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A temporary full-time bonus as a solution to reduce the labor shortage

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Abstract

The current labor market faces a worker shortage. This paper explores the potential solution of increasing work hours to alleviate the shortage. We consider full-time work as an experience good, where employees know their utility of working full time after they have worked these hours. We propose a temporary full-time work bonus where the government is tempted to provide the bonus due to the fiscal externality. Through an intertemporal choice model under uncertainty, we analyze the conditions under which a temporary full-time bonus policy would be optimal for social welfare. We find that employees are more inclined to work full time and discover their preferences in a model with multiple periods, as they can apply their awareness. The bonus gives an occasion to employees to discover their preferences. The study concludes that providing a temporary bonus, under specific conditions, can be beneficial for the government, employers, and employees, resulting in increased work hours and economic growth.

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Overview of symbols

In making the intertemporal model, many symbols will be used. Therefore, the following table describes the different symbols. The third column shows the page on which the symbol is defined.

Abbreviation	Meaning	Page
π_P	The profit generated by a part-time employee.	11
π_F	The profit generated by a full-time employee.	11
R_P	The revenue generated by a part-time employee.	11
R_F	The revenue generated by a full-time employee.	11
w_P	The wage of a part-time employee.	11
w_F	The wage of a full-time employee.	11
c_P	The costs of working part time for an employee.	11
${c_F}^L$	The costs of working full time for a low type employee.	12
${c_F}^H$	The costs of working full time for a high type employee.	12
U^{out}	The outside option utility.	12
U_P	The utility of working part time.	12
τ	The percentage of wage tax.	12
${U_F}^L$	The utility of working full time for a low type employee.	12
${U_F}^H$	The utility of working full time for a high type employee.	12
G	The revenues of the government from wage taxes.	14
w	The wage of an employee.	14
p	The probability of being a high type employee.	14
EU_F	The expected utility of working full time.	14
p_1	The maximum probability of being a high type employee for which employees decide to work full time in the simple model.	14
${U_{F2}}^L$	The utility of working full time for a low type employee in the two-period model.	16
U_{P2}	The utility of working part time in the two-period model.	16
EU_{F2}	The expected utility of working full time in the two-period model.	17
p_2	The maximum probability of being a high type employee for which employees decide to work full time in the two-period model.	17
N	The number of periods after the first year in the $(N+1)$-period model.	18
${U_{FN}}^L$	The utility of working full time for a low type employee in the $(N+1)$-period model.	19

U_{PN}	The utility of working part time in the $(N+1)$-period model.	19
EU_{FN}	The expected utility of working full time in the $(N+1)$-period model.	19
p_N	The maximum probability of being a high type employee for which employees decide to work full time in the $(N+1)$-period model.	19
ω	Social welfare.	22
T	The total number of employees.	22
U	The utility of an employee, depending on their type and work hours.	22
S	The total number of all employers.	22
γ	The parameter of how the government's expenditures are valued.	22
β	The bonus provided to an employee in one period.	23
σ	The lump sum tax for one individual.	23
β^G	The maximum bonus that the government will provide for an employee.	23
${b_\beta}^E$	The benefits of the bonus of a full-time employee compared to a part-time employee for the employer.	25
c_β	The costs of the bonus for one employee who decides to work full time instead of part time in one period.	25
β^E	The maximum bonus that the employer will provide for an employee.	26

1 Introduction

In the labor market of Europe, the increasing worker shortage is becoming a problem in different sectors (EURACTIV Network & Allenbach-Ammann, 2022). The United States copes with the shortage as well. The data of the labor force shows that the United States have around ten million open vacancies in 2023 (U.S. Bureau of Labor Statistics, 2023). In addition, the United States face approximately six million unemployed workers. Even if all the workers would get a job in the labor market, the worker shortage would still exist. For Europe, the job vacancy rate is equal to 2.9%. The rate is defined as the number of job vacancies divided by the total occupied posts and the number of job vacancies (Eurostat, 2023b). To conquer part of the shortage, increasing the work hours of individuals may be an effective solution.

The supply of goods and services is lower than demand for goods and services because of the labor shortage. Because of the increasing demand, the prices may rise, causing inflation. Less transactions are reached due to the shortage, which has a negative effect on economic growth, compared to a situation with enough labor supply (Burda & Wyplosz, 2017). Therefore, we are interested in raising the work hours of employees to increase economic growth.

The work hours can expand by increasing the number of full-time employees. The data from Eurostat (2023a) shows that the total part-time employment rate is equal to 17.4% in the third quarter of 2022. Part-timers work less than 30 hours. The part-time employment rate for women is equal to 28.2%, while the rate for men is only 8.0%. The difference between men and women could be an effect of women taking care of the household (Roeters, 2018). But what if women work part time while not yet having to spend a lot of effort on the household?

In the complex and uncertain economic environment of today, individuals often face tough decisions regarding their work hours. One of the obstacles in making these decisions is the lack of information about the preferences on work hours for an individual. Some individuals have always worked part time, which means they might prefer working full time, but they are not aware of this (Central Bureau of Statistics, 2022). Our study is socially relevant because we try to determine when employees want to work more, and we aim to incentivize employees to work full time. To maximize social welfare, motivating these individuals to work more hours by providing a full-time work bonus in the short run could lead to working full time in the long run, which is eventually beneficial for social welfare because of the fiscal externality.

The goal of this paper is to give more insights on how individuals make decisions on the number of work hours under uncertainty. With this information, an opportunity arises to design a bonus to increase

the overall work hours. In this research, an intertemporal choice model will be created to emphasize under which conditions individuals are willing to work full time and what the benefits are for social welfare. The research question is:

Under which conditions will a temporary full-time bonus policy be socially optimal to reduce the labor shortage?

The intertemporal model arises from a simple model. We use different variables to determine under which conditions employees choose to work full time. The salary from work increases the utility of an employee. Working full time gives certain costs now, and in the future, like more work hours and the possibility of health issues. The cost of working part time is equal for all individuals, while the costs of working full time brings additional costs, which varies across individuals.

We find that employees have an enticement to work full time to learn what their preference is about their work hours. The encouragement increases in a situation where employees benefit more years from this awareness. Our paper shows that the government and employers can adapt to the enticement of employees by providing a temporary full-time bonus in the first period. We have determined the conditions for which the employee will work full time in the first period and both the government, and the employers have an incentive to provide the bonus. The overall social welfare will rise as an outcome of the bonus with the defined conditions; hence the bonus can contribute to economic growth.

The structure of the paper is as follows. First, the relevant literature is discussed in chapter 2. In the following chapter, we will create an intertemporal model with an undefined number of periods. To construct this model, we start by creating a simple model with one period, and then we establish an intertemporal model with two periods. In chapter 4, the conditions of the temporary full-time bonus will be generated. In chapter 5 we will discuss the limitations of this paper and chapter 6 contains the findings and the conclusion of this paper. The appendices provide the mathematical computations and their outcomes.

2 Literature review

We hope to contribute to the field of research through this study. In this chapter we will discuss the theory behind our study. Furthermore, the research that has already been done on policies to motivate employees to work full time, and the decisions of employees regarding their employment arrangement will be discussed.

The intertemporal choice model is a simplistic model of reality where individuals make choices over time (Frank & Cartwright, 2016). In decision-making, individuals consider the effects of their choices now and in the future. The model gives an opportunity to analyze how individuals allocate their resources in different time periods to optimize their utility. The results of an intertemporal choice model can be used to develop the optimal approaches for businesses or the government, for instance, to reach their objectives.

In our model, the costs of working full time are uncertain until an employee has worked full time for one year. Working full time can therefore be seen as an experience good. Consumers can only determine the value and quality of an experience good after actually consuming the good (Shapiro, 1983). Shapiro investigated pricing of experience goods. The price depends on the demand of consumers who base their choice on the expected quality. Consumers can either over- or underestimate the quality. In case of underestimation, the price needs to decline to realize a transaction, while the price could rise when consumers overestimate the quality.

Employees estimate the expected utility of working full time. Overestimating the utility leads to more full-time employment, whereas employees decide to work part time due to underestimation. After experiencing a good, Shapiro concludes that negative welfare effects arise with underestimation since less individuals consume the product than the optimal number of consumers. On the other hand, overestimating has no effects in the long run for social welfare. We ascertain the same result in the model.

Why people prefer a certain number of hours depends on several reasons. Employees prefer working more hours due to an increase in relative income, while a bad work-life balance results in the preference of working less hours (Schalembier et al., 2019). Individuals partly experience their optimal work-life balance by working, since it depends on different options like working from home, flexible work hours and onsite childcare (Beauregard & Henry, 2009).

The government could influence the number of work hours of employees by changing the amount of social security. Fan et al. (2022) created a life-cycle model to analyze the effect of social security on individuals' decisions about labor supply, consumption, and human capital investment. They find through indirect inference that a decrease in social security results in higher labor supply later in the life cycle. From this paper, we can conclude that income is a crucial factor in the choice of work hours.

Another essential factor in deciding whether to work more hours are the childcare costs (Immervoll & Barber, 2006). Immervoll and Barber suggest that social benefits play a part in deciding the level of childcare costs. If an individual does not work, he receives social benefits from the government. When he starts to work and earns a salary, he also must pay taxes and childcare costs. The benefits of working may be lower than the increase in costs of working, which leads to an adverse work incentive. In conclusion, lowering the childcare costs does not automatically lead to increased work hours. The government must consider whether a new policy in stimulating more work hours leads to this result.

Waterreus and Dobbelsteen (2001) have analyzed the effect of teachers' net hourly wage on their work hours, based on a study of Dutch teachers. The paper shows a positive correlation between hourly wage and the work hours, since the wage elasticity is equal to 0.2 for men and 0.4 for women. The wage of employees could be increased in general, or through a full-time work premium. Comparing these two methods, the results of Waterreus and Dobbelsteen show that a general wage increase is expensive, while the same outcomes can be achieved by only applying a bonus to full-time employees. They find that the costs of the premium were half a billion guilders to increase the work hours by 8%, while a general wage increase costs around 3.5 billion guilders. In conclusion, a full-time work premium is cost-effective, and therefore it is a solution for labor shortage.

An issue regarding providing this bonus is that some employees would have chosen to work full time anyway without the bonus. Dur et al. (2004) discussed the possibility of educational subsidies depending on parental income. Some students who have parents with high income do not need the high subsidies to receive education, which means these inframarginal education subsidies can decrease. The full-time bonus supplied to individuals that already prefer a full-time position can be seen as inframarginal, since these employees will also work full time without bonus. The relative benefits of the bonus reduce, as the bonus only affects the choice of employees that would have worked part time without receiving this bonus.

In line with the results of Waterreus and Dobbelsteen, Goos and Konings (2007) discovered that payroll tax exemptions lead to an increase of around 5 to 8 percent in full-time employment. Thus, a higher net income results in more work hours for employees. Workers in Belgium were analyzed in a natural

experiment with firm-level data. Furthermore, the impact of employment subsidies on employment is larger in industries with more elastic product and labor demand.

From this chapter, we can determine that employees could be incentivized to work more by increasing their income. However, some employees have always worked part time, and these employees may need a higher raise to work full time. Therefore, we aim to find out under what circumstances part-time employees are willing to work more hours.

3 The intertemporal choice model

In this chapter, the intertemporal choice model will be explained. To set up this model, we create a simple model which contains only one period. The simple model clarifies how individuals make decisions on work hours. The information obtained from this model will be implemented in the intertemporal model, first with two periods and then with an unspecified number of periods. The model aims to give more insights on the work hour decisions where learning is relevant.

3.1 The simple model

The simple model consists of employees who decide either to work part time or full time for employers. The employees choose to work if they benefit from working. We assume that all individuals are rational in this model. Some employees prefer working part time, while others prefer a full-time job. Their decision is based on the wage and the costs of working. We will determine under what condition employees are willing to work full time.

The wage an employee receives from working is determined by the employer. The employers' profit consists of the revenues generated by the employee and the wage for the employee. The profit generated by part-timers (π_P) is:

$$\pi_P = R_P - w_P, \tag{1}$$

and by full-timers (π_F) is:

$$\pi_F = R_F - w_F, \tag{2}$$

where R_P is the revenue generated by a part-time employee and R_F is the revenue generated by a full-time employee. The wage is also specific for part-timers (w_P) and full-timers (w_F). We assume that the revenues for full-time employees are higher than the revenues for employees who work part time, as full-time employees work more hours. Another assumption is that perfect competition arises between employers. This causes the wages for both part-time and full-time employees to be equal to the revenues generated by these employees.

The choice on work hours of an employee depends on costs of working. The costs of working part time (c_P) are identical for all employees. On the other hand, the costs of working full time differ across

employees. An employee can have low full-time working costs ($c_F{}^L$), who we call a low type employee, or high full-time working costs ($c_F{}^H$), who we name a high type employee. We assume that:

$$c_P < c_F{}^L < c_F{}^H. \tag{3}$$

The costs of working contain every factor that negatively affects the utility from working. Some short-run costs are the lack of a work-life balance, the effort and stress of work, and childcare costs. Specifically for part-time work, an employee might have limited career opportunities. In the long run, working could lead to health problems. These costs differ across employees and employment arrangements. Employees that work part time have less costs for childcare and might experience less stress, compared to full-time employees. The difference in low type and high type employees could come from parents who experience childcare costs for example, which makes working full time less attractive, while employees without children do not bear these costs.

The model contains two scenarios, one scenario where employees are aware of their costs of working full time and one scenario in which these costs are uncertain. We will first investigate choosing the work hours under certainty.

The choice of work hours under certainty

An employee chooses the work hours for which he maximizes utility. The employees are aware of their costs of working full time. Combining the wage and the costs of working, we can determine the utility generated with different work hours. The outside option utility (U^{out}), which means the employee will not work, is equal to zero. The utility of working part time (U_P) is:

$$U_P = w_P(1-\tau) - c_P, \tag{4}$$

where the wage taxes (τ) reduce the benefits of working. Furthermore, the utility of employees who have low costs of working full time ($U_F{}^L$) is equal to:

$$U_F{}^L = w_F(1-\tau) - c_F{}^L, \tag{5}$$

while the utility of employees with high costs of working full time ($U_F{}^H$) is:

$$U_F{}^H = w_F(1-\tau) - c_F{}^H. \tag{6}$$

In this model, we suppose that everyone achieves a higher utility out of working than they would from the outside option. The following conditions hold:

$$w_P(1-\tau) - c_P > 0 \wedge w_F(1-\tau) - {c_F}^L > 0 \wedge w_F(1-\tau) - {c_F}^H > 0. \quad (7)$$

Since the employees are rational, they will choose the employment arrangement with the highest utility. There are three different outcomes for this model. All employees decide to work part time, all employees decide to work full time, or the low type employees choose to work full time while the high type employees choose to work part time.

The first scenario, where all employees choose to work part time, only holds if the utility of working part time is higher than the utility of working full time, such that:

$$w_P(1-\tau) - c_P > w_F(1-\tau) - {c_F}^L \wedge w_P(1-\tau) - c_P > w_F(1-\tau) - {c_F}^H. \quad (8)$$

All employees choose to work full time in the second scenario when:

$$w_P(1-\tau) - c_P < w_F(1-\tau) - {c_F}^L \wedge w_P(1-\tau) - c_P < w_F(1-\tau) - {c_F}^H. \quad (9)$$

Lastly, in the third scenario low type employees choose to work full time while the high type employees decide to work part time if the following conditions are true:

$$w_P(1-\tau) - c_P < w_F(1-\tau) - {c_F}^L \wedge w_P(1-\tau) - c_P > w_F(1-\tau) - {c_F}^H. \quad (10)$$

We assume that the utility of working full time for low type employees is higher than the utility of working part time and the utility of high type employees who work full time is below the utility of working part time:

$$w_F(1-\tau) - {c_F}^H < w_P(1-\tau) - c_P < w_F(1-\tau) - {c_F}^L. \quad (11)$$

After visualizing the possible scenarios, condition 11 shows that the third scenario holds. Employees with low costs of working full time tend to work full time while those who have high costs choose to part-time work. In this case, all employees maximize their utility. we assume that the condition still holds when wage taxes are equal to zero.

Social welfare in this model consists of the profit generated by the employers, employees' utility, and the tax revenues, since the government is also affected by alterations in the labor force. Public goods are

acquired with tax revenues, which is beneficial for society. Hence, the fiscal externality exists in this model. The revenues of the government from wage taxes (G) in one period for one employee is:

$$G = w\tau, \tag{12}$$

where the wage tax is taken from the wage of an employee (w). These revenues for the government increase if the wage of an employee or the wage tax increase. We assume that working does not lead to other externalities in this model.

The employer generates a profit of zero on the employees, regardless of their choice on work hours. For government revenues, it would be optimal when all employees work full time. However, the utility of working part time is higher than the utility of full-time work for high type employees. In their choice, employees do not take the effect of the fiscal externality of working into account. Consequently, low type employees work full time and high type employees work part time to maximize their utility. As a result, the level of social welfare could be higher when employees consider the fiscal externality. We will further discuss this in chapter 4.

The choice of work hours under uncertainty

In the previous section, we assumed that individuals know what their full-time employment costs are. Now, we will discover under which conditions individuals work full time, in a situation where uncertainty exists about what type of employee they are.

An employee has probability p of being a high type employee with high costs of working full time. The probability of being a low type employee, with low costs of working full time, is $1 - p$. The probability is equal for each employee. An employee is risk neutral, and all other variables remain unchanged. An employee will work full time if the expected utility of working full time (EU_F) is higher than the utility of working part time:

$$EU_F = p[w_F(1-\tau) - {c_F}^H] + (1-p)[w_F(1-\tau) - {c_F}^L] > w_P(1-\tau) - c_P. \tag{13}$$

With this condition, the probability can be established for which individuals are willing to work full time (p_1), which is:

$$p_1 < \frac{[w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]}{{c_F}^H - {c_F}^L}. \tag{14}$$

The calculations of the condition can be found under Appendix A. The fraction shows that employees will only work full time if their utility of working full time based on a low type employee is higher than the utility of working part time. Under condition 11, we assumed this. Furthermore, the costs of working full time for a high type employee are higher compared to a low type employee as stated under assumption 3.

The restriction on the probability of being a high type employee must increase to raise the chance of employees to choose for full-time work. The maximum probability increases if the wage of full-time work, the costs of part-time work, and the costs of working full time for a low type increase. The restriction will also raise if the wage of part-time work, the costs of full-time work for a high type employee, or the wage tax decrease.

We find that, under uncertainty, all employees decide to work full time or part time, depending on the value of p. All employees will choose to work full time if condition 14 is met. This is optimal for low type employees, as their utility of working full time is higher than their utility of working part time. On the contrary, high type employees are worse off in this situation, as their utility would have been higher if they decided to work part time.

All employees decide to work part time if the probability of being a high type is greater than the fraction shown in condition 14. The low type employees receive less utility than they would have if they had been a full-time employee. Because part-time work leads to a higher utility relative to full-time work for high type employees, they are better off. The government generates higher tax revenues when employees work full time instead of part time, which increases social welfare.

Comparing the welfare effects under certainty and uncertainty, we find that employees could optimize social welfare under certainty as they maximize utility, and each individual makes rational choices. However, employees do not take the fiscal externality into account in deciding the optimal work hours. The fiscal externality for social welfare is not maximized under certainty since high type employees work part time, which leads to less tax revenues compared to full-time work.

Under uncertainty, not all employees are able to optimize their utility. Some employees will have the work hours that maximize their utility, but others do not. There is no possibility where all employees maximize utility, and so yield the optimal social welfare. In case all employees decide to work full time, the fiscal externality is maximized. These externalities do increase social welfare. In case the employees choose to work part time under uncertainty, social welfare is higher under certainty than under uncertainty. To increase social welfare, all employees should know what type they are. We will disclose what happens when employees learn their type in the following chapter.

3.2 The two-period intertemporal model

The maximization of social welfare is what we want to accomplish. As employees might not be able to maximize social welfare under uncertainty due to the lack of information, we aim to increase social welfare by introducing another period. More periods give employees the chance to discover their utility of full-time work after one year. Besides that, working more hours causes a higher fiscal externality. Full-time work can be seen as an experience good, which is explained in the literature review. We will begin by creating a model with two periods, followed by a model where we have $N + 1$ periods.

The subsequent model consists of two time periods, period 1 and 2, where each period is equal to one year. Individuals prefer either a part-time job or a full-time job. Again, the preference of hours is known in the first scenario and unknown in the second scenario. We assume that the preferences of an employee remain unchanged in all periods.

Employees can choose their employment arrangement in each period. If individuals are aware of their full-time working costs, they will choose to work part time or full time for both periods, based on the highest utility. For low type employees, the highest utility is reached by working full time. This means they receive a total utility in two periods (${U_{F2}}^{L}$), which is equal to:

$$ {U_{F2}}^{L} = 2[w_F(1-\tau) - {c_F}^{L}]. \tag{15} $$

The high type employees prefer to work part time in both periods, which gives the utility for part-time work in two periods (U_{P2}) of:

$$ U_{P2} = 2\big[w_p(1-\tau) - c_P\big]. \tag{16} $$

The utilities in this situation are maximized and the employers make zero profit. The tax revenues of the government could increase if high type employees work full time. However, employees do not take the tax revenues into consideration. Therefore, the optimal level of social welfare may not have been attained yet.

A two-period intertemporal model under uncertainty

When employees are not certain what type they are, they try to optimize their utility. Deciding the work hours under uncertainty can lead to multiple outcomes. It is possible for an employee to work part time in both situations. The utility is given in equation 16.

Employees can also choose to work full time in the first period. Low type employees will work full time in the second period as well, while high type employees learn after the first period that they are better off by working part time. The expected utility (EU_{F2}) can be expressed as:

$$EU_{F2} = p\{[w_F(1-\tau) - {c_F}^H] + [w_P(1-\tau) - c_P]\} + (1-p)2[w_F(1-\tau) - {c_F}^L]. \quad (17)$$

Since the employee does not know their type, they have the probability p to be a high type employee and $1-p$ to be a low type employee. The employees start in the first period with working full time if the expected utility of working full time in the first period and the optimal employment arrangement in the second period is higher than the utility of working part time in both periods:

$$\begin{aligned} p\{[w_F(1-\tau) - {c_F}^H] + [w_P(1-\tau) - c_P]\} + (1-p)2[w_F(1-\tau) - {c_F}^L] \\ > 2\big[w_p(1-\tau) - c_P\big]. \end{aligned} \quad (18)$$

With this condition, we can determine for which probability (p_2) employees decide to try working full time in the first period of a two-period model:

$$p_2 < \frac{2\big\{[w_F(1-\tau) - {c_F}^L] - \big[w_p(1-\tau) - c_P\big]\big\}}{{c_F}^H - {c_F}^L + [w_F(1-\tau) - {c_F}^L] - [w_P\,(1-\tau) - c_P]}. \quad (19)$$

The constraint shows that everyone is willing to work full time in the first period of a two-period model if the probability meets the restriction. In case the probability of being a high type employee turns out to be higher, all employees work part time in both periods. Appendix B shows the calculations of the constraint.

The variables that affect the maximum probability for which individuals decide to work full time in the first period are the same as in the simple model. However, the impact of changes in the part-time utility and the full-time utility of a low type employee is larger in a two-period model. Adjustments in the costs of working full time in the model with two periods have less impact, compared to changes the simple model.

The condition for which employees prefer to work full time in the first period of a two-period intertemporal model is different from the condition in the simple model. Comparing condition 14 with condition 19, we find that the constraint is higher in a two-period model if the restriction holds that:

$$w_F(1-\tau) - {c_F}^H < w_P(1-\tau) - c_P. \quad (20)$$

This result can be found in Appendix C. Due to condition 11, we know this restriction holds. It turns out that individuals are willing to work full time in the first period of a two-period model with a higher probability of being a high type employee, compared to a one-period model. The increase on probability is given by:

$$\frac{[w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]}{{c_F}^H - {c_F}^L} < p < \frac{2\{[w_F(1-\tau) - {c_F}^L] - [w_p(1-\tau) - c_P]\}}{{c_F}^H - {c_F}^L + [w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]}. \quad (21)$$

The reason for the higher maximum probability is the fact that employees learn after one period what type they are. Due to learning, employees can apply their knowledge in the second period by choosing the optimal employment arrangement. Taking the risk of working full time in a two-period model is therefore more appealing, compared to a one-period model.

We conclude that social welfare is optimized in a two-period model with certainty, which is the same result we found in the simple model. However, we do not include the effects of tax revenues yet. Expanding the knowledge of employees in a two-period model is beneficial for social welfare under uncertainty. The restriction of probability of being a high type employee is higher, so individuals are more inclined to work full time in the first period to learn their type.

Lastly, we compare social welfare in the one- and two-period model. High type employees do not achieve their optimal utility in the first period if condition 18 holds in the two-period model. However, in the second period all employees choose the optimal arrangement, which maximizes their utility and therefore increasing social welfare in the second period. In the simple model, high type employees gain less utility in the situation where the condition on the probability holds, as employees can not apply their knowledge. When condition 18 is not true, all employees choose to work part time in a two-period model, and both one- and two-period models have the same level of social welfare. In this situation, government interventions provide the opportunity to optimize social welfare.

3.3 The $(N+1)$-period intertemporal model

In the actual world, employees typically work for more than two years. We will expand our model by including more years. The benefits of discovering your type increase since the employees can apply the awareness of their preferences throughout multiple years. The model consists of $N+1$ periods where N is at least more than one period. The N periods are the years for which the preferences of employees remain constant. Employees choose their employment arrangement each year.

In a world without uncertainty, the employees will choose the optimal employment arrangement. Just like in the two-period model, the high type employees will work part time and the low type employees prefer working full time. The utility for low type employees working full time (${U_{FN}}^{L}$) is:

$$ {U_{FN}}^{L} = [w_F(1-\tau) - {c_F}^{L}] + N[w_F(1-\tau) - {c_F}^{L}] = (N+1)[w_F(1-\tau) - {c_F}^{L}], \qquad (22) $$

and the utility of part-time work (U_{PN}) for high type employees is:

$$ U_{PN} = [w_P(1-\tau) - c_P] + N[w_P(1-\tau) - c_P] = (N+1)\big[w_p(1-\tau) - c_P\big]. \qquad (23) $$

As mentioned in the previous section, we find that employees maximize their utility under certainty and that social welfare is equal to the utility of employees and the government revenues.

An $(N+1)$-period intertemporal model under uncertainty

When uncertainty arises, we still want to optimize social welfare. Therefore, we determine the utility if an employee decides to work part time or full time in the first period. Employees do not learn what type they are by working part time. As a result, they keep working part time. The utility of part-time work in $N+1$ periods is described in equation 23.

In case an employee chooses to work full time in the first period, he learns his type. Low type employees keep working full time after the first period. High type employees learn that they are better off by working part time. The expected utility (EU_{FN}) can be expressed as:

$$ \begin{aligned} EU_{FN} = p\{[w_F(1-\tau) - {c_F}^{H}] + N[w_P(1-\tau) - c_P]\} \\ + (1-p)(N+1)[w_F(1-\tau) - {c_F}^{L}]. \end{aligned} \qquad (24) $$

Working full time in the first period is more appealing in case the expected utility of working full time in the first period combined with working the hours that maximize the utility in the other N periods is higher than the utility of working part time in all periods. The utilities are compared in Appendix D. We find the following restriction on probability (p_N) in a model with an unspecified number of periods:

$$ p_N < \frac{(N+1)\big\{[w_F(1-\tau) - {c_F}^{L}] - \big[w_p(1-\tau) - c_P\big]\big\}}{{c_F}^{H} - {c_F}^{L} + N[w_F(1-\tau) - {c_F}^{L}] - N[w_P(1-\tau) - c_P]}. \qquad (25) $$

In an $(N+1)$-period intertemporal model, everyone is willing to work full time in the first period if the probability of being a high type employee meets the restriction, as we have also discussed in the previous models. If the probability of being a high type employee turns out to be higher, all employees work part time in all periods. The effect of changes in the variables on the probability are mentioned in the two-period model. In this model, we find that the constraint becomes larger as the number of periods increase.

We analyze the maximum probability of being a high type employee under the two- and $(N+1)$-period intertemporal model. In Appendix E we find that the restriction on the probability is higher in the model with an undefined number of periods compared to the other models. The relationship between the maximum probability in the models is:

$$p_1 < p_2 < p_N. \tag{26}$$

Individuals are more inclined to work full time in the first period of an $(N+1)$-period model under uncertainty since they benefit more years from learning what type they are. Therefore, the probability that all employees eventually choose the employment arrangement which maximizes their utility is higher in the long run.

Analyzing the social welfare outcomes

By working full time in the first period, everyone at every point can achieve maximum utility except high type employees in the first period if there are multiple years in a model and the probability meets restriction 25. Social welfare reached in this case is higher compared to the situation where the probability of being a high type employee exceeds the restriction. In case of a higher probability, all employees opt to work part time.

In all models with uncertainty, we find two outcomes. Firstly, everyone may choose to work full time in the first period when the chance to be a high type employee meets the condition. In the models with multiple periods, the employees choose the work hours that maximize their utility after the first year. This outcome increases social welfare in the models with multiple periods, compared to part-time work of employees. On the other hand, the probability exceeds the restriction in the second outcome and all individuals will choose to work part time. Social welfare is not optimal and remains the same across all three models.

In terms of social welfare, the model with an unspecified number of periods leads to a higher chance of optimizing social welfare since employees are most likely to work full time in the first period. Comparing the three models, we observe that social welfare is optimized if employees aim to learn what

type they are in the first period. However, social welfare is not optimized since employees do not take the fiscal externality into account. This is crucial because high type employees decide to work part time even though full-time employment could result in a higher overall level of social welfare. Besides that, there is still a chance that employees work part time, and the optimal social welfare is not reached. To motivate employees to work full time, we can implement an incentive in the model. We will discover this in the next chapter.

4 The temporary full-time bonus

In our intertemporal model with uncertainty, we find the possibility that low type employees decide to work part time, while full-time work leads to the optimal level of social welfare. To improve social welfare in the long run, employees need an incentive to work full time. In this chapter, we introduce the temporary full-time bonus.

4.1 The government stimulating full-time employment

The government aims to maximize social welfare, where social welfare is the sum of workers' utilities, profit of employers and the tax revenues. We will discover how the government could contribute to increasing social welfare in the $(N+1)$-period intertemporal model under uncertainty. Social welfare (ω) is defined as:

$$\omega = UT + S\pi + \gamma GT, \tag{27}$$

where U is the utility of an employee, depending on their type and work hours, T is the total number of employees, S is the number of all employers, and γ is the parameter of how the government's expenditures are valued. In a situation where the government can determine the work hours of all workers, social welfare can be maximized.

The government could decide that all low type employees work full time, while high type employees work part time. The maximum social welfare is:

$$\begin{aligned} \omega &= (N+1)\big\{pT[w_P(1-\tau) - c_P] + (1-p)T[w_F(1-\tau) - {c_F}^L] + S\pi \\ &\qquad + \gamma\big[pTw_p\tau + (1-p)Tw_F\tau\big]\big\} \\ &= (N+1)T(p\{w_P[1-\tau(1-\gamma)] - c_P\} + (1-p)\{w_F[1-\tau(1-\gamma)] - {c_F}^L\}). \end{aligned} \tag{28}$$

This depends on the restriction of the parameter γ, and is calculated in Appendix F. The restriction on γ is:

$$\gamma < \frac{[w_P(1-\tau) - c_P] - [w_F(1-\tau) - {c_F}^H]}{(w_F - w_P)\tau}. \tag{29}$$

In case the spendings on public goods is valued higher than condition 29, the government revenues should increase to realize maximum social welfare. All employees should work full time to raise the government revenues of wage taxes and the maximum social welfare is:

$$\begin{aligned}\omega &= (N+1)\{T[w_F(1-\tau) - pc_F{}^H - (1-p)c_F{}^L] + S\pi + \gamma T w_F \tau\} \\ &= (N+1)T\{w_F[1-\tau(1-\gamma)] - pc_F{}^H - (1-p)c_F{}^L\}.\end{aligned} \tag{30}$$

Suppose that condition 25 on the maximum probability does not hold. In this case all employees will choose part-time work, and social welfare is equal to:

$$\begin{aligned}\omega &= (N+1)\{T[w_P(1-\tau) - c_P] + S\pi + \gamma T w_p \tau\} \\ &= (N+1)T\{w_P[1-\tau(1-\gamma)] - c_P\}.\end{aligned} \tag{31}$$

As social welfare is not optimized due to the choice over work hours of employees, the government could step in. An intervention to encourage all employees to work full time is to provide a full-time bonus (β). This bonus can be granted temporarily by the government in the first period to enable employees to become familiar with their type. To finance the bonus, the government could collect a lump sum tax (σ). We suggest a lump sum tax for simplicity, as this tax does not affect the choices of individuals in our model. The total revenues from the lump sum tax are meant to finance the bonus, so these revenues are not valued with parameter γ. Social welfare with the bonus and lump sum tax included is:

$$\begin{aligned}\omega &= T[w_F(1-\tau) + \beta - pc_F{}^H - (1-p)c_F{}^L] - T\sigma \\ &\quad + NT\{p[w_P(1-\tau) - c_P] + (1-p)[w_F(1-\tau) - c_F{}^L]\} + S\pi \\ &\quad + \gamma T\{pNw_p\tau + [(1-p)N+1]w_F\tau\} + T\sigma - T\beta \\ &= T\{w_F[1-\tau(1-\gamma)] - pc_F{}^H - (1-p)c_F{}^L\} \\ &\quad + NT(p\{w_P[1-\tau(1-\gamma)] - c_P\} \\ &\quad + (1-p)\{w_F[1-\tau(1-\gamma)] - c_F{}^L\}).\end{aligned} \tag{32}$$

We find that social welfare in equation 32 where all employees work full time in the first period with the bonus is higher than social welfare where all employees work part time in equation 31. The bonus must be high enough to make all employees work full time. This constraint of the bonus provided by the government (β^G) is calculated in Appendix G and is equal to:

$$\beta^G > [(1-p)N+1]\{[w_p(1-\tau) - c_P] - [w_F(1-\tau) - c_F{}^L]\} + p(c_F{}^H - c_F{}^L), \tag{33}$$

where the bonus must increase in case the utility of working part time becomes higher, the number of periods increase, the wage taxes increase, and in case the utility of working full time for a low type employee decrease. The effect of the high type employee probability is ambiguous. If all employees receive this bonus for full-time work in the first period, everyone will work full time.

In the situation where employees initially choose to work part time, the government can offer the bonus which results in more hours worked by the employees since they choose to work full time in the first period. The employees eventually learn their type and low type employees will work full time in following years. High type employees will still decide to work part time after the first year and all employees maximize their utility. Besides that, the government revenues from wage taxes increase, which leads to more investments in public goods.

The bonus is beneficial for social welfare in a situation where employees would have chosen to work part time and condition 33 holds. The government's expenditures on public goods increase due to more work hours of employees. Low type employees generate overall more utility since they are better off by working full time instead of part time. Due to the bonus, social welfare will be optimized in case condition 29 on the parameter of government expenditures holds. All employees work full time in the first period and the low type employees will eventually work full time in the long run, while all employees only work part time without bonus.

Our goal is to increase the work hours of employees. Increasing the work hours leads to more social welfare, which means the government benefits from incentivizing employees on extending the work hours. In case the employees work part time because the probability of being a high type employee is above the restriction, the government can provide the bonus. Our government proposal is to offer a temporary full-time bonus on which condition 33 holds to attract employees to work full time. The bonus can be financed by a lump sum tax on all employees. In conclusion, low type employees will work full time in the following periods, whereas they would have worked part time without the bonus in all periods.

A pitfall in providing this bonus by the government is that there is a chance for employees to bribe the employer into collecting the bonus from the government, while the employee does not work full time. In this case, the employee receives the bonus while he does not have to work more hours. The work hours do not increase and the benefits of the bonus for the government are absent.

4.2 Employers encouraging full-time employment

Besides the government, the employers could also provide the bonus. An employer is willing to pay the bonus to his employees when the increase in revenues generated through employees working full time is higher than the costs of the bonus. In the situation described in the simple model, we assumed that employers do not make profit. Employers have no incentive to give a bonus for full-time work in this case.

We could also think of this bonus when there is no perfect competition between employers. Employers can supply the bonus since they make profit from employees. We assume that the profit generated by full-time employment is higher than the profit of part-time employment as full-timers work more hours, and so produce more. The wage per hour is equal for all employees. The assumptions are:

$$\pi_P = R_P - w_P > 0 \wedge \pi_F = R_F - w_F > 0, \tag{34}$$

and

$$\pi_F > \pi_P. \tag{35}$$

Under these circumstances, the employers face an opportunity to increase their profit when employees work full time instead of part time. To achieve the extra benefits of full-timers, the employee can offer the bonus as well. The benefits are determined by the increase in profit of one employee (${b_\beta}^E$), which is:

$${b_\beta}^E = \pi_F - \pi_P. \tag{36}$$

We observe that the positive effect of the bonus on one employee is the increase in profits of a part-time employee who will work full time due to the implemented bonus. To determine if this bonus is worth the investment, we need to compare the benefits of the bonus with the costs for every employee. We can express the costs of the bonus for one full-time employee in one period (c_β), which is:

$$c_\beta = \frac{\beta T}{(1-p)NT + T} = \frac{\beta}{(1-p)N + 1}, \tag{37}$$

where the total number of employees receive the bonus in the first period. Dividing these costs by all employees that work full time in the short run, and employees that eventually work full time in the long

run, who are the low type employees, give the relative costs for each full-timer in one period. The costs increase if the bonus and the probability of being a high type employee increase and decrease if there are more periods. Comparing the costs and benefits, we find the restriction on the bonus (β^E) for one employee:

$$\beta^E < [(1-p)N+1](\pi_F - \pi_P), \tag{38}$$

which is determined in Appendix H. We find that the maximum bonus, provided by an employer, increases in case the revenues of a full-time employee, the wage of a part-time employee, the number of periods or the probability of being a low type employee increase. In a situation where the wage of working full time or the revenues of working part time increase, the maximum bonus will decrease.

The employers will provide the bonus to employees in case the following restriction holds:

$$\begin{aligned}[(1-p)N+1]\{[w_p(1-\tau)-c_P]-[w_F(1-\tau)-{c_F}^L]\}+p({c_F}^H-{c_F}^L)<\beta^E \\ <[(1-p)N+1](\pi_F-\pi_P).\end{aligned} \tag{39}$$

With this condition, employers are better off by conveying the bonus since more employees are willing to work full time and therefore the profit increases. For some employees, namely low type employees, the bonus provides the opportunity to learn their type and choose the work hours that maximize their utility. The bonus compensates the costs that the high type employee faces by working more hours. In conclusion, all employees maximize their utility in all periods.

The employers increase their profit due to the bonus under condition 39 since the low type employees decide to work full time in the long run. Working full time leads to a higher profit compared to part-time work. The benefits from the bonus are higher than the costs of the bonus for the employer, and the low type employees increase their utility by working more hours. Lastly, society also benefits from the increase in work hours since more tax revenues are earned from this, which can be used to provide public goods.

Combining the increase in profit of employers, the increase in utility of low type employees, and the increase in tax revenues of the government, we find that social welfare increases as an effect of the bonus. Our proposal to employers is to provide the bonus to employees, on the occasion that all employees who might prefer full-time work actually work part time. The employers need to make profit on the employees to be able to provide the bonus, and the costs of the bonus must be below the benefits of the bonus. Eventually, the total number of work hours will be higher than without the bonus. Social welfare will increase and eventually be optimized in the long run.

5 Discussion

We have been focusing on a model in this paper. The fact that we make several assumptions is a primary concern we must consider. The labor force cannot be divided into people with high and low costs of working full time. Therefore, our results cannot simply be implemented by employers and the government. Nonetheless, some individuals have less problems with working full time compared to others. Think of a mother who must take care of their children. Working full time might be less beneficial for her compared to a woman with children. Other limitations on this paper are the employees that would have worked full time without bonus anyway. The full-time bonus is futile for these employees, which means the relative benefits of the bonus decrease.

The real world is not reflected in our model. However, we can expand our knowledge of how individuals make decisions on labor hours by using our findings. The knowledge can be used to support policy and employers' decisions that encourage full-time work. Removing some of the assumptions could create a more realistic situation in which employees choose their work hours with a full-time bonus.

6 Conclusion

In an economy where worker shortage exists, it is important to understand how individuals make decisions. We first created a simple model where employees need to decide on work hours under certainty and uncertainty. All employees choose the hours that maximize their utility under certainty. However, when employees do not know their preferences, there is a chance that employees do not maximize their utility. Employees who prefer working full time may work part time due to the possibility of having high costs for working more hours. Including more periods in our model, employees get the chance to learn what their type is and implement this knowledge into the following periods. As a result, the restriction for which employees are willing to work full time is lower in an intertemporal model with multiple periods compared to a one-period model.

The intertemporal model leads to the conclusion that working full time is more attractive in one period if the employee has a chance to increase the utility in following periods. For low type employees, the utility will eventually increase if they know that they prefer working full time. They need to try working full time, though, to know this preference. The government and the employers can incentivize employees on full-time work by a temporary full-time bonus.

In generating the full-time bonus, we have focused on employees that would have worked part time without bonus. We found a condition for which it is beneficial for the government to stimulate full time work in the first period. Since the government aims to maximize social welfare, the work hours for low type employees must increase to reach the optimal social welfare. The bonus must be high enough to make working more hours engaging for employees. Condition 33 displays the restrictions for which the government will provide an effective bonus. By subsidizing the bonus through a lump sum tax, the choices of individuals in the model do not change.

The bonus is cost-effective for the employers in case they generate profit from employees and the benefits due to profit increase are higher than the costs of the bonus. The requirements that the temporary bonus must meet to be provided by the employers are specified in condition 39. With these conditions, a temporary full-time bonus policy will be socially optimal to reduce the labor shortage.

We already found in the paper of Waterreus and Dobbelsteen (2001) that a full-time work bonus leads to more work hours for teachers. Through our intertemporal model, we can visualize a situation in which a full-time bonus is optimal for the government and employers. Our results are in line with the paper of Waterreus and Dobbelsteen, however they suggest a total increase in wage of full-time employees, while

the government and employers must apply the bonus in one period in our model, since we focus on uncertainty regarding preferences of employees.

Dutch employers in the health care sector have implemented a bonus for employees who work more hours to reduce the worker shortage (Rösken, 2023). Multiple nurses in a single hospital worked together over 400 hours more per week, which is about eleven extra full-time jobs. As the bonus was recently provided, the long-term effects are not clear. The government considers an overall full-time bonus in all sectors. Our model predicts a probability that some employees will continue working more hours after realizing they benefit from doing so.

To conclude, our recommendation from this paper is for the government and employers to consider a temporary full-time bonus. In case the conditions determined in this model hold, we find that social welfare increases as an effect of the bonus. Employees will work more hours, and this will eventually contribute to economic growth.

For further research in stimulating full-time work, the intertemporal model could be extended by continuous costs of working full time for employees, since these costs between employees differ based on their preferences. Furthermore, while we focused on increasing the benefits of working full time, it may also be interesting what the effects of lowering the full-time work costs will be in an intertemporal model. An example is introducing working from home. Research questions could be to what extent this implication leads to more work hours and if the costs of enabling telecommuting weighs up against the benefits for employees.

7 References

Beauregard, T. A., & Henry, L. C. (2009). Making the link between work-life balance practices and organizational performance. *Human resource management review, 19*(1), 9-22. https://doi.org/10.1016/j.hrmr.2008.09.001

Burda, M., & Wyplosz, C. (2017). *Macroeconomics, A European Text* (7th ed.). Oxford University Press.

Central Bureau of Statistics. (2022). Emancipatiemonitor 2022. In *Central Bureau of Statistics*. Retrieved April 19, 2023, from https://longreads.cbs.nl/emancipatiemonitor-2022/

Dur, R., Teulings, C., & Van Rens, T. (2004). Should higher education subsidies depend on parental income?. *Oxford Review of Economic Policy, 20*(2), 284-297. https://doi.org/10.1093/oxrep/grh016

EURACTIV Network, & Allenbach-Ammann, J. (2022, September 14). *Labour shortages felt all over Europe*. Euractiv. Retrieved April 19, 2023, from https://www.euractiv.com/section/politics/news/labour-shortages-felt-all-over-europe/

Eurostat. (2023a). *Full-time and part-time employment* [Dataset]. Retrieved April 19, 2023, from https://ec.europa.eu/eurostat/databrowser/view/LFSQ_EPGAIS__custom_5166170/bookmark/table?lang=en&bookmarkId=32946948-cddb-4d6e-a21f-245512d35bd2&page=time:2022-Q3

Eurostat. (2023b). *Job vacancies* [Dataset]. Retrieved April 19, 2023, from https://ec.europa.eu/eurostat/databrowser/view/tps00172/default/table?lang=en

Fan, X., Seshadri, A., & Taber, C. R. (2022). *Estimation of a Life-Cycle Model with Human Capital, Labor Supply and Retirement* (No. 29905). National Bureau of Economic Research. https://doi.org/10.3386/w29905

Frank, R., & Cartwright, E. (2016). *Microeconomics and Behaviour* (2nd ed.). McGraw-Hill Education.

Goos, M., & Konings, J. (2007). The Impact of Payroll Tax Reductions on Employment and Wages: A Natural Experiment using Firm Level Data. *Social Science Research Network Discussion Paper 178*, 1-30. https://doi.org/10.2139/ssrn.958027

Immervoll, H., & Barber, D. (2006). Can parents afford to work? Childcare costs, tax-benefit policies and work incentives. *OECD Social, Employment and Migration Working Papers* (No. 31). https://doi-org.eur.idm.oclc.org/10.1787/312744260654

Roeters, A. (2018). Time use in the Netherlands. In *The Netherlands Institute for Social Research*. The Netherlands Institute for Social Research. Retrieved April 19, 2023, from https://digitaal.scp.nl/timeuse1/

Rösken, T. (2023, March 30). *Tijdelijke bonus om parttimers meer uren te laten werken boekt eerste succes*. NU.nl. Retrieved July 1, 2023, from https://www.nu.nl/economie/6257287/tijdelijke-bonus-om-parttimers-meer-uren-te-laten-werken-boekt-eerste-succes.html

Schalembier, B., Bleys, B., Van Ootegem, L., & Verhofstadt, E. (2019). How relative income affects work hours preferences. *Applied Economics, 51*(51), 5545–5558. https://doi.org/10.1080/00036846.2019.1613512

Shapiro, C. (1983). Optimal Pricing of Experience Goods. *The Bell Journal of Economics, 14*(2), 497-507. https://doi.org/10.2307/3003650

U.S. Bureau of Labor Statistics. (2023). *America Works Data Center* [Dataset]. U.S. Chamber of Commerce. Retrieved April 19, 2023, from https://www.uschamber.com/workforce/america-works-data-center

Waterreus, I., & Dobbelsteen, S. (2001). Wages and teachers' hours of work. *De Economist, 149*(3), 277-298.

8 Appendix

Appendix A

Proof of condition 14: the probability of being a high type employee for which individuals choose to work full time in the simple model.

$$EU_F > U_P$$

$$p[w_F(1-\tau) - {c_F}^H] + (1-p)[w_F(1-\tau) - {c_F}^L] > w_P(1-\tau) - c_P$$

$$p{c_F}^H - p{c_F}^L < [w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]$$

$$p({c_F}^H - {c_F}^L) < [w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]$$

$$p_1 < \frac{[w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]}{{c_F}^H - {c_F}^L}$$

Appendix B

Proof of condition 19: the probability of being a high type employee for which individuals choose to work full time in the two-period model.

$$EU_{F2} > U_{P2}$$

$$p\{[w_F(1-\tau) - {c_F}^H] + [w_P(1-\tau) - c_P]\} + (1-p)2[w_F(1-\tau) - {c_F}^L] > 2\big[w_p(1-\tau) - c_P\big]$$

$$p\{[w_F(1-\tau) - {c_F}^H] + [w_P(1-\tau) - c_P] - 2[w_F(1-\tau) - {c_F}^L]\} > 2\big[w_p(1-\tau) - c_P\big] - 2[w_F(1-\tau) - {c_F}^L]$$

$$p\{w_F(1-\tau) - 2{c_F}^L + {c_F}^H - [w_P(1-\tau) - c_P]\} < 2[w_F(1-\tau) - {c_F}^L] - 2\big[w_p(1-\tau) - c_P\big]$$

$$p\{{c_F}^H - {c_F}^L + [w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]\} < 2\big\{[w_F(1-\tau) - {c_F}^L] - \big[w_p(1-\tau) - c_P\big]\big\}$$

$$p_2 < \frac{2\big\{[w_F(1-\tau) - {c_F}^L] - \big[w_p(1-\tau) - c_P\big]\big\}}{{c_F}^H - {c_F}^L + [w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]}$$

Appendix C

Proof of condition 20: the restriction on the probability of being a high type employee for which an individual chooses to work full time in a two-period model is higher than the maximum probability in a simple model.

$$p_2 > p_1$$

$$\frac{2\{[w_F(1-\tau) - {c_F}^L] - [w_p(1-\tau) - c_P]\}}{{c_F}^H - {c_F}^L + [w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]} > \frac{[w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]}{{c_F}^H - {c_F}^L}$$

$$\frac{2\{[w_F(1-\tau) - {c_F}^L] - [w_p(1-\tau) - c_P]\}}{{c_F}^H - {c_F}^L + [w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]} > \frac{2\{[w_F(1-\tau) - {c_F}^L] - [w_p(1-\tau) - c_P]\}}{2({c_F}^H - {c_F}^L)}$$

$${c_F}^H - {c_F}^L + [w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P] < 2({c_F}^H - {c_F}^L)$$

$$w_F(1-\tau) - {c_F}^H - [w_P(1-\tau) - c_P] < 0$$

$$w_F(1-\tau) - {c_F}^H < w_P(1-\tau) - c_P$$

Appendix D

Proof of condition 25: in an $(N+1)$-period model, employees choose to work full time if the probability of being a high type employee meets the following restriction.

$$EU_{FN} > U_{PN}$$

$$p\{[w_F(1-\tau) - {c_F}^H] + N[w_P(1-\tau) - c_P]\} + (1-p)(N+1)[w_F(1-\tau) - {c_F}^L] > (N+1)[w_p(1-\tau) - c_P]$$

$$p\{[w_F(1-\tau) - {c_F}^H] + N[w_P(1-\tau) - c_P] - (N+1)[w_F(1-\tau) - {c_F}^L]\} > (N+1)[w_p(1-\tau) - c_P] - (N+1)[w_F(1-\tau) - {c_F}^L]$$

$$p\{-w_F(1-\tau) + {c_F}^H - N[w_P(1-\tau) - c_P] + (N+1)[w_F(1-\tau) - {c_F}^L]\} < (N+1)[w_F(1-\tau) - {c_F}^L] - (N+1)[w_p(1-\tau) - c_P]$$

$$p\{{c_F}^H - {c_F}^L + N[w_F(1-\tau) - {c_F}^L] - N[w_P(1-\tau) - c_P]\} < (N+1)\{[w_F(1-\tau) - {c_F}^L] - [w_p(1-\tau) - c_P]\}$$

$$p_N < \frac{(N+1)\{[w_F(1-\tau) - {c_F}^L] - [w_p(1-\tau) - c_P]\}}{{c_F}^H - {c_F}^L + N[w_F(1-\tau) - {c_F}^L] - N[w_P(1-\tau) - c_P]}$$

Appendix E

The maximum probability of being a high type employee is higher in a model with an undefined number of periods, compared to a model with two periods.

$$p_N > p_2$$

$$\frac{(N+1)\{[w_F(1-\tau) - {c_F}^L] - [w_p(1-\tau) - c_P]\}}{{c_F}^H - {c_F}^L + N[w_F(1-\tau) - {c_F}^L] - N[w_P(1-\tau) - c_P]} > \frac{2\{[w_F(1-\tau) - {c_F}^L] - [w_p(1-\tau) - c_P]\}}{{c_F}^H - {c_F}^L + [w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]}$$

$$\frac{2(N+1)\{[w_F(1-\tau) - {c_F}^L] - [w_p(1-\tau) - c_P]\}}{2\{{c_F}^H - {c_F}^L + N[w_F(1-\tau) - {c_F}^L] - N[w_P(1-\tau) - c_P]\}} > \frac{2(N+1)\{[w_F(1-\tau) - {c_F}^L] - [w_p(1-\tau) - c_P]\}}{(N+1)\{{c_F}^H - {c_F}^L + [w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]\}}$$

$$\frac{2\{{c_F}^H - {c_F}^L + N[w_F(1-\tau) - {c_F}^L] - N[w_P(1-\tau) - c_P]\}}{2(N+1)\{[w_F(1-\tau) - {c_F}^L] - [w_p(1-\tau) - c_P]\}} < \frac{(N+1)\{{c_F}^H - {c_F}^L + [w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]\}}{2(N+1)\{[w_F(1-\tau) - {c_F}^L] - [w_p(1-\tau) - c_P]\}}$$

$$2\{{c_F}^H - {c_F}^L + N[w_F(1-\tau) - {c_F}^L] - N[w_P(1-\tau) - c_P]\} < (N+1)\{{c_F}^H - {c_F}^L + [w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]\}$$

$$(N+1)({c_F}^H - {c_F}^L) < (N+1)\{[w_F(1-\tau) - {c_F}^L] - [w_P(1-\tau) - c_P]\}$$

$${c_F}^H - {c_F}^L > w_F(1-\tau) - {c_F}^L - w_P(1-\tau) + c_P$$

$$w_F(1-\tau) - {c_F}^H < w_P(1-\tau) - c_P$$

This condition holds due to condition 11.

Appendix F

Proof of condition 29: The maximum weight of government expenditures for which high type employees should work part time and low type employees should work full time to maximize social welfare.

$$(N+1)T(p\{w_P[1-\tau(1-\gamma)]-c_P\}+(1-p)\{w_F[1-\tau(1-\gamma)]-{c_F}^L\}) > (N+1)T\{w_F[1-\tau(1-\gamma)]-p{c_F}^H-(1-p){c_F}^L\}$$

$$p\{w_P[1-\tau(1-\gamma)]-c_P\} > p\{w_F[1-\tau(1-\gamma)]-{c_F}^H\}$$

$$w_F[1-\tau(1-\gamma)]-{c_F}^H < w_P[1-\tau(1-\gamma)]-c_P$$

$$w_F(1-\tau)+w_F\tau\gamma-{c_F}^H < w_P(1-\tau)+w_P\tau\gamma-c_P$$

$$(w_F-w_P)\tau\gamma < [w_P(1-\tau)-c_P]-[w_F(1-\tau)-{c_F}^H]$$

$$\gamma < \frac{[w_P(1-\tau)-c_P]-[w_F(1-\tau)-{c_F}^H]}{(w_F-w_P)\tau}$$

Appendix G

Proof of condition 33: the bonus for which all employees choose to work full time in the first period of an intertemporal model.

$$EU_{FN}+\beta > U_{PN}$$

$$p\{[w_F(1-\tau)-{c_F}^H]+N[w_P(1-\tau)-c_P]\}+(1-p)(N+1)[w_F(1-\tau)-{c_F}^L]+\beta > (N+1)\big[w_p(1-\tau)-c_P\big]$$

$$\beta > (N+1)\big[w_p(1-\tau)-c_P\big]-p\{[w_F(1-\tau)-{c_F}^H]+N[w_P(1-\tau)-c_P]\}-(1-p)(N+1)[w_F(1-\tau)-{c_F}^L]$$

$$\beta > N\big[w_p(1-\tau)-c_P\big]+\big[w_p(1-\tau)-c_P\big]-p[w_F(1-\tau)-{c_F}^H]-pN[w_P(1-\tau)-c_P]-(1-p)N[w_F(1-\tau)-{c_F}^L]-(1-p)[w_F(1-\tau)-{c_F}^L]$$

$$\beta > [(1-p)N+1]\big[w_p(1-\tau)-c_P\big]-(1-p)N[w_F(1-\tau)-{c_F}^L]-(1-p)[w_F(1-\tau)-{c_F}^L]-p[w_F(1-\tau)-{c_F}^H]$$

$$\beta > [(1-p)N+1]\{[w_p(1-\tau)-c_P]-[w_F(1-\tau)-{c_F}^L]\} + p\{[w_F(1-\tau)-{c_F}^L]-[w_F(1-\tau)-{c_F}^H]\}$$

$$\beta > [(1-p)N+1]\{[w_p(1-\tau)-c_P]-[w_F(1-\tau)-{c_F}^L]\}+p({c_F}^H-{c_F}^L)$$

Appendix H

Proof of restriction 38: employers are willing to give the bonus when the increase in profit due to full-time employees is higher than the total costs of the bonus.

$$c_\beta < {b_\beta}^E$$

$$\frac{\beta}{(1-p)N+1} < \pi_F - \pi_P$$

$$\beta^E < [(1-p)N+1](\pi_F-\pi_P)$$