed for our static models for the same reasons. A notable change in this part of our analysis is that the voluntary benefit ratio maintains a positive coefficient, but turns insignificant after accounting for its endogeneity in this dynamic estimation. The sign and significance of our wage variable are in line with the results of our static models.

Regarding the error-correction behaviour in our models, we find a negative coefficient for the error-correction term in both of our models. Yet, when we do not include the financial factors, the error-correction term is insignificant and the capital investment rate correlates positively with the capital investment rate in the previous period. Including the financial factors in our full model remedies this problem and the error-correction term turns significant, whereas the investment rate from the previous period turns insignificant as in previous work Chen and Zheng (2008). We therefore broadly confirm the error-correction hypothesis for this sample of Taiwanese stock market and over-the-counter market companies. Moreover, contemporary changes in the output level correlate positively with the investment rate, hence confirming the predictions of the accelerator model for our dynamic estimations. The financial variables, however, are found insignificant after controlling for their endogeneity in these models.

3.5 Conclusion: mandated benefits and fixed capital investment

In this chapter, we move beyond an analysis of an adjustment of mandated benefit contribution rates on labor market indicators and analyze its impact on company investment behaviour. In this part of our analysis we include company expenditures for health and labor insurance as well as for pension contributions over a time span from 2003 until 2012 in our explanatory variables. Based on neoclassical economic theory, we predict that an increase in mandated benefits imposes a cost burden upon a company, in turn triggering a negative overall scale effect, thus implying a negative effect on investment. Moreover, neoclassical economic theory predicts that, depending on whether labor and capital are complements or substitutes in production, an increase in labor costs may also indirectly affect the marginal return to capital in either direction due to potential substitution or complementarity effects.

We use detailed information from the financial statements of Taiwanese stock market companies in order to disentangle the overall effect of an increase in mandated benefits on capital investments. Since mandated benefits are defined as a fraction of wages in the Taiwanese labor market regulations, our first econometric specification includes uses the exogenous mandated benefit contribution rate which is calculated as the sum of labor insurance, health insurance and pension fund contribution rates as determined by the respective labor market regulations. We then introduce the observed ratio of mandated benefit expenditures divided by company level wage expenditures obtained from income statement data in order to account for differences in actual ratios across companies in our second model. Since the second model has introduced a multicollinearity problem into our specification, we employ the exogenous mandated benefit contribution rate to predict the realized values and include the predicted values as instrumental variable in our third regression. Our final three specifications are analogous to the first three, but also account for the role of compensating differentials by replacing income statement wage or voluntary benefit expenditures with their residuals obtained after accounting for changes in each of our mandated benefit indicators employed.

We adopt two estimation strategies for our models. The first is a static model that can be considered a simple approximation of a more complex dynamic process modelling companies on their path towards their optimal capital stock. Our second model provides a more nuanced picture of this search process through an error-correction specification that uncovers short-term and longer term dynamics. The former models are estimated as fixed-effects ordinary least squares panel data models, whereas the latter models are estimated using a GMM methodology that deals with the endogeneity of the regressors, in particular the lags of our dependent variable.

We find that mandated benefits exert a negative and significant effect on fixed asset investment rates across all of our model specifications. We further scrutinize these results via several robustness checks and conclude that our findings are robust across a range of different model specifications. The negative overall effect can be explained by a scale effect through the cost burden imposed on companies via mandated benefits that is a detrimental force for capital investment. An additional or alternative explanation is that capital and labor act as complements in the production process and an increase of labor costs at a given level of productivity bears an adverse impact on capital investments.

An interesting additional finding is the difference in coefficients between mandated and voluntary benefits. While company managers are required to adjust their mandated benefit expenditures according to the requirements of policy-makers, they have significant leverage over adjustments in voluntary benefits. The latter were therefore only increased when the firm was financially able to do so and the coefficient of our voluntary benefit variable is positive throughout our models. An alternative explanation is a positive correlation between fixed and human capital investments since the latter is one element included in our voluntary benefit variable.

Our results in this chapter may also serve as a reference for policy makers in other economies, in particular those in emerging economies undergoing reforms of the mandated benefit system similar to those currently implemented in Taiwan. Since our sample is restricted to listed companies from the manufacturing sector, future research may also investigate the effects of mandated benefit requirements on the development in other sectors and broader samples. In the following chapter, we will apply the theoretical background of this chapter to another type of mandated labor costs and analyze the effects of minimum wage hikes on firm investments using data from China.

4 What is the effect of raising the minimum wage on firm investments in fixed and human capital? Evidence from the China Annual Census of Industrial Firms

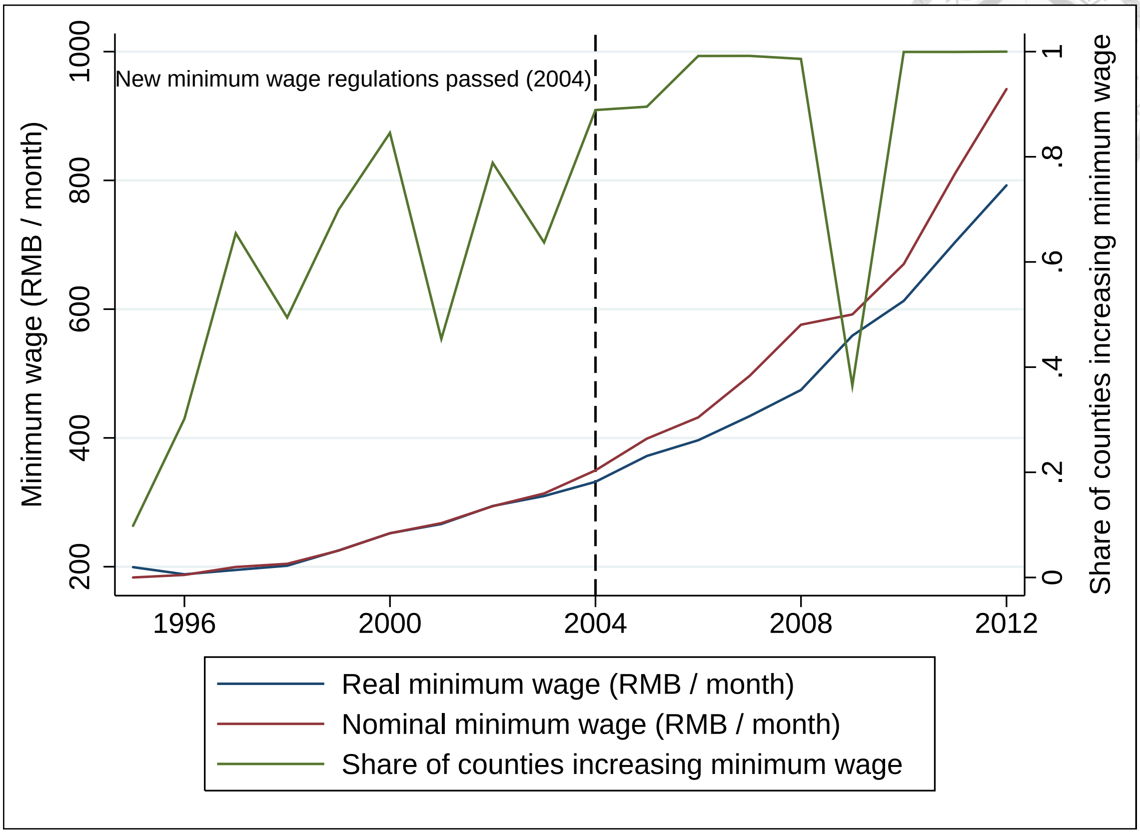
4.1 The Chinese minimum wage system

As part of its endeavor to ensure the provision of basic living standards of its workforce, China accepted the ILO Minimum Wage Fixing Convention in 1984 and issued its first minimum wage regulation in 1993. In 1993, Shanghai was the first city to establish a minimum wage and in the subsequent years the policy spread throughout the country. By the year 1995, a minimum wage had been implemented in more than 2000 Chinese counties.

Figure 4.1 below depicts how the national average value of the real and nominal minimum wage has evolved over time and how the share of counties with at least one minimum wage amendment per year has steadily increased. Since the introduction of the minimum wage, their national average level as increased steadily. After the new minimum wage regulations were passed in 2004, the growth rate of nominal minimum wages accelerated slightly, but this effect was hardly transmitted to real minimum wage growth due to increased inflation during that period. After the reform in 2004, annual minimum wage adjustments have been consistently implemented in more than 90% of Chinese counties and since 2006 this figure has remained above 98% with the notable exception of the recession year in 2009 when only roughly a third of the Chinese counties experienced a minimum wage increase.

The development of real minimum wages over time is shown in table 4.1. As mentioned in the introduction, Chinese minimum wages have increased rapidly especially after the introduction of the new regulations in 2004. From an empirical perspective, another interesting feature of the Chinese system of minimum wages is

Figure 4.1: Chinese minimum wages and frequency of increases over time



Note: All RMB values have been deflated to the price level in year 2000 using province-level consumer price inflation. The national real minimum wage has been calculated based on monthly average minimum wages weighted by city-level population data.

that it not only developed rapidly over time, but the levels also differ significantly between provinces and within provinces between different counties. To name some examples, at the end of our study period in 2007, the nominal minimum wage in Shanghai was at 840 RMB, roughly 2.6 times the level of 320 RMB in the less developed areas of Gansu province. At the same time the minimum wage level in Lanzhou, the capital of Gansu province, was already at 430 RMB, hence about 34% above the lowest level in the same province. Liaoning province can be credited with the most complex minimum wage system and its nominal minimum wages ranged from 420 to 700 RMB in the final year of our study. It should be noted that the dates of minimum wage amendments can also differ even within the same province.

Unlike in most previous work from other economies that typically analyzed the effect of a one time nation-wide introduction or increase in the minimum wage, the Chinese system of minimum wages therefore provides significant variation both over

Table 4.1: Chinese provincial minimum wages over time (in RMB per month)

Province	2000	2001	2002	2003	2004	2005	2006	2007
East								
Beijing	406.0	410.8	444.5	458.2	507.6	541.2	581.8	638.0
Fujian	259.8	282.6	302.6	313.9	314.6	343.4	406.6	463.0
Guangdong	338.6	350.7	362.7	371.2	365.0	417.4	447.9	488.9
Hainan	277.5	308.6	348.9	348.4	361.2	383.1	415.2	434.9
Hebei	242.5	241.3	283.9	285.9	354.4	426.9	424.8	419.9
Jiangsu	275.8	301.0	319.6	360.8	404.3	426.2	488.5	535.6
Shandong	264.1	287.0	325.4	347.5	335.3	408.9	416.1	430.8
Shanghai	424.8	467.5	510.0	549.4	586.5	638.8	676.2	720.1
Tianjin	347.3	394.1	425.0	449.0	481.2	524.6	600.6	641.1
Zhejiang	372.5	398.6	410.6	423.8	468.8	525.9	578.6	625.5
Northeast								
Heilongjiang	262.6	260.5	262.4	284.9	274.4	271.2	353.0	377.4
Jilin	231.6	228.6	251.8	278.3	303.0	298.5	369.7	514.6
Liaoning	265.7	268.7	278.4	273.8	276.1	346.1	378.1	424.3
Central								
Anhui	220.1	272.9	290.7	300.5	293.8	308.3	321.5	361.0
Henan	209.8	208.4	208.2	216.5	238.3	253.3	309.0	325.7
Hubei	203.7	203.1	276.8	270.8	258.1	289.7	293.1	351.8
Hunan	231.3	252.4	280.9	311.6	326.1	345.7	373.2	392.1
Jiangxi	214.1	220.3	220.1	218.4	243.1	300.6	301.7	392.6
Shanxi	225.9	226.3	270.7	265.9	387.1	418.6	417.1	431.6
West								
Chongqing	246.2	257.5	279.0	287.9	322.9	343.6	373.9	431.1
Gansu	227.6	235.2	235.2	232.7	283.2	278.4	291.0	304.2
Guangxi	172.0	223.7	313.0	309.7	313.4	354.8	359.0	366.9
Guizhou	213.4	209.6	238.8	290.3	291.1	323.4	349.3	430.5
Inner Mongolia	238.1	236.7	251.2	289.9	324.5	358.6	363.2	375.5
Ningxia	264.2	264.0	311.1	306.1	321.3	319.0	362.7	377.4
Qinghai	236.3	230.3	225.1	220.7	238.8	311.2	352.7	374.3
Shaanxi	213.0	225.7	273.3	269.2	262.4	335.4	420.2	413.8
Sichuan	160.9	161.4	211.0	253.4	276.6	318.1	291.4	366.0
Xinjiang	257.7	258.4	292.0	290.8	306.6	316.4	345.1	401.1
Yunnan	233.1	235.2	261.2	283.2	286.5	339.6	367.3	379.0

Notes: Minimum wages have been calculated as time-weighted average values based on county level data. Values have been deflated to the price level in year 2000.

time and between different parts of the country.

4.2 Literature review: minimum wages and investment

The conclusions derived from neoclassical models of the labor market with regard to the effect of an increase in the minimum wage on human capital investments parallel those introduced in the previous chapter for the impact on fixed capital investments. In the standard human capital model with competitive labor markets based on Becker (1993), workers finance their on-the-job training through lower wages. The introduction of a minimum wage thus reduces the level of training because it introduces a limit on the pay reductions workers can accept to finance the training (Rosen, 1972; Feldstein, 1973).

Contrary to the predictions of neoclassical models of the labor market, non-competitive models of the labor market predict that firms will increase training investments in the face of minimum wage hikes in order to increase worker productivity and reap the resulting rents (Acemoglu and Pischke, 1999). Our review of the empirical literature below stresses the fact that research findings on the various effects of minimum wages at the firm level are also highly diverse.

During the past decades, a monumental body of literature has analyzed the various adjustment channels through which firms absorb the labor cost increase due to minimum wage hikes. In addition to the employment effect, which has been identified for the case of China at least for parts of the labor force, profit reductions are generally considered a key channel of adjustment. Analyzing this topic for another Asian developing economy, Cuong (2013) employs a difference-in-difference methodology with propensity score matching and finds no statistically significant effect on firm profits in Vietnam after a minimum wage hike of about 20% in 2005. Draca et al. (2011) adopt a difference-in-difference approach and show that the introduction of the UK minimum wage in 1999 has reduced firm profitability. Metcalf (2008) concludes that the ability of firms to absorb the increase in labor costs through a reduction in company profits is one of the reasons for an absence of a negative employment effect of the policy in the UK. In a detailed survey study jointly analyzing a range of adjustment channels for local US quick-service restaurants, Hirsch et al. (2011) find that companies adjust through a range of channels, including price increases, profit reductions, lower wage growth for high-pay workers and savings on other cost components. While an extensive exposition of the literature analyzing company effects of minimum wages other than those on firm investment is beyond the scope of this paper, it is important to bear in mind that the ability of companies to absorb the cost increase due to minimum wages via other channels also affects the impact on fixed and human capital investments.

Regarding the company fixed capital investment decision, little research has been conducted on this topic so far and mixed effects have been found in these studies. Rama (1999, 2001) finds that doubling the minimum wage in Indonesia during the early 1990s has led to a decrease in employment of 2% and a decrease in investment of 5%. Based on a model of labor markets with frictions, Pischke (2005) argues that labor market institutions such as unions and minimum wages, which distribute rents to lower skilled workers, raise the incentive for firms to invest in their training and the fixed capital which is associated with their jobs. His empirical analysis based on OECD economies and differences in labor market institutions between Europe and the US roughly supports this theory. Employing a search-and-matching model, Koeniger and Leonardi (2007) draw on comparative evidence for Germany and the U.S. and find that German firms have raised their capital-labor ratios in response to labor market institutions such as minimum wages. A recent report by Riley and Bondibene (2013), however, concludes that the introduction of a national minimum wage in the UK has not affected employment and investment levels.

As explained in section 3, according to the two different theories on the link between the minimum wage and training, minimum wages could either lead to a reduction in on-the-job training (Rosen, 1972; Feldstein, 1973) or an increase in training (Acemoglu and Pischke, 2003). Interestingly, the empirical evidence on this topic is also mixed which could either be due to the absence of any effect, heterogeneous and potentially offsetting effects or problems related to the measurement of training in the different studies (Neumark and Wascher, 2008). After most of the earlier studies on the topic were plagued by methodological problems, Neumark and Wascher (2001) were the first to control for US state variation in minimum wage levels and inter-state differences in training unrelated to the minimum wage. The authors conclude that the minimum wage has led to a reduction in on-the-job training. Acemoglu and Pischke (2003) critize the methodology in Neumark and Wascher (2001) for using all young workers as treatment group and arriving at unreasonably high estimates for the size of the negative effect. After revising their treatment group to workers with wages below the minimum wage, the authors find no significant effects of the minimum wage. The effect on training expenditures may therefore vary between companies and industries depending on these factors. More recently, Fairris and Pedace (2004) were the first to use an employer survey on the incidence of training and find no evidence of a reduction in training hours or the amount of workers covered by staff training. In the only notable study conducted outside the US, Arulampalam et al. (2004) find no evidence that the minimum wage has reduced training and some evidence that it has improved training in the UK.

The inconsistency of previous results, the scarcity of studies from less advanced economies and a frequent focus on the introduction of a uniform national level minimum wage as single policy shift underline the fact that significant scope exists for future research on the effect of minimum wages on firm investment behaviour.

4.3 Methodology

4.3.1 Measuring the firm-level impact of the minimum wage

For our empirical analysis of the effect of Chinese minimum wages on the capital investment decision we construct a panel data set of Chinese companies. Since the new minimum wage regulations were introduced in 2004, we choose the period from 2000 until 2007 as our study period. Including the reform year as well as pre- and post-reform period provides significant variation over time in terms of the impact of the minimum wage on individual companies.[36]

A crucial element of our methodology is to identify the companies that are affected by the minimum wage in their county.[37] As in previous work using firm-level data (Draca et al., 2011; Riley and Bondibene, 2013; Cuong, 2013), we employ average worker wage cost data to measure the extent to which firms are affected by the local minimum wage level.[38] In particular, we calculate two measures for the exposure to the minimum wage for the firms in our data set: a dichotomous treatment indicator variable and a continuous variable measuring the treatment intensity for the firms included in our treatment group. Using aw_{it} to denote the logarithm of the average wage level of firm i in year t and mw_{jt} to denote the logarithm of the minimum wage level of county j in period t, we identify our treatment group as:[39]

$$treatdum_{it} = \begin{cases} 0 & \text{if } aw_{it} \geq mw_{jt} \\ 1 & \text{if } aw_{it} < mw_{jt} \end{cases} \tag{17}$$

Our continuous variable measuring the treatment intensity for the treated companies takes the following form:[40]

$$treatint_{it} = \begin{cases} 0 & \text{if } aw_{it} \geq mw_{jt} \\ mw_{jt} - aw_{it} & \text{if } aw_{it} < mw_{jt} \end{cases} \tag{18}$$

[36] Since we need to take first differences for the calculation of our investment variable, our study period includes three pre-policy years, the year when the new minimum wage regulations were implemented (2004) as well as three post-policy years.

[37] Compliance with minimum wage regulations is generally problematic in developing countries (see, for example, Rani et al. (2013)). However, recent research concludes that Chinese companies broadly comply with minimum wage laws (Ye et al., 2014).

[38] Because of regional differences in Chinese minimum wage regulations, the minimum wage level in five jurisdictions also includes social security contributions. We therefore also add the contributions for labor and health insurance and pensions incurred by firms located in Beijing, Henan, Jiangsu, Jiangxi and Shanghai to their wage expenditures.

[39] An endogeneity issue exists between these two variables, because an increase in the minimum wage drives up the average wage of affected firms, hence causing a reduction in the number of firms included in our treatment group and decreasing the difference between treatment and control group in terms of the impact of the minimum wage. The overall effects may therefore be even larger than those identified in this study.

[40] An alternative variable measuring the treatment intensity has been proposed by Mayneris et al. (2014). Implementing our regressions with their treatment intensity variable does not qualitatively alter our findings and we therefore do not report these alternative regression results.

Both of our treatment indicators therefore take on the value zero for our control group companies and values greater than zero for treated companies.[41]

4.3.2 Fixed capital investments: estimation strategy

After identifying our treatment and control groups, we proceed to the estimation strategy for our fixed capital and human capital regressions. For our fixed capital investment estimations, we again employ the error-correction model introduced in section 3.2.3, which we reproduce here for expository purposes:

$$\Delta k_{it} = \alpha_0 \Delta k_{i,t-1} + \alpha_1 \Delta y_{it} + \alpha_2 \Delta y_{i,t-1} + \alpha_3 (k_{i,t-2} - y_{i,t-2}) + \theta_i + \zeta_t + \varepsilon_{it} \tag{19}$$

where lower-case Latin letters denote the logarithms of the capital stock (k) and output (y). The dataset employed in this chapter is not as detailed as the stock market dataset used in the previous chapter, and we can therefore only utilize a limited number of financial variables. Similar to the empirical implementation in Chen and Zheng (2008), we also include current and lagged firm profits and debt levels as additional explanatory variables to control for the impact of financial factors on the investment decision. The role of operating profits for the effect of minimum wages is of particular importance, because it has been identified as an important mitigation channel for the impact of minimum wages in previous research (Huang et al., 2014). We normalize both of these variables with the capital stock at the beginning of each period. Using I to denote investment rates, $treat$ to denote either our dichotomous or continuous treatment variable and summarizing the above coefficients ($\boldsymbol{\beta}$) and variables ($\boldsymbol{x_{it}}$) in matrix notation, we obtain our fixed capital investment regression equation as:

$$I_{it} = \alpha\, treat_{it-1} + \boldsymbol{\beta}' \boldsymbol{x_{it}} + \varepsilon_{it} \tag{20}$$

[41] We also experiment with different threshold points for the identification of our treatment group. For example, raising (or lowering) the cut-off point to 1% above (below) the local minimum wage level increases (decreases) our treatment group by about 3%. For higher cut-off points, the absolute value of our investment rate regression coefficients turns smaller, implying a smaller effect as we reduce the strictness of our treatment group identifier.

To estimate this regression, we utilize the first-difference Generalized Method of Moments (GMM) estimator developed by Arellano and Bond (1991). Since the problem of instrument proliferation is negligible in our case, we adopt the most general specification and use all available higher-order lagged values of our right hand side variables in equation 19 as well as of our financial variables as instruments.[42] The consistency and unbiasedness of our GMM estimator relies on the assumptions that serial correlation in the error term is absent and the instruments are valid.[43] We again implement the Hansen test for joint instrument validity and autocorrelation tests proposed in Arellano and Bond (1991) to ascertain the validity of both assumptions.

4.3.3 Human capital investments: estimation strategy

For our analysis of the effect of minimum wage hikes on the human capital investment decision, we estimate the following regression:

$$H_{it} = \gamma \, treat_{it-1} + \boldsymbol{\delta}' \boldsymbol{z_{it}} + \varepsilon_{it} \tag{21}$$

Where our dependent variable H are investments in human capital measured as training expenditures per worker, $treat$ is either our dichotomous or our continuous treatment variable, $\boldsymbol{z}$ is a vector of control variables and ε is a stochastic error term. As in previous literature analyzing the effect of the minimum wage on firm training expenditures (Arulampalam et al., 2004; Fairris and Pedace, 2004), our firm level controls essentially aim to capture firm level heterogeneity by including variables such as workforce size, wages, labor productivity and dummy variables for state or foreign ownership and exporter status of a firm. These dummies take on zero values

[42] Roodman (2009) provides a detailed analysis of the problems arising from employing too many instruments in GMM estimation. The rule of thumb in empirical GMM estimations is that the number of instruments should be less than the number of cross-sectional units. In our case we employ a maximum of 37 instruments, while the minimum number of cross-sectional units included in the GMM regressions for the smallest subset of firms is 26331.

[43] Note that first order autocorrelation of the differenced error terms is expected due to the common element of first-differenced error terms in adjacent periods.

for non-state owned companies, local companies and non-exporters, respectively.[44] We also control for industry-level fixed effects at the two-digit level and include firm-specific effects by including a range of variables reflecting the staff structure of firms. These variables have only been investigated in the 2004 version of the CASIF survey and we include those values for each firm in all time periods covered. In particular, we include a dummy variable for the presence of a workers' union and calculate the shares of technological staff, staff with university degree and the share of female workers.

Because a large number of firms reach a corner solution in their human capital investment decision, these firms report zero values for their expenditures. Least squares estimation of our human capital model would therefore result in biased estimators (see, for example, Greene (2003)). To resolve this problem, we estimate tobit models with human capital investment as dependent variable and analyze the effect of the minimum wage on human capital investments of all firms in our data set.

4.4 Data set and desriptive statistics

4.4.1 Data sources and data editing

The first type of data used in this section are the minimum wage data which have been collected from the websites of local governments across China. In particular, we obtain the precise dates of minimum wages amendments and minimum wage levels for a total of 2,606 Chinese counties and calculate the respective weighted annual average minimum wage in each of these geographical units.[45]

The second data source used in this section is the China Annual Survey of In-

[44] Our definition of state-owned companies includes all state-owned and state-holding companies, i.e. all companies in which the state holds a majority. This is the broad definition adopted by the Chinese National Bureau of Statistics. Local non-state owned companies include collectively owned and private companies. For foreign ownership we also adopt the Chinese definition and consider companies with a foreign capital share of at least 25% as foreign invested.

[45] In this chapter, we collectively refer to counties and prefecture level cities as "counties". These administrative units included in our analysis are located across all of the Chinese provincial level administrative divisions, i.e. the 22 provinces, five autonomous regions and four municipalities, to which we collectively refer as "provinces".

dustrial Firms (CASIF) which is conducted by the National Bureau of Statistics (NBS).[46] The survey includes data from all state-owned firms as well as all non-state owned industrial firms with a revenue of more than 5 million RMB.[47] This firm level data set enables us to calculate our dependent and explanatory variables as well as a range of control variables including sales volume, employment levels and industry classifications. In order to construct a panel data set, our main method to match companies over time is to use their registration ID. Since some company IDs change over time and a few IDs occur for multiple firms, we adopt the procedure proposed in Brandt et al. (2012) and also use other firm information such as the names of legal firm representatives, office phone numbers and addresses to merge firms over time.[48] Disaggregated deflators for the prices of output and capital at the industry and province level have been collected from various editions of the China statistical yearbook (NBS, 2008).[49] We deflate all monetary values in our data set to the price level in year 2000, which is the first year included in our data set. We then clean our data set from reporting errors and typos in the construction of the data base by deleting all companies with zero or negative values for one of the following variables: capital stock, number of employees, output or sales volume and wage expenditures. As a final logical consistency check, we also exclude observations reporting a depreciation in the current period that is higher than the capital stock in the previous period.[50] As in other work analyzing the effects of policies on company investments, we exclude the companies with fixed capital investment rates

[46] Hsieh and Klenow (2009) and Song et al. (2011) are recent contributions in the English literature employing this dataset. A detailed introduction in Chinese has been provided by Nie et al. (2012).

[47] The China national economic census conducted by the NBS in 2004 allows for a comparison with the 2004 CASIF data set. The firms included in the 2004 CASIF survey constitute about 20.3% of all Chinese firms included in the economic census. They contribute about 90.7% of Chinese industrial output, hence covering almost all of Chinese industrial activity.

[48] Amongst the company observations that could be matched to the previous year, we were able to match 95.93% based on company IDs, while the remaining 4.07% were matched using other company information.

[49] Upward et al. (2013) have collected the deflators from NBS and make them available on their website. Since their time span is slightly shorter than ours, we supplement their data set with deflators obtained directly from national yearbooks.

[50] We identify 11607 firm-year observations for the employment variable, 24412 for the capital stock, 28040 for sales volume, 23667 for wages and 25569 because their depreciation exceeds the capital stock. Through this procedure, a total of 82165 firm-year observations is deleted.

greater than one from our analysis in order to prevent outliers from contaminating our results. Our company data set is then merged with our minimum wage data set through a six digit administrative division code.

4.4.2 Key variables and relevant statistics

We then proceed to the calculation of our wage variable and our dependent variables. We calculate the average wage per worker in year t as firm level wage expenditures divided by the average of the staff number at the beginning and the end of each year. Since wage costs are incurred throughout the year while the number of employees is only reported at the end of the year, this measure will be inaccurate if large lay-offs or hirings occur unevenly throughout the year. In order to prevent this effect from congesting our explanatory variable, we delete all observations with excessive staff growth or staff reductions in each year by deleting the outlying top and bottom 1% of the firm employment growth distribution.

For the calculation of our fixed capital investment variable, we employ the perpetual inventory method and calculate firm level investment rates as:

$$I_{i,t} = \frac{K_{i,t} - K_{i,t-1} + D_{i,t}}{K_{i,t-1}} \tag{22}$$

where K is the real capital stock and D is the amount of depreciation incurred. Our variable measuring firm investments in human capital is calculated as the amount of training expenditures divided by the number of employees.[51] Our final data set consists of 1,092,378 firm-year observations from the seven year period between 2001 and 2007.[52]

Table 4.2 shows the key statistical properties of our dependent variables as well as the ratio of the minimum wage to the firm level average wage for each year in our data set. The steady growth in size and number of Chinese companies results in the

[51] The training expenditures variable refers to a range of expenditures related to staff training, including training in new technologies, continued staff education and the purchase of teaching equipment.

[52] Observations from the years 1999 and 2000 are only used as lagged values in our GMM estimations.

Table 4.2: Summary statistics for key variables over time

Year	Variable	Mean	Std. Dev.	Min.	Max.	Obs.
2001	Investment rate	0.075	0.273	-0.838	1	93419
	Training / labor	0.057	0.130	0	1.404	98101
	Min. Wage / Avg. Wage	0.580	0.356	0.036	4.027	98101
2002	Investment rate	0.089	0.277	-0.838	1	106034
	Training / labor	0.066	0.143	0	1.406	114034
	Min. Wage / Avg. Wage	0.577	0.359	0.040	4.561	114034
2003	Investment rate	0.084	0.287	-0.838	1	112130
	Training / labor	0.071	0.151	0	1.404	122593
	Min. Wage / Avg. Wage	0.559	0.350	0.042	4.852	122593
2004	Investment rate	0.052	0.311	-0.838	1	114881
	Training / labor	0.073	0.143	0	1.404	126341
	Min. Wage / Avg. Wage	0.631	0.327	0.043	5.481	126341
2005	Investment rate	0.121	0.295	-0.838	1	170795
	Training / labor	0.071	0.152	0	1.406	192128
	Min. Wage / Avg. Wage	0.637	0.320	0.042	5.214	192128
2006	Investment rate	0.117	0.294	-0.838	1	185971
	Training / labor	0.086	0.173	0	1.406	206434
	Min. Wage / Avg. Wage	0.517	0.246	0.044	4.922	206434
2007	Investment rate	0.099	0.292	-0.838	1	210733
	Training / labor	0.089	0.181	0	1.404	232747
	Min. Wage / Avg. Wage	0.501	0.246	0.044	5.223	232747

Note: Data have been deflated to the price level in year 2000. The unit of measurement for training expenditures per worker is thousand RMB.

successive inclusion of additional firms in our data base and the number of annual observations increases from 98,101 observations in 2001 to 232,747 observations in 2007. The minimum wage level amounts to roughly between 50% and 60% of the company-level average wage in most years covered. In the reform year of 2004 and the first year thereafter, the minimum wage rises to more than 60% of average wages until companies adjust their wage levels and the ratio drops to a level below the pre-reform period. Average training expenditures per worker rise from 57 RMB in the first year to a level of about 89 RMB towards the end of our study period. Differences between companies are large for this variable and companies with high investment expenditures in human capital spend more than 1406 RMB per worker. Moreover, about 58.81% of our company-year observations report zero investment in human capital, hence necessitating the estimation of human capital investment regressions through tobit models. The variable with the highest variation both over time and between firms is our fixed capital investment rate. Starting from 22.5% in 2001 it rises to about 37.7% in 2005 before dropping again to a level just above 30% in the final two years of our analysis. All three indicators exhibit significant variation both over time and between firms.

4.5 Wage growth comparison of firms in treated and control group

The key underlying assumption of the theoretical link between minimum wage regulations and company development indicators is that a minimum wage increase drives up company wage expenditures for affected companies. We briefly investigate the link between the two variables by analyzing the difference in subsequent wage growth between treated and non-treated companies. In order to control for the difference in average wage levels between treated and non-treated companies, we split our companies into fifty quantiles according to their wage level and then compare subsequent changes in the log wage for the two groups in order to analyze whether they have been affected differently. The results displayed in table 4.3 show that wage growth of treated companies is about twice as high as wage growth of the non-treated group in the lowest quantiles. As we move up towards higher quantiles in the wage distribution, wage growth of the treated group amounts to about four times the wage growth of non-treated companies.[53]

As pointed out by Ye et al. (2014), compliance rates with the minimum wage policy differ between companies depending on the ownership structure of a firm.[54] We therefore also investigate whether the impact of the minimum wage treatment

[53] Above the 20th wage quantile our treatment group contains less than thirty observations and we therefore do not report these results.

[54] According to Ye et al. (2014), compliance rates are lowest for Hong Kong, Macao and Taiwan invested companies and 9.4% of workers for this company type earn below the minimum wage. Compliance rates for non-state domestic companies and state-owned companies are 2.9% and 2.8%, respectively. Foreign owned companies are the most compliant and only 2.3% of their workers earn less than the minimum wage.

Table 4.3: Change in log wage for treated vs. control firms

Quantile	Control group	Treatment group
1	0.481	0.734
2	0.273	0.565
3	0.233	0.548
4	0.216	0.529
5	0.211	0.523
6	0.206	0.516
7	0.186	0.514
8	0.180	0.523
9	0.178	0.531
10	0.166	0.516
11	0.163	0.522
12	0.158	0.499
13	0.153	0.504
14	0.147	0.521
15	0.135	0.495
16	0.143	0.509
17	0.138	0.491
18	0.130	0.483
19	0.123	0.532
20	0.121	0.619

Notes: The average wage of companies in the *1*st and *20*th wage quantile is 455.83 RMB and 904.36 RMB, respectively. The treatment groups shrink to less than thirty companies above the *20*th quantile and the remaining quantiles have therefore been omitted.

differs between different company types. In particular, we distinguish between local non-state-owned companies, state-owned companies, companies with investors from Hong Kong, Macao or Taiwan as well as foreign invested companies. As displayed in table 4.4, the four company types differ markedly in terms of their wage growth even within the same wage quantile. Foreign companies exhibit the highest wage growth, while wage growth in the state-owned sector is the lowest amongst the four at about a quarter of foreign company wage growth. The four company groups, however, hardly differ in terms of the treatment effect on wage growth and wage growth amongst treated companies is higher in almost all quantiles for all four company types. Despite the differences in policy compliance rates and wage growth, the treatment effect on wage growth therefore occurs for all four company types.

Table 4.4: Change in log wage for treated vs. control firms by ownership type

Quantile	LOEs		SOEs		NMCOEs		FOEs	
	Control	Treatment	Control	Treatment	Control	Treatment	Control	Treatment
1	0.497	0.759	0.306	0.492	1.029	1.193	1.180	1.165
2	0.295	0.581	0.146	0.323	0.359	0.786	0.502	0.806
3	0.244	0.553	0.130	0.302	0.313	0.656	0.445	0.744
4	0.224	0.528	0.100	0.275	0.336	0.612	0.408	0.703
5	0.218	0.517	0.093	0.344	0.284	0.607	0.368	0.592
6	0.208	0.516	0.093	0.287	0.332	0.539	0.337	0.637
7	0.188	0.506	0.056	0.255	0.314	0.585	0.317	0.644
8	0.182	0.512	0.063	0.257	0.270	0.612	0.282	0.598
9	0.180	0.513	0.057	0.347	0.262	0.638	0.265	0.609
10	0.166	0.502	0.057	0.257	0.236	0.583	0.247	0.621

Notes: The average wage of companies in the *1*st and *20*th wage quantile is 455.83 RMB and 904.36 RMB, respectively. LOEs refers to local private or collective firms, SOEs refers to state-owned enterprises, the non-mainland Chinese owned enterprises (NMCOEs) are those owned by investors from either Hong Kong, Macao or Taiwan and FOEs are foreign-owned enterprises. The treatment groups shrink to less than thirty companies above the *10*th quantile in the state-owned sector and the remaining quantiles have therefore been omitted for all ownership types.

4.6 Fixed and human capital investment regression results

4.6.1 Basic investment regression results

The first column in table 4.5 below displays the regression results of our fixed capital investment models with our dummy treatment indicator as explanatory variable, while the second column shows our fixed capital investment results with our treatment intensity indicator as explanatory variable. For both of our explanatory variables, we find a significant positive effect of the minimum wage on fixed capital investments.

Regarding the coefficient of our control variables, the change in the logarithm of output correlates positively and significantly with fixed capital investment, hence confirming the predictions of the accelerator model of investment. The error-correction term is negative and significant, hence confirming error-correction behaviour of firms towards their optimal capital stock. The financial variables are insignificant, which was also previously found in Chen and Zheng (2008) for companies in most Chinese regions. The average wage correlates positively with investment rates, possibly reflecting the fact that a higher human capital stock raises the returns to physical capital investments.

Table 4.9 below displays the logit and tobit regression results of our human capital investment regressions with the dummy treatment indicator as explanatory variable (Models 3 and 5) and our treatment intensity indicator as explanatory variable (Models 4 and 6). In our logit estimations, we omit the companies which do not display any variation in the dependent variable, i.e. the ones that either invest in human capital in every period or never invest in human capital. Our logit results for both explanatory variables indicate that the total effect on the likelihood of firms to invest in human capital is insignificant. Overall, the minimum wage policy therefore neither encourages nor discourages initial non-investors from undertaking human capital investments. For our tobit regressions we can retain all firms and

Table 4.5: Fixed capital investment regression results

	GMM models	
	(1)	(2)
Treatment dummy (lag)	0.017***	
	(0.005)	
Treatment intensity (lag)		0.030**
		(0.013)
Investment rate (lag)	0.097	0.096
	(0.220)	(0.220)
Change in log output	0.225***	0.227***
	(0.083)	(0.083)
Change in log output (lag)	−0.113**	−0.113**
	(0.048)	(0.048)
Error correction term	−0.123***	−0.123***
	(0.047)	(0.048)
Profit per capital	0.002	0.002
	(0.007)	(0.007)
Profit per capital (lag)	−0.002	−0.002
	(0.006)	(0.006)
Debt per capital	0.000	0.000
	(0.000)	(0.000)
Debt per capital (lag)	−0.002	−0.002
	(0.004)	(0.004)
Average wage	0.000**	0.000**
	(0.000)	(0.000)
Observations	242619	242619
Firms	96209	96209
Number of instruments	37	37
Hansen Test (p-value)	0.706	0.702
AR(1) (p-value)	0.002	0.002
AR(2) (p-value)	0.206	0.207

Notes: Standard errors in parentheses. The respective significance symbols denote: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

all censored and uncensored firm-year observations.[55] Our tobit regressions with two alternative explanatory variables unequivocally show that the minimum wage has reduced the amount of training expenditures incurred per worker for Chinese companies.

Some interesting findings also emerge from the results of our human capital regression covariates. The human capital stock and firm size both correlate positively

[55] The sample for these regressions includes 350,311 censored and 287,833 non-censored observations.

Table 4.6: Human capital investment regression results

	Tobit models	
	(3)	(4)
Treatment dummy (lag)	−0.026***	
	(0.002)	
Treatment intensity (lag)		−0.052***
		(0.004)
Average wage	0.000***	0.000***
	(0.000)	(0.000)
Log workforce size	0.027***	0.027***
	(0.001)	(0.001)
Labor productivity (lag)	−0.023***	−0.022***
	(0.007)	(0.007)
State owned	−0.003	−0.003
	(0.002)	(0.002)
Foreign owned	−0.054***	−0.054***
	(0.002)	(0.002)
HK/MC/TW owned	−0.079***	−0.078***
	(0.002)	(0.002)
Exporter dummy	−0.000	−0.000
	(0.001)	(0.001)
Union dummy	0.090***	0.090***
	(0.001)	(0.001)
Technical staff (%)	0.105***	0.106***
	(0.019)	(0.019)
University degree (%)	0.291***	0.291***
	(0.009)	(0.009)
Female staff (%)	−0.056***	−0.058***
	(0.006)	(0.006)
Constant	−0.326***	−0.328***
	(0.006)	(0.006)
Industry fixed effects	✓	✓
Observations	638144	638144
Log likelihood	-182786.3	-182828.7
Chi^2	31822.1	31732.4
Prob $\text{Chi}^2 > 0$	0.000	0.000
σ_u	0.197***	0.197***
σ_e	0.186***	0.186***
ρ	0.528	0.528

Notes: Standard errors are shown in parentheses. The significance symbols denote: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

with human capital investments. Foreign-owned companies in the Chinese market are characterized by lower investment rates than local companies. Exporters are less likely to invest in human capital and generally invest less than non-exporters, reflecting the reliance of the export sector on labor-intensive low skill production. The establishment of a workers' union as well as the shares of technical staff and university graduates in total staff all correlate positively with human capital investment rates, while the share of female workers correlates negatively with human capital investment rates.

4.6.2 Investment regression results by firm ownership type

In this subsection we again split our companies into groups according to the four different ownership types introduced in the previous section and implement our fixed and human capital investment regressions separately for each group.[56] For our fixed capital investment regressions shown in table 4.7 the results differ markedly between company types.[57] The positive impact of the minimum wage policy on capital investment rates is only confirmed for locally owned companies, while the other three company types have not adjusted their fixed capital investment behaviour in response to the minimum wage. Error correction behaviour and the output effect predicted by the accelerator model of investment are confirmed in all regressions except for the state-owned group.

In contrast to the fixed capital investment regression results, the results of our human capital investment regressions are remarkably homogeneous across different company types and mirror the results of our basic regression results. The logit model treatment variable is insignificant for all company types. The respective coefficient

[56] In order to make the exposition more concise, we only report the results of our dummy treatment variable regressions in this subsection. The results for our treatment intensity variable are in line with the results for the treatment dummy variable, i.e. either both insignificant or significant with the same sign.

[57] To simplify the search for the optimal number of instruments, we drop the insignificant financial variables and implement the basic error-correction model shown in equation 19. Our strategy for selecting the optimal instruments is to start from the specification implemented for our complete sample. If this specification fails the Hansen test or the second order autocorrelation test for any of our sub-samples, we move on towards deeper lags, see Guariglia et al. (2011). The number of instruments employed therefore differs between different sub-samples of firms.

Table 4.7: Fixed capital investment regression results by firm ownership type

	GMM models			
	LOEs	SOEs	NMCOEs	FOEs
Treatment dummy (lag)	0.023***	−0.006	0.000	0.009
	(0.008)	(0.007)	(0.008)	(0.011)
Investment rate (lag)	0.162	−0.187	−0.378**	−0.207
	(0.271)	(0.239)	(0.153)	(0.260)
Change in log output	0.323***	0.008	0.217**	0.263**
	(0.097)	(0.126)	(0.096)	(0.111)
Change in log output (lag)	−0.152***	−0.004	−0.110**	−0.147**
	(0.054)	(0.072)	(0.049)	(0.058)
Error correction term	−0.158***	−0.011	−0.100**	−0.158***
	(0.053)	(0.080)	(0.051)	(0.058)
Average wage	0.000	0.000**	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	157677	26331	31031	29030
Groups	67734	11892	14026	12950
Number of instruments	25	25	37	37
Hansen Test (p-value)	0.655	0.187	0.304	0.206
AR(1) (p-value)	0.005	0.073	0.067	0.090
AR(2) (p-value)	0.162	0.586	0.068	0.867

Notes: Standard errors are shown in parentheses. The respective significance symbols denote: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The definitions of LOEs, SOEs, NMCOEs and FOEs are mentioned in the footnote of table 4.4.

in our tobit model is negative and significant and its size is very similar for all four company types. The minimum wage policy therefore does not significantly affect the likelihood of firms to engage in human capital investment for non-investors, but lowers firm level human capital investment rates irrespective of the ownership structure of the firm.

Table 4.8: Human capital investment regression results by firm ownership type

	Tobit models			
	LOEs	SOEs	NMCOEs	FOEs
Treatment dummy (lag)	-0.025^{***}	-0.025^{***}	-0.029^{***}	-0.026^{***}
	(0.002)	(0.003)	(0.006)	(0.007)
Average wage	0.000^{***}	0.000^{***}	0.000^{***}	0.000^{***}
	(0.000)	(0.000)	(0.000)	(0.000)
Log workforce size	0.031^{***}	0.028^{***}	0.020^{***}	0.025^{***}
	(0.001)	(0.001)	(0.002)	(0.002)
Labor productivity (lag)	-0.002	-0.063^{***}	-0.034	-0.029
	(0.008)	(0.012)	(0.025)	(0.022)
Exporter dummy	0.009^{***}	-0.002	-0.018^{***}	-0.005^{*}
	(0.001)	(0.003)	(0.003)	(0.003)
Union dummy	0.087^{***}	0.057^{***}	0.092^{***}	0.102^{***}
	(0.001)	(0.004)	(0.003)	(0.004)
Technical staff (%)	0.083^{***}	0.022	0.110^{*}	0.184^{***}
	(0.022)	(0.035)	(0.058)	(0.054)
University degree (%)	0.274^{***}	0.151^{***}	0.440^{***}	0.262^{***}
	(0.011)	(0.017)	(0.026)	(0.021)
Female staff (%)	-0.030^{***}	0.004	-0.101^{***}	-0.156^{***}
	(0.007)	(0.016)	(0.018)	(0.018)
Constant	-0.360^{***}	-0.262^{***}	-0.354^{***}	-0.352^{***}
	(0.008)	(0.012)	(0.017)	(0.018)
Industry fixed effects	✓	✓	✓	✓
Observations	449333	43859	75823	71967
Log likelihood	-137698.4	-1043.1	-20579.6	-22128.0
Chi^2	23176.9	9057.5	3643.4	4571.3
Prob Chi$^2 > 0$	0.000	0.000	0.000	0.000
σ_u	0.199^{***}	0.136^{***}	0.201^{***}	0.208^{***}
σ_e	0.192^{***}	0.131^{***}	0.178^{***}	0.200^{***}
ρ	0.508	0.523	0.549	0.527

Notes: Standard errors are shown in parentheses. The significance symbols denote: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The (significant) constant term has been omitted to save space. The definitions of LOEs, SOEs, NMCOEs and FOEs are mentioned in the footnote of table 4.4.

4.7 Robustness checks

In this section, we present results based on an alternative sample, alternative model specifications, and an alternative treatment group identifier variable.[58]

4.7.1 Evidence from a balanced panel of firms

As mentioned in section 4.4, the CASIF dataset employed in this study has undergone changes in its composition over time. Specifically, additional firms have been included as soon as they fulfilled the requirement of annual revenues exceeding 5 million RMB. The fact that these are growing firms that potentially outperform other firms potentially introduces a bias to our results. In this subsection, we remove this effect by only retaining the firms that were already included in the first year of our study period and trace their development over time until 2007.

After dropping the firms that are not included in all years of our study period, we retain 19,919 firms for this part of our analysis. Our results presented in the first, fourth and seventh column of table 4.9 are fully in line with those obtained from our unbalanced panel of firms, i.e. significant positive effects for fixed capital investments, insignificant effects for our logit models of human capital investments and negative effects in our tobit models for human capital investments. The additional inclusion of growing firms over time has therefore not biased our results.[59]

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[58] Two other robustness checks we conducted deserve mention, but are not discussed in more detail in this section. The first one is an implementation of our panel data regressions with the treatment intensity variable employed by Mayneris et al. (2014). The results of this model are qualitatively identical to the treatment intensity variable we employed above and we therefore do not discuss them. The other one is an alternative specification for training intensity as training per output. The results from these regressions are also qualitatively in line with the results we obtain for our training intensity measured as training per worker. Since we consider the per worker specification more insightful, we only discuss these results throughout our paper.

[59] As previously, our GMM model passes the Hansen test and the second order autocorrelation tests. In our logit model, we include the 11,652 firms that displayed variation in the level of our dependent variable, i.e. firms that invested in training in at least one period, but not in all periods.

4.7.2 Evidence from cross-section estimates

This subsection and the subsequent subsection deal with two other criticisms to the way we employ our data set. The first argument is based on the fact that provincial governments consider a range of factors when they adjust their minimum wages. These factors may also include the ability of firms to absorb the cost increase, as evidenced by the decision to not increase the minimum wage across most of the country during the recession year of 2009. One may therefore argue that changes in local minimum wage levels are not entirely exogenous to firm development. The only policy change that can be considered essentially exogenous is the enactment of the new minimum wage regulations in 2004. This motivates a cross-section specification as implemented in Mayneris et al. (2014) that utilizes the change in each outcome variable between the final pre-policy year 2003 and the first post-policy year 2005 as dependent variable. While we maintain that a cross-section implementation is generally not desirable for our research question because it does not control for unmeasurable heterogeneity of firms as in our panel data models and cannot reveal the dynamic processes for our fixed capital investment regressions, we implement the cross-section specification to gain a better understanding of the robustness of our results.

For our cross-section specification, we calculate our dependent variables as the two-period average difference between the value of our outcome variables and those values in the two previous periods ($\Delta Y_{i,2005-2003}$). We control for a range of firm characteristics measured in the final pre-policy year ($z_{i,2003}$), including the average wage, labor productivity, staff size and dummy variables for state ownership, foreign ownership, exporter status as well as industry and city dummy variables ($\mu_{c,k}$), thus exploiting differences between exposed and non-exposed firms in the same sector and city. As before, our treatment group is identified through a dummy variable that is equal to one if the average wage of a firm was below the minimum wage level in its county in 2003. To measure the intensity of the treatment, this dummy variable is multiplied with the difference in the logarithm of the minimum wage between 2005 and 2003. This model, which is analogous to equation one in Mayneris et al. (2014), can be summarized as follows:

$$\Delta Y_{i,2005-2003} = \alpha\,(\Delta mw_{j,2005-2003} \times treat_{i,2003}) + \boldsymbol{\beta' z_{i,2003}} + \gamma\,\mu_{c,k} + \varepsilon_{i,2005} \quad (23)$$

Our results from the cross-section specification are shown in columns two, five and eight of table 4.9. The signs of the coefficients of our regressions for the change in the fixed capital investment rate and for the human capital investment rate are in line with those from more complex models. However, none of the coefficients turns out significant. Our conclusion for this part of our analysis based on this simplified OLS model is therefore that these models do not contradict the results from our panel data regressions.

4.7.3 Evidence from an alternative treatment group identifier

Restricting our study period to the final period before and the first period after the enactment of the new minimum regulations also permits us to implement a regression model that makes use of additional firm data uniquely included in the CASIF survey from 2004. In this subsection, we employ these data and propose an alternative measure to the widely employed treatment indicator based on the relationship between average wages at the company level and mandated minimum wage levels. Our motivation is that the average wage may correlate insufficiently with the number of affected people in a firm due to differences in inner-firm wage distributions.

We therefore revise our treatment indicator as follows. According to previous analysis on Chinese minimum wages conducted by Fang and Lin (2013), female workers are about six times as likely to receive the minimum wage or less as the average worker. Moreover, workers whose highest educational attainment is a middle school degree or less are about seven times as likely to receive the minimum wage as staff with a college degree.[60] In this subsection, we therefore exploit data on the share of female workers with a middle school degree or less calculated for each firm, and obtain this information from data on the staff structure of firms that has been uniquely investigated as part of the 2004 CASIF data set.

In particular, we use fms_i to denote the share of female staff with a middle school degree or less and fms_{50p} to denote the median of the female staff share distribution for all firms. Based on these two variables we identify our treatment group as:

$$treatdum_{it} = \begin{cases} 0 & \text{if } fms_{i,2004} < fms_{50p,2004} \\ 1 & \text{if } fms_{i,2004} \geq fms_{50p,2004} \end{cases} \tag{24}$$

and adopt the specification shown in equation 23 above with this alternative treatment group identifier.

Our regression results for this alternative treatment identifier are displayed in columns three, six and nine of table 4.9. The coefficients obtained from these regressions are in line with the more sophisticated models implemented in the previous section. The coefficient in our fixed capital regression and the ordinary least squares model for changes in the decision to invest in human capital are found insignificant. The coefficient for this explanatory variable is found significant in our regression for the human capital investment rate with a negative sign, as previously in our tobit regression results. The latter finding suggests that this finding is particularly robust even to alternative specifications of our treatment identifier.

[60] The precise percentages of workers earning no more than the minimum wage calculated based on the Urban Household Survey employed in the study are: 67.01% of female workers compared to 8.91% for all workers, 25.16% of workers with no more than an elementary school degree, and 15.43% of workers with a middle school degree compared to, for example, only 2.99% of workers with a college degree; see table 3 in Fang and Lin (2013).

TABLE 4.9: Robustness checks: summary of three alternative estimation results

	Fixed capital			Human capital		
	Balanced	OLS1	OLS2	Balanced	OLS1	OLS2
Treatment dummy (lag)	0.016^{**}			-0.007^{**}		
	(0.006)			(0.003)		
Treatment intensity (Alt.1)		0.015			−0.011	
		(0.033)			(0.012)	
Treatment intensity (Alt.2)			−0.006			-0.019^{***}
			(0.017)			(0.008)
Observations	99,595	61,141	61,141	99,595	61,141	61,141
Firms	19,919	61,141	61,141	19,919	61,141	61,141

Notes: Robust standard errors are shown in parentheses. The significance symbols denote: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first row displays the results from our balanced sample. The cross-section model labelled OLS1 refers to the model as implemented in Mayneris et al. (2014). The cross-section model labelled OLS2 implements their regression, but utilizes data on the female staff share with low education to identify the group of affected firms. The other independent variables included in each model are not displayed for conciseness. In the regression models for our balanced sample, the other regressors are the same as those included in the respective models with the full sample. The other regressors in our cross-section models are the second lags of the firm characteristics included in the respective models in the previous subsection as well as dummy controls for cities and industries.

4.8 Conclusion: minimum wages and investments

During the past two decades, China has implemented a complex system of minimum wages across the country. Consequently, minimum wages have risen sharply, especially since the introduction of the new minimum wage regulations in 2004. In this chapter, we focus on the potential adverse effects on firm behaviour due to the Chinese minimum wage policy by empirically analysing the effect on the firm investment decision.

The theoretical predictions regarding the effect of the minimum wage on the investment decision of firms differ between standard theories for competivive labor markets and more recent theories based on non-competitive labor markets. According to standard economic theory, an increase in labor costs through minimum wage adjustments imposes a negative scale effect on companies, in turn leading to a reduction in fixed capital investment. Standard models of human capital theory also predict a negative effect on human capital investment since a wage floor reduces the ability of employees to accept wage reductions in order to enable companies to finance worker training. On the other hand, models of non-competitive labor markets generally predict that company fixed and human capital investments associated with affected labor groups will rise in face of an exogenous increase in labor costs. In this chapter, we therefore provide empirical evidence contributing to this debate.

Our empirical results indicate that the Chinese minimum wage policy has indeed reduced firm investment rates in human capital, while it has generally led to an increase in fixed capital investment rates. The substitution effect identified in our fixed capital investment regressions as well as the negative scale effect found in our tobit regression results for human capital investments provide general support for the predictions of neoclassical models of the labor market. Our logit regressions estimating the likelihood of companies to invest in human capital, however, provide some support to alternative theories in the sense that offsetting effects exist in this part of our analysis and previous non-investors are not significantly discouraged from undertaking human capital investments in face of minimum wage hikes.

An important detail of our analysis is the finding that the ownership structure of a firm matters and that only Chinese privately owned companies have shifted away from investing in labor and increased their investments in fixed capital. Our human capital regression results, however, do not differ by ownership structure and the minimum wage policy unequivocally lowers training expenditures per worker for all ownership types.

Overall, the negative scale effect imposed on companies due to minimum wage regulations outweighs other consequences of the policy and the competitiveness of Chinese companies may suffer as a consequence of the minimum wage regulations. The decrease in human capital investment rates is likely to reduce labor productivity growth and further adverse effects on the labor market may occur in the long term.

5 Concluding remarks and discussion

In this dissertation we analyze some of the effects of the recent labor market reforms pertaining to the mandated labor cost system implemented in Taiwan and China. In particular, we focus on the effects of increases in mandated benefits in the Taiwanese economy and the effects of minimum wage increases in China. For each of these economies, the respective type of labor cost is of particular importance.

In Taiwan, the recent reforms of the mandated benefit system, which includes, but is not limited to, health insurance, labor insurance and pension fund contributions, are a potential contributing factor to stagnating wage growth in Taiwan during the past two decades. In the first empirical analysis of this dissertation, we confirm that the most recent and ongoing increases in labor insurance contribution rates have indeed contributed to a reduction in private sector wages. A second critical issue for the Taiwanese economy is that the increase in labor costs may lower the return to capital investments and therefore be a potential contributing factor to decreasing investment rates and an increasing outflow of capital from the Taiwanese economy. In the second empirical analysis conducted in this dissertation, we find that the overall increases in the three major types of mandated benefits during the past decade have indeed depressed fixed capital investment rates of Taiwanese stock market companies. Taken together, we find a double negative effect resulting from increases in mandated benefit rates in the economy. Firms tend to shift the cost increases due to mandated benefits backward onto worker wages. As their costs rise during this transition process, Taiwanese companies also experience a reduction in investment rates. Because the reduction in capital investment rates affects worker productivity and wages, the policy of increasing mandated benefit requirements that brings about some short-term worker benefits is likely to bear a negative long-term overall impact on Taiwanese workers.

The third empirical analysis conducted as part of this dissertation contributes to the literature on the effects of minimum wages in the Chinese economy. In China, the recent policy of increasing minimum wages has ignited controversy and critics argue that it may hamper firm competitiveness, while its proponents argue that the policy provides an impetus to a transformation of Chinese businesses away from labor-intensive production toward more skill-intensive operations. In our third empirical analysis, we find that the minimum wage policy has caused a decrease in human capital investment rates for all Chinese firms. Moreover, we also find that Chinese locally owned firms display a substitution effect and have increasingly invested in fixed capital rather than human capital. This also implies that the elasticity of substitution between capital and labor is higher for Chinese private firms than for other firms in the Chinese economy and significantly higher than the one for the Taiwanese companies in our study.

Another important question is to what extent the results of this dissertation support neoclassical theories of competitive labor markets vis-a-vis the more recent models of non-competitive labor markets in which employers can exert monopsony power. The results of our first empirical analysis can be explained by both types of labor market models. The results of our final two empirical chapters, i.e. the reductions in investment rates and the substitution effect found for the case of Chinese private firms, however, can only be reconciled with models competitive labor markets. While these are overall results at the company level, an analysis using more detailed data on the employees of each firm may be able to reveal differential effects across the workforce within each firm, as predicted by non-competitive models of the labor market.

Overall, the results of our analysis show that, while an increase in employer social security contribution rates is desirable in the short-term, it bears important side-effects on companies that need to be considered. In the long term, the effects on firm human capital investments and fixed capital investments may affect workers even more profoundly than the short-term increases in insurance and pension contribution rates or minimum wages. Overall, our analysis therefore also calls for a more holistic approach to labor market policy making that considers these diverse effects to achieve the most desirable long-term outcomes for the society as a whole.

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Appendix

A Derivation of wage residuals accounting for compensating differentials

According to the theory of equalizing differences, other forms of labor compensation (C), in our case wages and voluntary benefits, can be modelled as a function of an indicator for the level of mandated benefits (B). Since both of these variables follow a time trend, we derive their time-differenced version as follows. Starting from the initial relationship:

$$C_{it} = \alpha_0 \ + \ \alpha_1 \ * \ B_{it} \ + \ \epsilon_{it} \tag{A1}$$

We obtain the lag of the above equation as:

$$C_{it-1} = \alpha_0 \ + \ \alpha_1 \ * \ B_{it-1} \ + \ \epsilon_{it-1} \tag{A2}$$

And take first differences to obtain:

$$\Delta \ C_{it} = \ \alpha_1 \ * \Delta \ B_{it} \ + \ \Delta \ \epsilon_{it} \tag{A3}$$

Applying this procedure as a preparatory step to each of our estimations 7, 8 and 9b yields our first-stage estimation equations as follows:

$$\Delta \ C_{it} = \ \alpha_1 \ * \Delta \ MR_{it} \ + \ \Delta \ \epsilon_{it} \tag{A4}$$

$$\Delta \ C_{it} = \ \alpha_1 \ * \Delta \ ER_{it} \ + \ \Delta \ \epsilon_{it} \tag{A5}$$

To obtain our compensation residual for equation 12 we proceed analogous to estimation 9a. We first estimate the effect of changes in ER on changes in actual

Table A.1: First-stage estimation results testing for compensating differentials

	Pre-estimation			*First-stage estimations*		
	Dependent variable: $\Delta\ MR$			Dependent variable: $\Delta\ W$		
Model 4:				$\Delta\ ER$	706.921***	(82.882)
Model 5:				$\Delta\ MR$	-1190.887***	(159.607)
Model 6:	$\Delta\ ER$	0.288***	(0.033)	$\Delta\ \widehat{MR}$	2453.044***	(287.604)
	Dependent variable: $\Delta\ MR$			Dependent variable: $\Delta\ VR$		
Model 4:				$\Delta\ ER$	-0.065*	(0.037)
Model 5:				$\Delta\ MR$	0.096***	(0.019)
Model 6:	$\Delta\ ER$	0.288***	(0.033)	$\Delta\ \widehat{MR}$	-0.227*	(0.130)

Notes: The symbols *, ** and *** denote significance at the 10%, 5% and 1%-levels, respectively. Heteroskedasticity-robust Huber/White standard errors are shown in parentheses.

mandated benefit expenditures (M).

$$\Delta\ M_{it} = \ \beta_1\ * \Delta\ ER_{it}\ +\ \Delta\ \epsilon_{it} \tag{A6}$$

We then use the time-differenced predicted values of the mandated benefit expenditures ($\hat{M}$) to estimate the effect on changes in the compensation level:

$$\Delta\ C_{it} = \ \alpha_1\ * \Delta\ \hat{M}_{it}\ +\ \Delta\ \epsilon_{it} \tag{A7}$$

After obtaining our estimates for the coefficient α_1, α_0 is calculated using mean values for dependent and independent variable. We then return to equation (A1) above and calculate the compensation residual ($\hat{C}$) as:

$$\hat{C}_{it} = C_{it} - \alpha_0\ -\ \alpha_1\ *\ X_{it} \tag{A8}$$

The three compensation residuals are our instrumental variables to be included in equations 10, 11 and 12 instead of the wage and voluntary benefit variables obtained from company income statements.