ERASMUS UNIVERSITY ROTTERDAM
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Bachelor Thesis [Economics of Markets and Organizations]

Wages and Employment with Powerful and Careful Employers. A Theoretical Analysis.

Name student: Sanne Janzen
Student ID number: 560447

Supervisor: dr. Robert Dur
Second Assessor: dr. Arjan Non

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Abstract

Not only the landscape is different between provinces in the Netherlands. So does the population density, the vacancy rate and the average income. Moreover, altruism is more likely to be present in regions that exist out of small villages rather than big cities since people in small villages are more likely to know each other. Additionally, employers have more monopsony power in less densely populated areas because employees are restricted in their job choice by their commute time. It is proven that altruism has a positive effect on wages and monopsony power a negative effect. Which of these effects will have a bigger impact on wages? To research this, I analyzed four models about perfect competition or monopoly with monopsony and altruism or egoism. I found theoretical proof that monopsony power together with monopoly power decreases wages, employment and output, but it increases the product prices. In contrast, altruism will increase wages, employment and output but will decrease product prices. Additionally, the effect of monopsony power has the biggest influence, meaning that wages and employment will be lower in less densely populated areas (monopoly and monopsony with altruism) compared to densely populated areas (perfect competition with egoism). This is also in line with observations about the areas in the Netherlands (however it is not yet proven that it is statistically significant).

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Introduction

The Netherlands reached a new national record a year ago. Not with olympic sports, but on the labor market. Namely, the labor market has not been this tight in ages, reports NOS. There were 133 vacancies for every 100 unemployed people in the first quarter of 2022. And there is a lot of competition on the labor market due to the fact that the unemployment level is very low while there are a lot of jobs available (NOS, 2022a). Consequently, the employers have trouble finding enough employees. Therefore, restaurants in the Netherlands were only open 4 days a week or people ordered their food via a QR-code or the employers increased the hourly wages if they could afford it. The latter is a reaction to other jobs, such as call centers, who are stealing the employees away with the promise of a very high hourly wage (NOS, 2022b). The competition on the labor market is causing problems for society. Important jobs that are needed to solve problems in society, such as the housing market, healthcare and education, are not filled and therefore society cannot make progress in solving these problems (Klein, 2022).

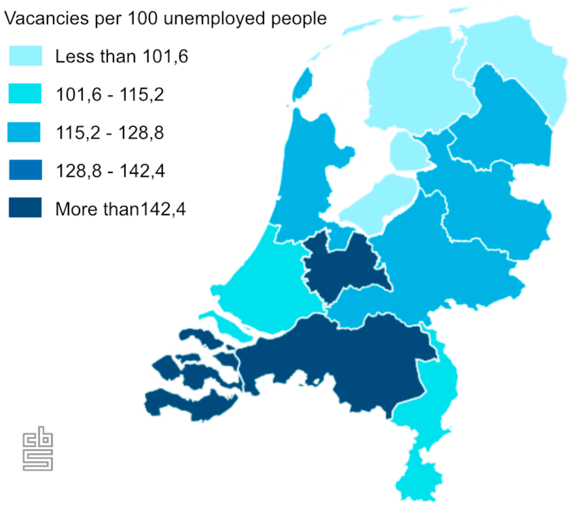

Figure 1. Vacancy rate per province in Netherlands in the last quarter of 2022
Source: Central Bureau for Statistics., Spanning op de arbeidsmarkt naar regio, 2023

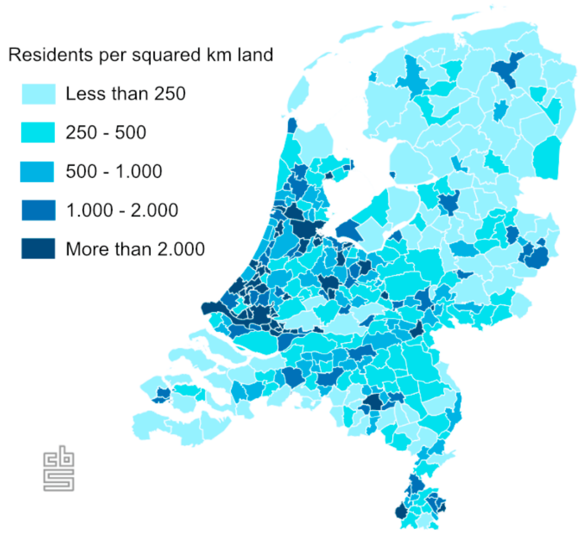

Figure 2. Population density per area in the Netherlands in 2022
Source: Central Bureau for Statistics, Inwoners per gemeente, 2023

However, not every region of the Netherlands is affected equally by the competition on the labor market. Province Utrecht is the winner with 156 vacancies per 100 unemployed people in the last quarter of 2022. And Flevoland has the lowest rate with only 88 vacancies per 100 unemployed people. This could maybe cause a difference in wages for similar jobs throughout the Netherlands (Central Bureau for statistics, n.d.-b).

This looks somewhat similar to the population density per province, as can be seen in the next picture. It is found that there is a strong association between higher rates of entrepreneurship and a faster growth of local economies. New organizations can take advantage of knowledge spillovers in a region (Acs & Armington, 2004). Moreover, it is easier to find input suppliers and the appropriate labor force in the city. This will boost entrepreneurship and employment growth (Glaeser, 2009). Thus, there will be more job creation in densely populated areas. As a consequence, the job vacancy rate will be higher in these regions.

Moreover, people are restrained on their job choice by the distance from their home to the workplace. Dutch workers travel 6,1 kilometers per day to their work on average in 2021 (Central Bureau for Statistics, n.d.-a). Additionally, it is found that commute time decreases as employment density and job growth increases in the Netherlands in the areas around big cities (Schwanen et al., 2004). Meaning that in rural areas the competition between employers increases as the employees have more choice. However, in the less densely populated areas, there is less competition and employees are limited in their job choice. As a result, employers in less densely populated regions have relatively more monopsony power over their employees, which can result in welfare losses. Several empirical studies show that wages will drop in case of monopsony power (Ashenfelter et al., 2010). For example, teachers in Norway earn 65% less than their marginal value (Falch, 2010). Additionally, places that are less densely populated are more likely to exist out of several small villages instead of big cities. It is known that people in small villages are more likely to have a connection. And those people will care more for each other than complete strangers (Cohen, 1972). So, an employer in a less densely populated area will have more altruistic feelings towards his employees than an employer in a relatively densely populated area. Moreover, an altruistic employer establishes a better reputation and will have a larger audience (Macfarlan et al., 2012). Since the utility of employees exists mainly out of wages, the wage level will rise as a consequence of altruism. So, monopsony and altruism both have a different effect on wages. Therefore my research question will be:

Can employer altruism prevent the wages of employees to go down or does monopsony power win?

And my corresponding sub questions are:

How are wages of employees influenced by competition if the employer is egoistic?
How are wages of employees influenced by competition if the employer is altruistic?

To research these questions, I will analyze four different models about perfect competition or monopoly and monopsony in combination with egoism or altruism. The reason for this is that different sectors have different market structures and an employer can be egoistic or altruistic.
This is scientifically relevant because there have been numerous studies about altruism, different market structures and monopsony. However, the combination of these effects has not been studied before in my knowledge. So this research contributes to the existing research about these topics.
It is socially relevant because this will bring more insights about how wages change in different circumstances. These insights can be used to protect employees and implement new relevant policies. For example it brings insights to when a minimum wage is needed and it can help prevent the income gap between regions becoming bigger and bigger.

First, an overview of the related literature will be given, then the models will be analyzed. After that there is an overview of the results and lastly a conclusion and discussion will follow.

Related literature

The concept of perfect competition has been developed and improved by several famous economists such as Smith (1776) , Cairnes (1874), Cournot (1995) and many more. Nowadays, perfect competition means that there are an infinite number of traders who act independently of each other, so no one can influence the demand or supply curve on its own. Moreover, they have full knowledge (also called perfect information) and the owners are free to leave or enter the market. Additionally, the expected rate of return of each resource is equal in the long run, otherwise a firm can be more efficient (Stigler, 1957). I assume that owners maximize their utility just as Jones (1965). This way, the model remains easy to comprehend and the main focus will not be distorted by any outside options that are unknown.
There are some critics on the concept of perfect competition. For example, external economies are ignored (Dahlman, 1979), but this can be dealt with in individual cases. Secondly, it is stated that perfect competition is unrealistic. However, it is still used as the standard model for analysis, even when other models such as imperfect competition or monopolistic competition models were invented (Stigler, 1957). Moreover, other concepts such as monopolistic competition are somewhere in between perfect competition and monopoly. By comparing the two extremes, the results of my models will be more clear and distinct than if I would compare it to some sort of (more realistic) mixture of the two.

Just as perfect competition, monopoly is also a much discussed market structure since Mill first spoke about it (Sharkey, 1982). A monopoly exists if it is beneficial to produce output in a single firm because of economies of scale or a better production location. Additionally, there must be no easy entry or exit and the product needs to be heterogeneous to ensure that there is only one firm selling the product. Therefore, a single firm will have the market power to choose the price level such that it exceeds the break even level. This will eventually lead to lower output and higher costs than in the first-best efficient option, so regulations are made to limit a natural monopoly (Joskow, 2007).

Just as in the product market I will analyze two different market structures on the labor market: perfect competition and monopsony. Perfect competition in the labor market means that the employers are forced to accept the market wage because it is beyond their control. The wage function is elastic, meaning that a decrease in the wage results in all workers immediately leaving the firm. Similarly to perfect competition in the product market, this is not very realistic. But Manning (2013) said that economists judge theories by the quality of the

predictions instead of judging theories by how realistic the assumptions are. For example, he describes two models, with different assumptions and similar predictions. Causing the predictions to be of a better quality, while the assumptions are not very realistic. Moreover, he said that theories about perfect competition in the labor market are not useless if monopsony power is recognized, it just adds more knowledge. Additionally, the model of Cahuc et al. (2006) proves that competition is playing a big role, caused by on-the-job search.
By analyzing partial equilibrium models of static and dynamic monopsony it is found that the monopsony power is related to a relatively low wage elasticity in the labor supply faced by a single employer. Furthermore, if elasticity rises, the wage level reaches the marginal product of employees (Manning, 2013). Thus the first hypothesis is that *the wage level will be higher in the perfect competition model than in the monopoly and monopsony model.*

Moreover, it is discovered that wages increase as employment increases, this will be discussed more in the models. Additionally, it is found via a model that vacancy rates are low when there is monopsony power (Manning, 2013). This is consistent with the (not statistically tested) observation in the introduction. If the vacancy rate is high, a lot of new employees are searched, compared to the already existing employees. Therefore, assuming that unemployed people are willing to fill up the vacancy, the employment is growing more in markets with higher vacancy rates (perfect competition market), and vice versa. If this is combined with the fact that the output is lower (and in my model this also means that less employees are needed) in a monopoly, there is lower output and relatively slow employment growth. So, my second hypothesis will be that *employment will be lower in the monopoly and monopsony models, compared to the perfect competition models*.

Moreover, Burdett and Mortensen (1998) found that there is a difference in wages cross-employers that cannot be explained by differences in the worker or jobs. Their equilibrium search model shows that there is wage dispersion for workers identical in productivity (Mortensen, 2003). After some assumptions, this model shows that there is indeed a difference between the competitive and monopsony situation of Diamond (1971). This is similar to my research because the workers in my model are also identical in productivity and I will also look into differences in wages across employers in different market structures. However, they are using a different and much more complicated equilibrium model than me and they are not talking about altruism.

I will also use an equilibrium model, but mine is more similar to the equilibrium model of Jones (1965) compared to the partial equilibrium models of Manning (2013) or the equilibrium search model of Burdett and Mortensen (1998). Jones discusses a general equilibrium model with a demand and supply function, just as I do. He also has similar assumptions. However, he is using not only labor as input, but also land and he is comparing two products instead of two market structures. While my model will be more simple, some of his equations will be useful here. Additionally, there is still no sign of altruism in this general equilibrium model.

The theoretical models about monopsony are being tested empirically, delivering different results (Boal & Ransom, 1997; Bhaskar & Manning, 2002). However, Staiger et al. (2010) use a natural experiment by analyzing the effect of a legislated wage change of registered nurses in certain hospitals. Since hospitals only compete if they are neighbors, they use geographic differentiation to motivate monopsony, which is also used in this paper.The results show that hospitals are wage setters and hospitals that responded the most were located within 15 miles. Moreover, employment at individual hospitals did not change as a result of a different wage and elasticity of labor supply was estimated around 0.1 on average, which is very low. In conclusion, monopsony on the labor market exists, at least for nurses.

But none of these studies examines the effect of altruism to explain wage differences, although altruism has been studied intensively in theoretical studies about wages and effort. For instance, Ellingsen and Johannesson (2008) explain via their model that if the principal conveys an altruistic impression by trusting their agent, it is valuable for the agent to impress the principal. Moreover, they also found that an altruistic principal pays a higher wage compared to a selfish principal by analyzing a two-person gift exchange game as also proposed by Akerlof (1982). Therefore my third hypothesis will be that *altruism will increase wages in both market structures.*

Another model where altruism is used, is the model of Dur and Tichem (2015). While they use a principal-agent model, I will not use this. They find that because of altruism the threat of dismissal in a job becomes less credible but a bonus is more likely. So altruism can lead to higher bonuses and thus a higher wage, as stated in the third hypothesis. I will research the effect of altruism on wages too, but in a different way than a principal-agent model. It is new that a player can have feelings of altruism or spite instead of just one feeling in the paper of Dur and Tichem (2015). In my model I will also analyze two feelings, however those are altruism and egoism instead of spite. Moreover, in my model only the employer is altruistic or egoistic, because I want to focus on the decisions the employer makes for his firm given the market he is in. This is more similar to the research of Salas and Roe (2012), where the agent is egoistic and the principal is altruistic. However, their finding is that altruism is not affecting the structure of payments with a bonus, only the duration and willingness to cooperate with the agent.

Falk and Szech (2013) researched the change in behavior in individual decisions compared to market interactions, by experimenting with the willingness to kill a mouse. This research shows that people are more willing to kill the mouse in a market transaction. Their moral values erode and they become more egoistic. Additionally, Adam Smith (1759) stated that everyone acts in their own interest in the market (the invisible hand). However, he does not think about the situation where altruism and egoism are both present in market transactions. One argument is that altruism lowers money profit, because altruistic employers charge prices lower than the market equilibrium and thus they cannot exist. Becker (1981) states that this is "naïve" to believe because altruists already receive a part of their income mentally, they receive a part of their utility as they are selling their products. So they can still exist next to the selfish employers. Moreover, Smith (1759) does state that people are altruistic towards their families. And by analyzing a model about altruism in family firms it appears that altruism can facilitate the starting phases of a firm and is still very much present throughout the life of a company (Schulze et al., 2002). Additionally, family firms are more likely to grow and benefit in rural areas where population is less dense, as tested empirically (Baù et al., 2019).

In another empirical study it is found that the difference in wages between urban and non-urban regions is 19 percent. Two thirds of this can be explained by the fact that cities attract more skilled workers than non-urban regions (Yankow, 2006). As also stated by Glaeser and Maré (2001) after they found out that the real wage differences exist. Moreover it is found that cities make workers more productive due to learning externalities and a better employer-employee match. However, in order to earn the urban wage premium, someone needs to be in contact with highly skilled people (Rauch, 1993; Yankow, 2006). A part of the wage difference remains unexplained and these studies do not look into altruism.

Putting all this information together, it appears that less densely populated (fourth model) areas experience relatively more altruism and monopsony than the densely populated areas (first model) with several effects on employment, output and wages (which will be analyzed in the models). It is useful to analyze all four models because not every employer in the city will be selfish and vice versa. Moreover, it will bring more insights of the effects of the market structure combined with the employer's character since it appears to have never been researched before.

The different models

Perfect competition with egoism[1]

Before we dive into the models, a few assumptions need to be made to make analyzing the perfect competition situation possible. First of all, there are a lot of buyers and sellers and there has to be easy entry and easy exit of the market to make sure the threat of new (potential) competitors is present. Secondly, the goods are homogeneous and the consumers do not care from who they buy their product. Meaning that the producer can be replaced by any other producer from the perspective of the buyer. Moreover, there are no external effects influencing the decision of anyone. Additionally, everyone has perfect information. Lastly, the sellers will maximize their profit as their company strategy, because this will increase their utility.

We start with analyzing a simple demand function:

$Q = \overline{Q} - \alpha P$

Where:

- Q = the output that is produced in number of products
- $\overline{Q}$ = the maximum amount of output in number of products
- α = sensitivity to the price of consumers
- P = the price in euro's

All values can be zero or bigger, but a negative value is not possible.

The output will decrease with factor α if the price increases by one euro. This is logical, because if the price increases, less people are willing to buy the product. And therefore, less output is needed to satisfy total demand. This price sensitivity is not equal for all products and it can change over time. For example, people are paying more attention to what they buy due to uncertainty in an economic recession. Normally, the price sensitivity has a negative value, but here it has a positive value since it already has a negative impact on the output in this formula.

$\overline{Q}$ is the maximum amount of output, because if the price would be zero, the demanded amount by consumers is $\overline{Q}$.

Moreover, we assume that every employee produces one product:

$Q = N$

[1] The corresponding calculations can be found in appendix A

We assume that the employer does not have any other income or costs than his revenue from the output and labor costs. The labor costs are the wages of employees (W). Naturally, the employer will keep the wages as low as possible in order to increase his own utility. How low he can actually set the wages depends on the outside option of employees. Assuming that the utility an employee gets at this particular employer only consists out of his wage, it follows that:

$U_a \geq \overline{U_a} \Leftrightarrow W \geq \overline{U_a}$

So, $W = \overline{U_a}$ is the minimal level an employee will accept. Where U_a is the utility of an employee and $\overline{U_a}$ is the outside utility of an employee.

The employer also has an outside option. However, what this outside option is and what value it has, differs per employer. Because everyone has different goals, missions or dreams depending on where they stand in their life. Examples of outside options for employers could be emigrate to another country, retire, start a business in another branch or become an employee. What the value of these different options is, differs per employer. In the end, it is not relevant to this model what the outside option of the employer is. Therefore, the outside option of an employer is normalized to zero. This way, the models stay simple and clear and the focus will stay on things that matter.

The employer is a price taker, because he is too small to interfere with the market price. This will become clear if we analyze the following situation: If a seller finds a more efficient way and lowers his price, the other sellers will find out and also implement the new strategy, caused by the perfect information. This will go on and on until the sellers cannot decrease their price anymore because they reached the level of zero profit. If the price decreases, there will be more demand, driving the price up. Yet, supply will also increase because of easy entry, causing the price to drop again. Thus, the price will stay equal in the long run. And therefore also the expected rate of return, which is consistent with the related literature.

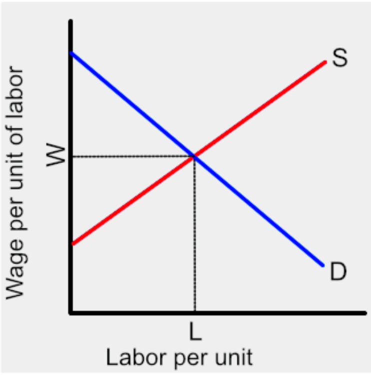

Figure 3. total demand and supply on the labor market
Source: drawn by myself.

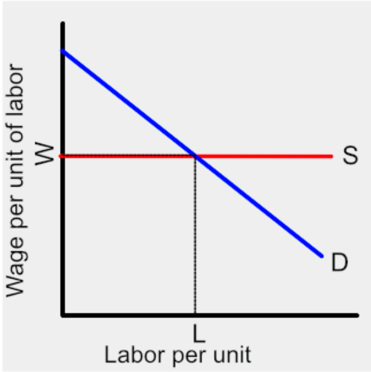

Figure 4. Demand and supply of one employer on the labor market
Source: drawn by myself.

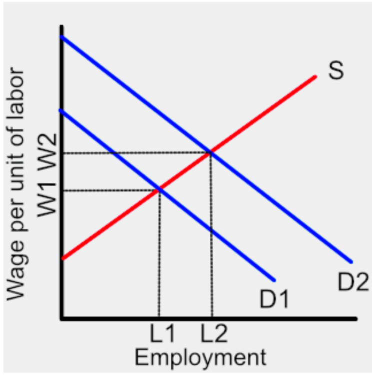

Figure 5. An increase in labor demand
Source: drawn by myself.

We assume that the wage depends on the number of employees working in this market. The wage level will be determined by the market equilibrium, as shown in Figure 3. If the labor demand rises, and supply remains equal the wage level will increase (Figure 5). As a consequence, more people are willing to accept the job. Hence there will be more employees and a higher wage in the new equilibrium. This can be described in the following wage function:

$W = S + cN$

Where:

- S = salary
- c = extra wage based on how many employees are hired

Nevertheless, we will be looking at only one employer. For a single employer, the wage level is given by the market. Thus, the supply curve is horizontal as shown in Figure 4. There are constant returns to scale in this model, because one employee produces one product. Meaning that the scale in the equilibrium is unknown, and therefore also the number of employees and the corresponding wage level of a single employer. But because of the threat of (potential) competitors, the single employer needs to implement the equilibrium wage level of the market or else he will potentially lose all his employees to competitors. Thus, the wage in this model will follow the same formula as the total market.

Now we can analyze the endogenous variables by looking at the utility of the employer. Egoism means that the employer only cares about his own utility, which is the profit (π) of the firm: $\pi = PQ - SN - cN^2$

As explained above, the profit will be equal to zero in the long run, so

$P = S + cN = W \Leftrightarrow P = S + cQ$

P can also be calculated in another way:

$P = \frac{1}{\alpha}\overline{Q} - \frac{1}{\alpha}Q$

It must hold that $\frac{1}{\alpha}\overline{Q} - \frac{1}{\alpha}Q > 0$, otherwise there will be no buyers on the market and the product will not be sold. This holds since $\overline{Q}$ is the maximum output and Q is the real output. Q can only be equal to or smaller than $\overline{Q}$, meaning that the difference can be positive or zero.

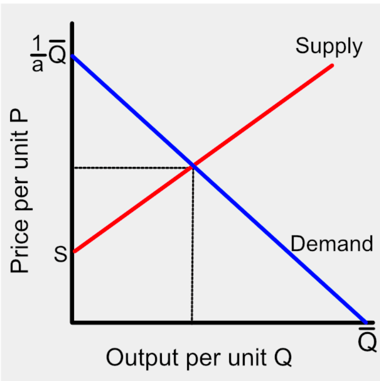

Figure 6. Equilibrium on the product market
Source: drawn by myself.

The two ways to describe P from above are illustrated in Figure 6.

$P = S + cQ$ is the supply curve. If there is no production the price is equal to S and the price will increase by c if one extra unit of Q is offered. Therefore, the price will also increase by c since the price is equal to the wage.

$P = \frac{1}{\alpha}\overline{Q} - \frac{1}{\alpha}Q$ is the demand curve. If there is no production the price is equal to $\frac{1}{\alpha}\overline{Q}$ and the price will decrease by $\frac{1}{\alpha}$ if one extra unit of Q is offered.

The equilibrium is the point where demand and supply are equal. This is the social optimum where all offered products are sold (see the dashed lines in the graph).

To calculate the equilibrium price, the two P functions are equated:

$S + cQ = \frac{\overline{Q} - Q}{\alpha}$

$Q = N = \frac{\overline{Q} - \alpha S}{1 + \alpha c}$

From this formula it follows that if $\overline{Q} - \alpha S < 0$ the output and employment will be negative and there will be no market. This can also be written as: $\alpha(\frac{1}{\alpha}\overline{Q} - S)$. This is the difference between the maximum price and the minimum labor costs. If this difference would be negative, the valuation of the product would be too small compared to the costs of producing the product. As a consequence, the product will not be sold on the market. Therefore, $\overline{Q} - \alpha S > 0$ will always hold.

It shows that the maximum output ($\overline{Q}$) positively influences the output and employment, because the demand curve shifts to the right if the maximum output increases. To satisfy the consumers, the employer will increase the output and therefore also the employment.
The effects of the base salary (S), the marginal costs (c) and price sensitivity (α) are negative. Because an increase in labor costs means that the employer can afford less employees while selling the same amount of products for the same price, since he has zero profit. Therefore, the employment and output will decrease if the wage increases. Moreover, if consumers are uncertain about their future, their price sensitivity increases and some people will even decide to stop buying this particular product.

Now, W can be calculated by substituting N into the wage function:

$$W = S + \frac{c\overline{Q} - \alpha c S}{1 + \alpha c}$$

It follows that if $c\overline{Q} - \alpha c S$ is negative, the wage will end up lower than the base salary. As a result, nobody wants to work for this employer. Again, meaning that $\overline{Q} - \alpha S > 0$ must hold.

If the maximum output ($\overline{Q}$) increases, the wage will also increase. This is due to the fact that for more output, more employees are needed. In order to attract these extra employees to the sector the wage must increase. The effects of the base salary (S) and the marginal costs of hiring an extra employee (c) are positive. This is sensible because the base salary and the marginal costs are part of the wage. Lastly, the effect of the price sensitivity (α) is negative. It can be that the demand decreases if price sensitivity increases. Meaning that labor demand also decreases and the new wage equilibrium will be lower.

Earlier it was found that $W = P$, so P can also be written as:

$$P = S + \frac{c\overline{Q} - \alpha c S}{1 + \alpha c}$$

The interpretation of this is the same as the interpretation of W, which is described above.

Monopoly and monopsony with egoism[2] [3]

Similar to the first model, a few assumptions need to be made in order to analyze the monopoly and monopsony situation. Firstly, there is only one seller and it will be difficult to enter the market. Additionally, the goods are heterogeneous.Together, this ensures that there is no threat of (potential) competitors. Although there will still be many buyers, there is only one seller who also has relatively more market power over his employees. There are no external effects and the employer still maximizes his utility (profit in this case).

The same output function is used as in the model above, to make comparing the different models easy. Therefore, the following functions stay the same:

$Q = \overline{Q} - \alpha P$

$Q = N$

$W = S + cN$

$\pi = PQ - SN - cN^2$

We assume that the employer does not have any other income or costs than his revenue from the output and labor costs. The labor costs are the wages of employees (W). Naturally, the employer will keep the wages as low as possible in order to increase his own utility.
In this model, the product market is monopolistic, because the employer (who is the seller) has all the market power. Besides that, the employer has monopsony power on the labor market. Because the employer is buying the labor of the employees and the employees are selling their effort in exchange for their wages. Meaning that the employer can decide the wage level causing it to be variable instead of constant.

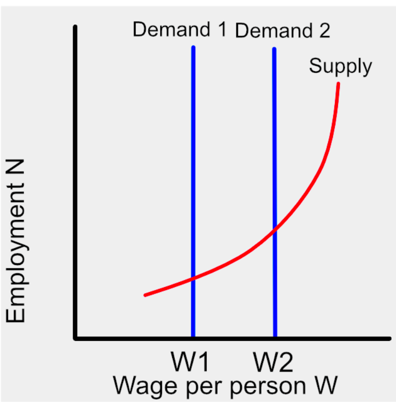

Figure 7. Labor supply depending on the wage level
Source: Notes from the course advanced microeconomics: personnel economics subject 6.

[2] The corresponding calculations can be found in appendix B
[3] I will call the employer a monopolist for simplicity. However, the monopolist is still also a monopsonist

We assume that the wage depends on the number of employees working in the firm. In order to attract more employees, the employer needs to increase the wage level as illustrated in Figure 7. However, the employer must raise all wages. So, the wage function can be described by:

$W = S + cN$

Where

- S = salary
- C = extra wage based on how many employees are hired

A monopolist is a price setter, which means that the monopolist chooses the price level. Since he is the only seller in the market, he will also automatically know the corresponding output level and employment. Here he will choose the level of Q, since the first outcome of the model above is also expressed as a function of Q, to make comparing the models easier.

The price needs to be larger than wages, otherwise there will be zero or a negative profit. If the profit is zero, the employer will be indifferent between selling products or doing nothing and if there is a loss he would rather do nothing. Thus, these functions will be equated and if the criteria coming from that hold, then this must also hold:

$P > W \Rightarrow \frac{\overline{Q}}{\alpha} - \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2 c} > S + \frac{c\overline{Q}-\alpha cS}{2+2\alpha c} \Rightarrow (\overline{Q} - \alpha S)(1 + \alpha c) > 0$

For this to hold it must be that both terms are negative or positive. It is impossible for $1 + \alpha c$ to be negative, and $\overline{Q} - \alpha S$ is also bigger than zero since it is the difference between the maximum price and the minimum labor costs, as explained before. So the price is larger than the wage.

Before the profit can be maximized, the price and profit need to be expressed in terms of Q.:

$P = \frac{\overline{Q}-Q}{\alpha}$

It must hold that $\frac{1}{\alpha}\overline{Q} - \frac{1}{\alpha}Q > 0$, as explained in the first model this criteria is met.

$\pi = (\frac{\overline{Q}-Q}{\alpha})Q - SQ - cQ^2 \Rightarrow \pi = \frac{1}{\alpha}\overline{Q}Q - \frac{1}{\alpha}Q^2 - SQ - cQ^2$

To find the maximum value of the profit, the derivative is taken and equated to zero. This is also called the first order condition:

$\frac{d\pi}{dQ} = \frac{1}{\alpha}\overline{Q} - \frac{2}{\alpha}Q - S - 2cQ = 0$

$Q = N = \frac{\bar{Q} - \alpha S}{2 + 2\alpha c}$

It shows that output and employment are smaller in the second model compared to the first. A reason for this is that the monopolist can also increase his profit by increasing the price, while the perfect competition employer can only increase his profit by increasing the output. This satisfies the second hypothesis, but for another reason as given in the literature. Moreover, this is also the reason why the maximum output ($\bar{Q}$) has a smaller effect. The effect of price sensitivity (α) is smaller, because the employer can decrease his price as he wishes, while this is not possible for the perfect competition employer since he already charges the smallest price, therefore the monopolist can sustain more of his consumers. The effect of the marginal costs (c) and the base salary (S) are also smaller because the monopolist can use part of his profit to compensate for the extra labor costs without firing employees, but the perfect competition employer is not able to do this.

Now W can be calculated, by substituting N:

$W = S + \frac{c\bar{Q} - \alpha c S}{2 + 2\alpha c}$

Again, $\bar{Q} - \alpha S > 0$ must hold. As discussed before, this holds and a market will exist.

It follows that the wage is smaller compared to the first model, because the monopsonist has more power. This is consistent with the existing literature and satisfies the first hypothesis. The effect of the maximum output ($\bar{Q}$) has less impact, since the monopolist can also choose to increase the price instead of the output. In that case, less employees are needed and the wage can stay lower. Moreover, price sensitivity (α) has less impact, because the perfect competition employer has to deal with competitors who will steal all his consumers, especially if the price sensitivity is high. But the monopolist does not have any competitors, so the threat of having no consumers is not as big.

Moving on, P can be described by substituting Q into the function:

$P = \frac{\bar{Q}}{\alpha} - \frac{Q}{\alpha} \Leftrightarrow P = \frac{\bar{Q}}{\alpha} - \frac{\bar{Q} - \alpha S}{2\alpha + 2\alpha^2 c}$

First of all, it follows that:

$\frac{\bar{Q}}{\alpha} - \frac{\bar{Q} - \alpha S}{2\alpha + 2\alpha^2 c} > 0 \Leftrightarrow \frac{\bar{Q}}{\alpha} > \frac{\bar{Q} - \alpha S}{2\alpha + 2\alpha^2 c}$

This criteria will hold, since on the right hand the numerator is smaller and the denominator is bigger. Both these effects let the value of the right hand fraction shrink.

The two P functions from the different models are very different from each other. The monopolist can influence the price and the perfect competition employer cannot. Therefore it would be logical that the price of the monopolist is higher than the price of the perfect competition employer. To see if this holds, the following is calculated:

$P_{monopoly} > P_{perfect\ competition} \Rightarrow \frac{\overline{Q}}{\alpha} - \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2 c} > S + \frac{c\overline{Q}-\alpha cS}{1+\alpha c}$

$2\overline{Q} + 2\alpha c\overline{Q} - \overline{Q} + \alpha S - 2\alpha S - 2\alpha^2 cS - 2\alpha c\overline{Q} + 2\alpha^2 cS > 0 \Rightarrow \overline{Q} - \alpha S > 0$

So, the price of the monopoly situation will have a higher value than the price of the perfect competition situation since $\overline{Q} - \alpha S > 0$ holds. Thus, the price will be higher in a monopoly.

The effect of the maximum output ($\overline{Q}$) on the price is positive and the effect of the price sensitivity (α) is negative. Both effects are bigger compared to the first model, since the monopolist can change his price and the perfect competition employer cannot do this.
The effects of the base salary (S) and marginal costs (c) are negative and have less impact. This is because the monopolist can choose to not fully transfer the extra costs into the price since he has profit and the price is higher than the wages.

Perfect competition with altruism[4]

The assumptions in this model are similar to the assumptions of the model named perfect competition with egoism. Therefore, the following functions stay the same:

$Q = \overline{Q} - \alpha P$

$Q = N$

$W = S + cN$

$\pi = PQ - SN - cN^2$

However, the principal also cares about the utility of his employees now, meaning that the employer maximizes the profit of the firm plus a bit extra. His utility will now be:

$U_p = \pi + \gamma U_a N \Rightarrow U_p = PN - SN - cN^2 + \gamma U_a N$

Where γ is the parameter of the degree of altruism, with $0 < \gamma < 1$. The bigger the value of γ, the more altruistic the seller is to his employees. Just as in the first model, the utility of the principal will be zero in the long run. Because the outside option is also zero in these models, since the value of it is unknown and the employer can do many different things outside being an employer.

$U_p = PN - SN - cN^2 + \gamma U_a N = 0 \Rightarrow P = W - \gamma U_a \Rightarrow P = S + cQ - \gamma U_a$

Another way of describing P is:

$P = \frac{1}{\alpha}\overline{Q} - \frac{1}{\alpha}Q$

It must hold that $\frac{1}{\alpha}\overline{Q} - \frac{1}{\alpha}Q > 0$, this holds as explained in the first model.

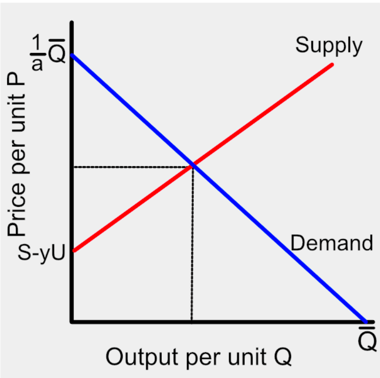

Figure 8. Equilibrium on the product market
Source: drawn by myself.

[4] The corresponding calculations can be found in appendix C

The two ways to describe P from above are illustrated in Figure 8.
The graph is the same as in the first model except for the starting point of the supply curve. Altruism lowers the starting point of the supply curve, because a part of the revenue needed to reach the same utility level as before is now substituted by his altruism.

The equilibrium is the point where demand and supply are equal. This is the social optimum where all offered products are sold (see the dashed lines).
To calculate the equilibrium price, these two P functions are equated:

$$S + cQ - \gamma U_a = \frac{\overline{Q}-Q}{\alpha}$$

$$Q = N = \frac{\overline{Q}+\alpha\gamma U_a-\alpha S}{1+\alpha c}$$

From this formula it follows that if $\overline{Q} + \alpha\gamma U_a - \alpha S < 0$ the output and employment will be negative and there will be no market. This can also be written as: $\alpha(\frac{1}{\alpha}\overline{Q} - (S - \gamma U_a)$. This is the difference between the maximum price and the minimum labor costs. If this difference would be negative, the valuation of the product would be too small compared to the costs of producing the product. As a consequence, the product will not be sold on the market. Therefore, $\overline{Q} + \alpha\gamma U_a - \alpha S > 0$ will always hold.

Compared to the first model, the outcomes are almost equal except for the term with altruism, which makes the outcome bigger. So, if the employer is more altruistic, he will hire more employees to make them and himself happier. Together, these employees will also produce more. Additionally, by increasing the number of employees, the wage of all employees will also go up, making the employees (and employer) even happier.
The effect of the maximum output ($\overline{Q}$) remains equal to the first model, because if the demand increases with one product there is still only one extra employee needed and this has nothing to do with altruism. Base salary (S) also remains equal since this is determined by the market instead of the employer. In contrast, the impact of price sensitivity is smaller because the employer cares more about the utility of his employees than consumers that do not buy his product anymore. The marginal costs (c) have a bigger effect, because the employer would rather fire some people and in return increase the utility of his remaining employees even more. Altruism (γ) and the utility of employees (U_a) are positively affecting the output and employment. The higher the altruism of the employer, the more he cares

about the utility of his employees. This will cause the employment to go up since he wants to make more employees happy.

Now W can be calculated, by substituting N into the function:

$$W = S + \frac{c\bar{Q} + \alpha c\gamma U_a - \alpha cS}{1+\alpha c}$$

The following criteria must hold to attract employees:

$$c\bar{Q} + \alpha c\gamma U_a - \alpha cS > 0 \Rightarrow \bar{Q} - \alpha S + \alpha\gamma U_a > 0$$

We know that $\bar{Q} - \alpha S + \alpha\gamma U_a$ is bigger than zero as explained above.

Again, the altruism term is positively influencing the outcome. Namely, if the employer increases the wages, employees will reach a higher utility which in turn increases the utility of the employer. This confirms the third hypothesis. The effects of the maximum output ($\bar{Q}$) and the base salary (S) remain equal to the first model. However, the effects of price sensitivity (α) and the marginal costs (c) did change. The price sensitivity has less impact and marginal costs have more impact, since the employer will also decrease his own utility if he decreases the utility of employees and vice versa.

Earlier, it was found that $P = W - \gamma U_a$, so P can also be written as:

$$P = S + \frac{c\bar{Q} + \alpha c\gamma U_a - \alpha cS}{1+\alpha c} - \gamma U_a$$

This formula is similar to the wage function, except for the last term. Meaning that the price will be lower than the wage. The loss that the company will make is compensated by the joy of altruism, which is not expressed in money.

To see if the price is higher or lower compared to the first model both P functions are equated:

$$S + \frac{c\bar{Q} - \alpha cS}{1+\alpha c} > S + \frac{c\bar{Q} + \alpha c\gamma U_a - \alpha cS}{1+\alpha c} - \gamma U_a$$

$$S + \alpha cS + c\bar{Q} - \alpha cS > S + \alpha cS + c\bar{Q} + \alpha c\gamma U_a - \alpha cS - \gamma U_a - \alpha c\gamma U_a \Rightarrow 0 > -\gamma U_a$$

Thus, the price in the first model will be higher, because the employer already earns a part of his utility through his altruism as also stated in the related literature. The only differences in derivatives compared to the wage function are the effects of γ and U_a. Both have a negative effect on the price, because an increase in one of those variables, increases the utility of the employer. As a consequence the employer needs to earn less to play even with his revenue and costs. So the price can be relatively lower when the employer is altruistic.

Monopoly and monopsony with altruism[5]

The assumptions in this model are similar to the assumptions of the model named monopoly and monopsony with egoism, except that now sellers maximize their utility instead of profit. Therefore, the following functions stay the same:

$Q = \overline{Q} - \alpha P$

$Q = N$

$W = S + cN$

$\pi = PQ - SN - cN^2$

$U_p = PQ - SN - cN^2 + \gamma U_a N$

As said before, the employer will certainly sell his products if the price is larger than the wage. Thus, these functions will be equated:

$\frac{\overline{Q}}{\alpha} - \frac{\overline{Q}+\alpha\gamma U_a - \alpha S}{2\alpha+2\alpha^2 c} > S + \frac{c\overline{Q}+\alpha c\gamma U_a - \alpha c S}{2+2\alpha c} \Rightarrow (\overline{Q} - \alpha S + \alpha\gamma U_a)(1 + \alpha c) > 0$

For this to hold it must follow that both terms are negative or positive. It is impossible for $1 + \alpha c$ to be negative, and $\overline{Q} - \alpha S + \alpha\gamma U_a$ is also bigger than zero as explained before.

Before the profit can be maximized, the price and profit need to be expressed in terms of Q:

$P = \frac{\overline{Q}-Q}{\alpha} \Rightarrow P = \frac{1}{\alpha}\overline{Q} - \frac{1}{\alpha}Q$

It must hold that $\frac{1}{\alpha}\overline{Q} - \frac{1}{\alpha}Q > 0$, as explained in the first model this criteria is met.

Now the utility of the employer can be written as:

$U_p = (\frac{\overline{Q}-Q}{\alpha})Q - SQ - cQ^2 + \gamma U_a Q \Rightarrow U_p = \frac{1}{\alpha}\overline{Q}Q - \frac{1}{\alpha}Q^2 - SQ - cQ^2 + \gamma U_a Q$

From the first order condition it follows that:

$\frac{dU_p}{dQ} = \frac{1}{\alpha}\overline{Q} - \frac{2}{\alpha}Q - S - 2cQ + \gamma U_a = 0$

$Q = N = \frac{\overline{Q}+\alpha\gamma U_a - \alpha S}{2+2\alpha c}$

The output and employment levels are higher compared to the second model because of altruism. The employer will hire more people and by doing so he increases their utility and

[5] The corresponding calculations can be found in appendix D

his own. However, it is smaller than the third outcome for the same reason as why the second outcome is smaller than the first: monopsony. Again, we see that the effect of the maximum output ($\overline{Q}$) and base salary (S) remains equal to the situation without altruism. And both effects have less impact compared to the third model. Price sensitivity (α) has less impact than in the second and third model. Moreover, the marginal costs (c) have more impact than in the second model and less compared to the third model. The explanations about altruism can be found in the third model and those of the different market structures in the second model. The positive effects of altruism (γ) and the utility of employees (U_a) are smaller. Namely, the employer can now also increase the utility of his employers by increasing the wages instead of only enlarging the employment as the perfect competition employer can do.

The wage can be determined by substituting N into the wage function:

$$W = S + \frac{c\overline{Q}+\alpha c\gamma U_a-\alpha cS}{2+2\alpha c}$$

It must hold that holds that $\overline{Q} - \alpha S + \alpha\gamma U_a > 0$, otherwise there will be no employees who are willing to work. This holds as explained above.

Comparing this to the other models, it follows that the wages will be higher than in the second model since the employer will reach a higher utility if his employees do. But the wages will be smaller compared to the third model because of monopsony power.
The effects of the maximum output ($\overline{Q}$) and base salary (S) remain equal to the second model. However, the maximum output has less impact and the base salary more compared to the third model. The price sensitivity (α) has less impact compared to the second and third model. Additionally, the marginal costs (c) have more impact than in the second model, but less than in the third model. The explanations about altruism can be found in the third model and those of the different market structures in the second model. The effects of altruism (γ) and the utility of employees (U_a) are smaller compared to the third model because the monopolist has monopsony power.

Another way of describing P is as follows:

$$P = \frac{\overline{Q}}{\alpha} - \frac{\overline{Q}+\alpha\gamma U_a-\alpha S}{2\alpha+2\alpha^2 c}$$

First of all it must hold that:

$$\frac{\overline{Q}}{\alpha} - \frac{\overline{Q}+\alpha\gamma U_a-\alpha S}{2\alpha+2\alpha^2 c} > 0 \Rightarrow \frac{\overline{Q}}{\alpha} > \frac{\overline{Q}+\alpha\gamma U_a-\alpha S}{2\alpha+2\alpha^2 c}$$

This holds and has a similar explanation as in the second model.

The price will be lower in this model than in the second model because of altruism. Hence, the monopolist needs to earn less profit, allowing him to implement a lower price.

The P functions of the third and fourth model are very different from each other. It would be logical that the price of the monopolist is higher than the price of the perfect competition employer. To see if this holds, the following is calculated:

$$P_{monopoly} > P_{perfect\ competition} \Rightarrow \frac{\overline{Q}}{\alpha} - \frac{\overline{Q}+\alpha\gamma U_a-\alpha S}{2\alpha+2\alpha^2 c} > S + \frac{c\overline{Q}+\alpha c\gamma U_a-\alpha cS}{1+\alpha c} - \gamma U_a$$

$$\overline{Q} - \alpha S + \alpha\gamma U_a > 0$$

Since $\overline{Q} - \alpha S + \alpha\gamma U_a > 0$ holds, the price will be higher in the monopoly.

The effect of the maximum output ($\overline{Q}$) remains equal to the effect of the second model and will be bigger compared to the third model. The effect of the base salary (S) is also equal to the effect of the second model but has less impact compared to the third model. Additionally, the price sensitivity (α) has less impact compared to the second model and more than in the third model. And the marginal costs (c) have more impact than in the second model but less impact compared to the third model. The explanations for this can be found in the second and third model. Lastly, altruism (γ) and the utility of the employees (U_a) have less effect compared to the third model because the perfect competition employer is more than happy to lower his price, now that he earns a part of his utility through the utility of his employees. But the monopolist does not necessarily want to lower his price, since he has no competitors.

An overview of the results

Tabel 1. The outcomes of the formulas

Model	Q = N	W	P
1. Perfect competition & egoism	$\frac{\bar{Q}-\alpha S}{1+\alpha c}$	$S + \frac{c\bar{Q}-\alpha cS}{1+\alpha c}$	$S + \frac{c\bar{Q}-\alpha cS}{1+\alpha c}$
2.Monopoly & monopsony & egoism	$\frac{\bar{Q}-\alpha S}{2+2\alpha c}$ smaller than model 1	$S + \frac{c\bar{Q}-\alpha cS}{2+2\alpha c}$ smaller than model 1	$\frac{\bar{Q}}{\alpha} - \frac{\bar{Q}-\alpha S}{2\alpha+2\alpha^2 c}$ biggest
3.Perfect competition & altruism	$\frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{1+\alpha c}$ biggest	$S + \frac{c\bar{Q}+\alpha c\gamma U_a-\alpha cS}{1+\alpha c}$ biggest	$S + \frac{c\bar{Q}+\alpha c\gamma U_a-\alpha cS}{1+\alpha c} - \gamma U_a$ smaller than model 1
4.Monopoly & monopsony & Altruism	$\frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2+2\alpha c}$ smaller than model 1 bigger than model 2 smaller than model 3	$S + \frac{c\bar{Q}+\alpha c\gamma U_a-\alpha cS}{2+2\alpha c}$ smaller than model 1 bigger than model 2 smaller than model 3	$\frac{\bar{Q}}{\alpha} - \frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2\alpha+2\alpha^2 c}$ bigger than model 1 smaller than model 2 bigger than model 3

In this table the outcomes per formula are shown to give an overview of all the results. Moreover, they are compared to each other, to make clear which one is the biggest or smallest.

This shows that the third model yields the highest employment, output and wage. The employer tries to maximize his utility by making his employees as happy as possible and selling as many products as possible, since he is altruistic and can maximize his utility only through increasing output. The second and fourth model have a smaller employment, output and wage than the first and third model because the employer is a monopolist who can also increase his profit by increasing the price and not only by increasing output. Moreover, he has monopsony power, which enables him to implement a lower wage.

The price level is the highest in the second model, because the monopolist can choose the price freely, without considering competitors. Additionally, the altruistic employers charge a lower price since they already fill a part of their utility by making their employees happy.

Table 2. Effect of maximum output $\overline{Q}$

Model	Q = N	W	P
1. Perfect competition & egoism	$\frac{1}{1+\alpha c} > 0$	$\frac{c}{1+\alpha c} > 0$	$\frac{c}{1+\alpha c} > 0$
2.Monopoly & monopsony & egoism	$\frac{1}{2+2\alpha c} > 0$ less impact than model 1	$\frac{c}{2+2\alpha c} > 0$ less impact than model 1	$\frac{1}{\alpha} - \frac{1}{2\alpha+2\alpha^2 c} > 0$ More impact than model 1
3.Perfect competition & altruism	$\frac{1}{1+\alpha c} > 0$ same as model 1	$\frac{c}{1+\alpha c} > 0$ same as model 1	$\frac{c}{1+\alpha c} > 0$ same as model 1
4.Monopoly & monopsony & Altruism	$\frac{1}{2+2\alpha c} > 0$ same as model 2 less impact than model 3	$\frac{c}{2+2\alpha c} > 0$ same as model 2 less impact than model 3	$\frac{1}{\alpha} - \frac{1}{2\alpha+2\alpha^2 c} > 0$ same as model 2 more impact than model 3

In this table the outcomes per formula are shown to give an overview of all the results. Moreover, they are compared to each other, to make clear which one is the biggest or smallest.

The maximum output has a positive effect on the output, employment, wage and price. If the maximum output increases, the output has to increase as well in order to satisfy consumers and to earn more profit. To satisfy demand, more employees are needed. Hence, the wage needs to increase in order to find more employees.
However, the effect on output, employment and wage is smaller in case of a monopoly, because the monopolist can also increase the price instead of only output. This is also why the maximum output has more impact on the price level in the monopoly models.
Moreover, there is no difference between the first and third model and between the second and fourth model, meaning that altruism is not influencing the effect of the maximum output on actual output, employment, wage and price. This is because the maximum output is determined by the demand function (the consumers) and therefore the employer cannot influence this.

Table 3. Effect of price sensitivity α

Model	Q = N	W	P
1. Perfect competition & egoism	$\frac{-S-c\bar{Q}}{(1+\alpha c)^2} < 0$	$\frac{-cS-c^2\bar{Q}}{(1+\alpha c)^2} < 0$	$\frac{-cS-c^2\bar{Q}}{(1+\alpha c)^2} < 0$
2.Monopoly & monopsony & egoism	$\frac{-S-c\bar{Q}}{2+4\alpha c+2\alpha^2 c^2} < 0$ less impact than model 1	$\frac{-cS-c^2\bar{Q}}{2+4\alpha c+2\alpha^2 c^2} < 0$ less impact than model 1	$-\frac{\bar{Q}}{\alpha^2} - \frac{\alpha^2 cS-\bar{Q}-2\alpha c\bar{Q}}{2\alpha^2+4\alpha^3 c+2\alpha^4 c^2} < 0$ more impact than model 1
3.Perfect competition & altruism	$\frac{\gamma U_a-S-c\bar{Q}}{(1+\alpha c)^2} < 0$ less impact than model 1	$\frac{c\gamma U_a-cS-c^2\bar{Q}}{(1+\alpha c)^2} < 0$ less impact than model 1	$\frac{c\gamma U_a-cS-c^2\bar{Q}}{(1+\alpha c)^2} < 0$ less impact than model 1
4.Monopoly & monopsony & Altruism	$\frac{\gamma U_a-S-c\bar{Q}}{2+4\alpha c+2\alpha^2 c^2} < 0$ less impact than model 2 less impact than model 3	$\frac{c\gamma U_a-cS-c^2\bar{Q}}{2+4\alpha c+2\alpha^2 c^2} < 0$ less impact than model 2 less impact than model 3	$-\frac{\bar{Q}}{\alpha^2} - \frac{\alpha^2 cS-\alpha^2 c\gamma U_a-\bar{Q}-2\alpha c\bar{Q}}{2\alpha^2+4\alpha^3 c+2\alpha^4 c^2}$ less impact than model 2 more impact than model 3

In this table the outcomes per formula are shown to give an overview of all the results. Moreover, they are compared to each other, to make clear which one is the biggest or smallest.

The effect of price sensitivity is negative on everything. If consumers pay more attention to the prices of the products (price sensitivity increases), some people will decide to stop buying this particular product. Thus, less output and employment is needed and therefore the wages can stay lower. Because the employees who are not getting fired really want the job and are willing to work for less money.

And to keep demand from decreasing too much, the price has to decrease. The perfect competition employer is relatively less able to do this, since he already charges the smallest price possible. And because the monopolist can decrease his price easily, his demand will not decrease as much, keeping the impact on the output, employment and wages also smaller.

The effect will also have less impact if the employer is altruistic, because if he decreases the output, he has to fire some of his employees. This will decrease their utility and thereby also his own utility. Thus, the incentive to lower the output and employment will be less. Moreover, an altruistic employer will care less about the fact that he earns less profit if he does not lower his product price, because he already gets utility from making his employees happy.

Table 4. Effect of altruism γ

Model	Q = N	W	P
3.Perfect competition & altruism	$\frac{\alpha U_a}{1+\alpha c} > 0$	$\frac{cU_a}{(1+\alpha c)^2} > 0$	$\frac{-U_a}{1+\alpha c} < 0$
4.Monopoly & monopsony & Altruism	$\frac{\alpha U_a}{2+2\alpha c} > 0$ less impact than model 3	$\frac{\alpha c U_a}{2+2\alpha c} > 0$ less impact than model 3	$-\frac{\alpha U_a}{2\alpha+2\alpha^2 c} < 0$ less impact than model 3

In this table the outcomes per formula are shown to give an overview of all the results. Moreover, they are compared to each other, to make clear which one is the biggest or smallest.

Table 5. Effect of employers utility U_a

Model	Q = N	W	P
3.Perfect competition & altruism	$\frac{\alpha\gamma}{1+\alpha c} > 0$	$\frac{c\gamma}{(1+\alpha c)^2} > 0$	$\frac{-\gamma}{1+\alpha c} < 0$
4.Monopoly & monopsony & Altruism	$\frac{\alpha\gamma}{2+2\alpha c} > 0$ less impact than model 3	$\frac{\alpha c\gamma}{2+2\alpha c} > 0$ less impact than model 3	$-\frac{\alpha\gamma}{2\alpha+2\alpha^2 c} < 0$ less impact than model 3

In this table the outcomes per formula are shown to give an overview of all the results. Moreover, they are compared to each other, to make clear which one is the biggest or smallest.

Altruism and the utility of employees have a positive effect on the output, employment and wage. Hence, the employer will reach a higher utility if he makes more employees happy by increasing the output and employment or wage.
In contrast, the price level is negatively influenced by the level of altruism and the wage of his employees. Explained by the fact that the employer needs to earn less profit to reach the same utility level, since he also earns a part of his utility by increasing the utility of his employees.
Additionally, altruism and the utility of employees play a bigger role in the third model, because the perfect competition employer has more incentives to make his employees feel loved since they can go work for a competitor more easily. The monopolist does not have this threat, and therefore will show his altruism less.

Table 6. Effect of the marginal costs of hiring an extra employee c

Model	Q = N	W	P
1. Perfect competition & egoism	$\frac{-\alpha(\bar{Q}-\alpha S)}{(1+\alpha c)^2} < 0$	$\frac{\bar{Q}-\alpha S}{(1+\alpha c)^2} > 0$	$\frac{\bar{Q}-\alpha S}{(1+\alpha c)^2} > 0$
2.Monopoly & monopsony & egoism	$\frac{-\alpha(\bar{Q}-\alpha S)}{2+4\alpha c+2\alpha^2 c^2} < 0$ less impact than model 1	$\frac{\bar{Q}-\alpha S}{2+4\alpha c+2\alpha^2 c^2} > 0$ less impact than model 1	$\frac{\bar{Q}-\alpha S}{2+4\alpha c+2\alpha^2 c^2} > 0$ less impact than model 1
3.Perfect competition & altruism	$\frac{-\bar{Q}\alpha-\alpha^2\gamma U_a+\alpha^2 S}{(1+\alpha c)^2} < 0$ more impact than model 1	$\frac{\bar{Q}-\alpha S+\alpha\gamma U_a}{(1+\alpha c)^2} > 0$ more impact than model 1	$\frac{\bar{Q}-\alpha S+\alpha\gamma U_a}{(1+\alpha c)^2} > 0$ more impact than model 1
4.Monopoly & monopsony & Altruism	$\frac{\alpha^2 S-\alpha\bar{Q}-\alpha^2\gamma U_a}{2+4\alpha c+2\alpha^2 c^2} < 0$ more impact than model 2 less impact than model 3	$\frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2+4\alpha c+2\alpha^2 c^2} > 0$ more impact than model 2 less impact than model 3	$\frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2+4\alpha c+2\alpha^2 c^2} > 0$ more impact than model 2 less impact than model 3

In this table the outcomes per formula are shown to give an overview of all the results. Moreover, they are compared to each other, to make clear which one is the biggest or smallest.

The marginal costs of hiring an extra employee have a negative effect on the output and employment. An explanation is that if the marginal costs increase, the labor costs will increase and the employer might not have enough revenue to pay all his employees. Thus, he has to fire some of his employees, causing a decrease in employment and output.
In a monopoly the effect will have less impact, because the monopolist has more spare revenue so he is able to pay all his employees a bit extra without firing some of them. Moreover, the effect becomes even stronger in the case of an altruistic employer, because he wants to make his employees as happy as possible. He does not care about the utility of already fired employees, so he would rather fire some people and in return increase the utility of his remaining employees even more.
The marginal costs of hiring an extra employee are positively affecting the wage and the price. The marginal costs are a part of the wage so it is logical that the wage will increase due to an increase of the marginal costs. Additionally, the wage is equal to the price in the first and third model. Meaning that the price will increase with the same amount. If the employer is altruistic, he does not mind to increase the wage because it will also increase his own utility. So the effect is even bigger in the third and fourth model.

Table 7. Effect of the base salary S

Model	Q = N	W	P
1. Perfect competition & egoism	$\frac{-\alpha}{1+\alpha c} < 0$	$1 + \frac{-\alpha c}{1+\alpha c} > 0$	$1 + \frac{-\alpha c}{1+\alpha c} > 0$
2.Monopoly & monopsony & egoism	$\frac{-\alpha}{2+2\alpha c} < 0$ less impact than model 1	$1 + \frac{-\alpha c}{2+2\alpha c} > 0$ more impact than model 1	$\frac{\alpha}{2\alpha+2\alpha^2 c} > 0$ less impact than model 1
3.Perfect competition & altruism	$\frac{-\alpha}{1+\alpha c} < 0$ same as model 1	$1 + \frac{-\alpha c}{1+\alpha c} > 0$ same as model 1	$1 + \frac{-\alpha c}{1+\alpha c} > 0$ same as model 1
4.Monopoly & monopsony & Altruism	$\frac{-\alpha}{2+2\alpha c} < 0$ same as model 2 less impact than model 3	$1 + \frac{-\alpha c}{2+2\alpha c} > 0$ same as model 2 more impact than model 3	$\frac{\alpha}{2\alpha+2\alpha^2 c} > 0$ same as model 2 less impact than model 3

In this table the outcomes per formula are shown to give an overview of all the results. Moreover, they are compared to each other, to make clear which one is the biggest or smallest.

The effect of the base salary on the output and employment is also negative for the same reason as the marginal costs. If the base salary increases, the employer will have more labor costs than before. In case of perfect competition, this will cause him to make a loss. To compensate for this, he needs to fire some of his employees.

However, altruism does not play a role here. And the monopolist can use part of his profit to make up for the loss, thus the effect is less strong in the second and fourth model.

The effect on the wage and price is positive. Namely, the base salary is part of the wage and in the first and third model the wage is equal to the price. In case of a monopoly, the impact is even bigger because the monopolist reaches a level of profit instead of the break even level. So, he has more room to increase the wages.

Conclusion and discussion

Table 8. Ranking of the models per formula from smallest to biggest.

	Smallest			Biggest
Q	2. Monopoly & monopsony & egoism	4. Monopoly & monopsony & Altruism	1. Perfect competition & egoism	3. Perfect competition & altruism
W	2. Monopoly & monopsony & egoism	4. Monopoly & monopsony & Altruism	1. Perfect competition & egoism	3. Perfect competition & altruism
P	3. Perfect competition & altruism	1. Perfect competition & egoism	4. Monopoly & monopsony & Altruism	2. Monopoly & monopsony & egoism

In this table the rankings per formula are shown to give you an overview.

Before I started this research, I wondered if the positive effect of altruism could overrule the negative effect of monopoly and monopsony power on wages and employment, because I could not find this in existing literature. Therefore my research question is:

Can employer altruism prevent the wages of employees to go down or does monopsony power win?

I researched this question by analyzing four different models about perfect competition or monopoly and monopsony combined with employer altruism or egoism. Table 8 contains a ranking of those four different models per outcome.

My research shows that the models about monopoly and monopsony have a lower output, employment and wage level than the models about perfect competition. This confirms the existing literature which states that the wage level is higher if workers can find a similar job more easily, which is the case in perfect competition (Manning, 2013). In a perfect competition, employees have relatively more market power than in a monopsony because the threat that they will leave is more credible since there are more similar jobs. Consequently, their wage will be higher. Moreover, employment and output will also be smaller in a monopoly with monopsony because the employer has two ways to increase his utility instead of one. Not only can he increase his profit by increasing the output as the perfect competition employer is able to do, he can also increase his profit by increasing the price. This is also the reason why the price is higher in the monopoly and monopsony than in the perfect competition situation. The monopolist can choose the price on his own while the perfect competition employer can only accept the market price.

Moreover, altruism also has an effect on the outcomes. It is positively influencing the output, employment and wage because the employer wants to reach the highest utility possible. And by increasing the number of employees or their utility through their wage, he is also increasing his own utility. Because he is already earning a part of his utility through his employees he needs less profit to reach the same level of utility as the selfish employer. Therefore, the prices can stay relatively low compared to an egoistic employer.
This answers my two sub questions. Namely, wages of employees are positively influenced by competition, and altruism increases this effect even more. However, this is still not an answer to the central research question.

By analyzing these models I found that the market structure has more effect on the wages than altruism, since the pairs of market structures are always next to each other in the ranking without being interrupted by another structure. For example, perfect competition is always the two biggest outcomes or the two smallest outcomes. Thus, the effect of monopsony power overrules the effect of altruism. Since the model about monopoly and monopsony with altruism has a lower wage compared to the model about perfect competition and egoism. In conclusion, the answer to my research question is: no, altruism cannot prevent the wages from decreasing and monopsony power wins. Because the wages and employment of the model about monopoly and monopsony with altruism are still relatively low compared to perfect competition with egoism. So, the effect of monopsony has a bigger impact than altruism.

Moreover, I stated before that less densely populated areas would resemble a monopoly and monopsony with altruism and a more densely populated area is more likely to be similar to a perfect competition situation with egoism. Table 8 shows that those two models are never the smallest or biggest of all models. And while it sounds like those models are the opposite, they are actually next to each other all the time. How big the differences are depends on the values of the variables in the models. But it is clear that the employment and wages should be higher in cities and the prices lower. CBS (2018) states that this is true for the Netherlands, since there is less work and a lower income for people living in less densely populated areas as the north. While there are areas with high income in and near big cities. However, this is just an observation as I did not test if it was significant. To test if this difference is statistically significant one could perform a regression analysis with data on the density of areas and income with control variables such as costs of living, how many children someone has (as this limits their commute time), average commute time, productivity and age. Since it is proven that employees are more productive in cities and will therefore earn more, but older people also earn more and young people are moving away from less densely populated areas in the Netherlands (Planbureau voor de Leefomgeving, 2019). Additionally there should also be controlled for gender, since Manning (2013) mentions that women are less motivated by money when choosing a job. However, it will never be known if there are other underlying reasons affecting the research since we will never know if we control for all valuable control variables. So, a causal relation can never be found with this method of research.

A better research method would be to test whether less densely populated areas are more monopsonic and altruistic by using an exogenous shock as a treatment. For example, Covid-19 is an exogenous shock. A lot of people moved to less densely populated areas as a reaction to the lockdowns (Central Bureau for Statistics, 2021) and then it can be tested how high the vacancy rate is in the new area and what their new wage is, since these are proven to be related to monopsony. Moreover, by interviewing these people it is possible to know if they think their new or old employer was more altruistic. By recording this data before and after the lockdowns it might be possible to estimate a causal effect through performing a test with individual fixed effects. That way the problem of changing unobservable variables is accounted for. However, Covid-19 as exogenous shock is not suitable for this research because the problem of selection bias is present here. Since there is only a certain group of people that decides to move away from the city, they can have a time-varying unobservable motivation in common, which might influence the outcome. Therefore the use of Covid-19 is just an example to give you an idea about how to follow up this research. Matching could also be a method to research this, but again there could be unobservable characteristics playing a role.

Lastly, I would like to remind you that the assumptions of the models are not very realistic. For example, people differ in productivity and they can make more than one product. There can also be externalities, and easy entry or easy exit is not always the case. However, as already stated in the related literature, models do not always have to resemble reality. And unrealistic models can still add new insights to the already existing knowledge. However, this does not mean that this model cannot be improved. New extensions can be added to the model, such as different market structures, like monopolistic competition. Or it can be analyzed what happens if the employees are altruistic too, as is done in the paper of Dur and Tichem (2015). Additionally, in real life it is harder for people to suddenly switch jobs. For example, it is possible that they need training before they can start at their new job. And lastly, other non-monetary factors could also influence the decision to leave the company. These suggestions could be added to the model to analyze their effects on the outcomes.

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Appendix A

Calculations of the first model: perfect competition with egoism

Standard functions:

$Q = \overline{Q} - \alpha P$

$W = S + cN$

$\pi = PQ - WN$

$\pi = PQ - (S + cN)N$

$\pi = PQ - SN - cN^2$

$\pi = 0$ together with $Q = N$ gives:

$\pi = PN - SN - cN^2 = 0$

$PN = SN + cN^2$

$P = \frac{SN+cN^2}{N}$

$P = S + cN = W$

$P = S + cQ$

P can also be calculated in another way:

$\alpha P = - Q + \overline{Q}$

$P = \frac{\overline{Q}-Q}{\alpha}$

$P = \frac{1}{\alpha}\overline{Q} - \frac{1}{\alpha}Q$

To calculate the optimal P, the two P functions are equated:

$S + cQ = \frac{\overline{Q}-Q}{\alpha}$

$S + cQ = \frac{\overline{Q}}{\alpha} - \frac{Q}{\alpha}$

$cQ + \frac{Q}{\alpha} = \frac{\overline{Q}}{\alpha} - S$

$\alpha cQ + Q = \overline{Q} - \alpha S$

$Q(1 + \alpha c) = \overline{Q} - \alpha S$

$Q = N = \frac{\overline{Q}-\alpha S}{1+\alpha c}$

Effect of $\overline{Q}$:

$\frac{dQ}{d\overline{Q}} = \frac{1}{1+\alpha c}$

Effect of S:

$\frac{dQ}{dS} = \frac{-\alpha}{1+\alpha c}$

Effect of α:

$\frac{dQ}{d\alpha} = \frac{-S-c\overline{Q}}{(1+\alpha c)^2}$

Effect of c:

$\frac{dQ}{dc} = \frac{-\alpha(\overline{Q}-\alpha S)}{(1+\alpha c)^2}$

$W = S + cN$ and $N = \frac{\overline{Q}-\alpha S}{1+\alpha c}$ gives:

$W = S + c(\frac{\overline{Q}-\alpha S}{1+\alpha c})$

$W = S + \frac{c\overline{Q}-\alpha cS}{1+\alpha c}$

Effect of $\overline{Q}$:

$\frac{dW}{d\overline{Q}} = \frac{c}{1+\alpha c}$

Effect of S:

$\frac{dW}{dS} = 1 + \frac{-\alpha c}{1+\alpha c}$

Effect of α:

$\frac{dW}{d\alpha} = \frac{(1+\alpha c)(-cS)-(c\overline{Q}-\alpha cS)c}{(1+\alpha c)^2}$

$\frac{dW}{d\alpha} = \frac{-cS-\alpha c^2S-c^2\overline{Q}+\alpha c^2S}{(1+\alpha c)^2}$

$\frac{dW}{d\alpha} = \frac{-cS-\alpha c^2S-c^2\overline{Q}+\alpha c^2S}{(1+\alpha c)^2}$

$\frac{dW}{d\alpha} = \frac{-cS-c^2\overline{Q}}{(1+\alpha c)^2}$

Effect of c:

$\frac{dW}{dc} = \frac{(1+\alpha c)(\overline{Q}-\alpha S)-(c\overline{Q}-\alpha cS)\alpha}{(1+\alpha c)^2}$

$\frac{dW}{dc} = \frac{\overline{Q}-\alpha S+\alpha c\overline{Q}-\alpha^2cs-(\alpha c\overline{Q}-\alpha^2cs)}{(1+\alpha c)^2}$

$\frac{dW}{dc} = \frac{\overline{Q}-\alpha S+\alpha c\overline{Q}-\alpha^2cs-\alpha c\overline{Q}+\alpha^2cs}{(1+\alpha c)^2}$

$\frac{dW}{dc} = \frac{\overline{Q}-\alpha S}{(1+\alpha c)^2}$

Earlier it was found that $W = P$, so P can also be written as:

$P = S + \frac{c\overline{Q}-\alpha cS}{1+\alpha c}$

The fact that $\pi = 0$ can also be proven in another way:

$TR = PQ$

$\frac{dTR}{dQ} = MR = P$

$TC = NW$

since $Q = N$, it follows that:

$TC = QW$
$\frac{dTC}{dQ} = MC = W$

So π is at its maximum if $MR = MC$ gives:
$P = W$

Substituting this into the profit function:
$\pi = PQ - QP = 0$

Appendix B

Calculations of the second model: monopoly and monopsony with egoism

Standard functions:

$Q = \overline{Q} - \alpha P$

$Q = N$

$W = S + cN$

$\pi = PQ - WN$

$\pi = PQ - (S + cN)N$

$\pi = PQ - SN - cN^2$

First, we need the price and profit expressed in terms of Q:

$\alpha P = - Q + \overline{Q}$

$P = \frac{\overline{Q} - Q}{\alpha}$

$\pi = PQ - SN - cN^2$ with $Q = N$ gives:

$\pi = PQ - SQ - cQ^2$

Substituting P into the profit function gives:

$\pi = (\frac{\overline{Q} - Q}{\alpha})Q - SQ - cQ^2$

$\pi = \frac{\overline{Q}Q - Q^2}{\alpha} - SQ - cQ^2$

$\pi = \frac{1}{\alpha}\overline{Q}Q - \frac{1}{\alpha}Q^2 - SQ - cQ^2$

The first order condition gives us:

$\frac{d\pi}{dQ} = \frac{1}{\alpha}\overline{Q} - \frac{2}{\alpha}Q - S - 2cQ = 0$

$\frac{2}{\alpha}Q + 2cQ = \frac{1}{\alpha}\overline{Q} - S$

$Q(\frac{2}{\alpha} + 2c) = \frac{1}{\alpha}\overline{Q} - S$

$Q = \frac{\frac{1}{\alpha}\overline{Q} - S}{\frac{2}{\alpha} + 2c} * \frac{\alpha}{\alpha}$

$Q = \frac{\overline{Q} - \alpha S}{2 + 2\alpha c}$

$N = \frac{\overline{Q} - \alpha S}{2 + 2\alpha c}$

Effect of $\overline{Q}$:

$\frac{dQ}{d\overline{Q}} = \frac{1}{2 + 2\alpha c}$

Effect of S:

$\frac{dQ}{dS} = \frac{-\alpha}{2 + 2\alpha c}$

Effect of α:

$$\frac{dQ}{d\alpha} = \frac{-S - c\overline{Q}}{2 + 4\alpha c + 2\alpha^2 c^2}$$

Effect of c:

$$\frac{dQ}{dc} = \frac{-\overline{Q}\alpha - \alpha^2 \gamma U_a + \alpha^2 S}{(1 + \alpha c)^2}$$

Now W can be calculated, by substituting N:

$W = S + cN$ and $N = \frac{\overline{Q} - \alpha S}{2 + 2\alpha c}$

$$W = S + c\left(\frac{\overline{Q} - \alpha S}{2 + 2\alpha c}\right)$$

$$W = S + \frac{c\overline{Q} - \alpha c S}{2 + 2\alpha c}$$

Effect of $\overline{Q}$:

$$\frac{dW}{d\overline{Q}} = \frac{c}{2 + 2\alpha c}$$

Effect of S:

$$\frac{dW}{dS} = 1 + \frac{-\alpha c}{2 + 2\alpha c}$$

Effect of α:

$$\frac{dW}{d\alpha} = \frac{(2 + 2\alpha c)(-cS) - (c\overline{Q} - \alpha c S)2c}{(2 + 2\alpha c)^2}$$

$$\frac{dW}{d\alpha} = \frac{-2cS - 2\alpha c^2 S - 2c^2\overline{Q} + 2\alpha c^2 S}{(2 + 2\alpha c)^2}$$

$$\frac{dW}{d\alpha} = \frac{-2cS - 2c^2\overline{Q}}{4 + 8\alpha c + 4\alpha^2 c^2}$$

$$\frac{dW}{d\alpha} = \frac{-cS - c^2\overline{Q}}{2 + 4\alpha c + 2\alpha^2 c^2}$$

Effect of c:

$$\frac{dW}{dc} = \frac{(2 + 2\alpha c)(\overline{Q} - \alpha S) - (c\overline{Q} - \alpha c S)2\alpha}{(2 + 2\alpha c)^2}$$

$$\frac{dW}{dc} = \frac{2\overline{Q} - 2\alpha S + 2\alpha c\overline{Q} - 2\alpha^2 cs - (2\alpha c\overline{Q} - 2\alpha^2 cs)}{(2 + 2\alpha c)^2}$$

$$\frac{dW}{dc} = \frac{2\overline{Q} - 2\alpha S + 2\alpha c\overline{Q} - 2\alpha^2 cs - 2\alpha c\overline{Q} + 2\alpha^2 cs}{(2 + 2\alpha c)^2}$$

$$\frac{dW}{dc} = \frac{2\overline{Q} - 2\alpha S}{(2 + 2\alpha c)^2}$$

$$\frac{dW}{dc} = \frac{2\overline{Q} - 2\alpha S}{(2 + 2\alpha c)^2}$$

$$\frac{dW}{dc} = \frac{2\overline{Q} - 2\alpha S}{4 + 8\alpha c + 4\alpha^2 c^2}$$

$$\frac{dW}{dc} = \frac{\overline{Q} - \alpha S}{2 + 4\alpha c + 2\alpha^2 c^2}$$

Since the monopolist earns profit, the price should be higher than the wage. Otherwise profit is not possible. So this is tested.

$P > W$

$\frac{\overline{Q}}{\alpha} - \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2 c} > S + \frac{c\overline{Q}-\alpha cS}{2+2\alpha c}$

$\frac{\overline{Q}}{\alpha} * \frac{2+2\alpha c}{2+2\alpha c} - \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2 c} > S * \frac{2\alpha+2\alpha^2 c}{2\alpha+2\alpha^2 c} + \frac{c\overline{Q}-\alpha cS}{2+2\alpha c} * \frac{\alpha}{\alpha}$

$\frac{2\overline{Q}+2\alpha c\overline{Q}}{2\alpha+2\alpha^2 c} - \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2 c} > \frac{2\alpha S+2\alpha^2 cS}{2\alpha+2\alpha^2 c} + \frac{\alpha c\overline{Q}-\alpha^2 cS}{2\alpha+2\alpha^2 c}$

$\frac{2\overline{Q}+2\alpha c\overline{Q}}{2\alpha+2\alpha^2 c} - \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2 c} > \frac{2\alpha S+2\alpha^2 cS}{2\alpha+2\alpha^2 c} + \frac{\alpha c\overline{Q}-\alpha^2 cS}{2\alpha+2\alpha^2 c}$

$2\overline{Q} + 2\alpha c\overline{Q} - \overline{Q} + \alpha S > 2\alpha S + 2\alpha^2 cS + \alpha c\overline{Q} - \alpha^2 cS$

$2\overline{Q} + 2\alpha c\overline{Q} - \overline{Q} + \alpha S - 2\alpha S - 2\alpha^2 cS - \alpha c\overline{Q} + \alpha^2 cS > 0$

$\overline{Q} + \alpha c\overline{Q} - \alpha S - \alpha^2 cS > 0$

$\overline{Q} - \alpha S + \alpha c(\overline{Q} - \alpha S) > 0$

$(\overline{Q} - \alpha S)(1 + \alpha c) > 0$

P can be described as follows:

$P = \frac{\overline{Q}}{\alpha} - \frac{Q}{\alpha}$ with $Q = \frac{\overline{Q}-\alpha S}{2+2\alpha c}$

$P = \frac{\overline{Q}}{\alpha} - \frac{\frac{\overline{Q}-\alpha S}{2+2\alpha c}}{\alpha}$

$P = \frac{\overline{Q}}{\alpha} - \frac{\overline{Q}-\alpha S}{\alpha(2+2\alpha c)}$

$P = \frac{\overline{Q}}{\alpha} - \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2 c}$

With criteria:

$\frac{\overline{Q}}{\alpha} - \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2 c} > 0$

$\frac{\overline{Q}}{\alpha} > \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2 c}$

Since the monopolist can choose his own price and the perfect competition employer cannot and has to implement the lowest price, it would be logical that the price of the monopolist is higher. So this is tested:

$P_{monopoly} > P_{perfect\ competition}$

$\frac{\overline{Q}}{\alpha} - \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2 c} > S + \frac{c\overline{Q}-\alpha cS}{1+\alpha c}$

$\frac{\overline{Q}}{\alpha} * \frac{2+2\alpha c}{2+2\alpha c} - \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2 c} > S * \frac{2\alpha+2\alpha^2 c}{2\alpha+2\alpha^2 c} + \frac{c\overline{Q}-\alpha cS}{1+\alpha c} * \frac{2\alpha}{2\alpha}$

$\frac{2\overline{Q}+2\alpha c\overline{Q}}{2\alpha+2\alpha^2 c} - \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2 c} > \frac{2\alpha S+2\alpha^2 cS}{2\alpha+2\alpha^2 c} + \frac{2\alpha c\overline{Q}-2\alpha^2 cS}{2\alpha+2\alpha^2 c}$

$2\overline{Q} + 2\alpha c\overline{Q} - \overline{Q} + \alpha S - 2\alpha S - 2\alpha^2 cS - 2\alpha c\overline{Q} + 2\alpha^2 cS > 0$

$\overline{Q} - \alpha S > 0$

Effect of $\overline{Q}$:

$$\frac{dP}{d\overline{Q}} = \frac{1}{\alpha} - \frac{1}{2\alpha+2\alpha^2 c}$$

To see if the effect is bigger in the first or second model, the derivatives are equated:

$$\frac{1}{\alpha} - \frac{1}{2\alpha+2\alpha^2 c} > \frac{c}{1+\alpha c}$$

$$\frac{1}{\alpha} * \frac{2+2\alpha c}{2+2\alpha c} - \frac{1}{2\alpha+2\alpha^2 c} > \frac{c}{1+\alpha c} * \frac{2\alpha}{2\alpha}$$

$$\frac{2+2\alpha c}{2\alpha+2\alpha^2 c} - \frac{1}{2\alpha+2\alpha^2 c} > \frac{2\alpha c}{2\alpha+2\alpha^2 c}$$

$$2 + 2\alpha c - 1 - 2\alpha c > 0$$

$$1 > 0$$

Effect of S:

$$\frac{dP}{dS} = \frac{\alpha}{2\alpha+2\alpha^2 c}$$

To see if the effect is bigger in the first or second model, the derivatives are equated:

$$\frac{\alpha}{2\alpha+2\alpha^2 c} = 1 + \frac{-\alpha c}{1+\alpha c}$$

$$\frac{\alpha}{2\alpha+2\alpha^2 c} = 1 * \frac{2\alpha+2\alpha^2 c}{2\alpha+2\alpha^2 c} + \frac{-\alpha c}{1+\alpha c} * \frac{2\alpha}{2\alpha}$$

$$\frac{\alpha}{2\alpha+2\alpha^2 c} = \frac{2\alpha+2\alpha^2 c}{2\alpha+2\alpha^2 c} + \frac{-2\alpha^2 c}{2\alpha+2\alpha^2 c}$$

$$\alpha = 2\alpha + 2\alpha^2 c - 2\alpha^2 c$$

$$\alpha = 2\alpha$$

$$\alpha < 2\alpha$$

Effect of α:

$$\frac{dP}{d\alpha} =- \frac{\overline{Q}}{\alpha^2} - \frac{(2\alpha+2\alpha^2 c)(-S)-(\overline{Q}-\alpha S)(2+4\alpha c)}{(2\alpha+2\alpha^2 c)^2}$$

$$\frac{dP}{d\alpha} =- \frac{\overline{Q}}{\alpha^2} - \frac{-2\alpha S-2\alpha^2 cS-(2\overline{Q}-2\alpha S+4\alpha c\overline{Q}-4\alpha^2 cS)}{4\alpha^2+8\alpha^3 c+4\alpha^4 c^2}$$

$$\frac{dP}{d\alpha} =- \frac{\overline{Q}}{\alpha^2} - \frac{2\alpha^2 cS-2\overline{Q}-4\alpha c\overline{Q}}{4\alpha^2+8\alpha^3 c+4\alpha^4 c^2}$$

$$\frac{dP}{d\alpha} =- \frac{\overline{Q}}{\alpha^2} - \frac{\alpha^2 cS-\overline{Q}-2\alpha c\overline{Q}}{2\alpha^2+84c+2\alpha^4 c^2}$$

$$- \frac{\overline{Q}}{\alpha^2} * \frac{2+4\alpha c+2\alpha^2 c^2}{2+4\alpha c+2\alpha^2 c^2} - \frac{\alpha^2 cS-\overline{Q}-2\alpha c\overline{Q}}{2\alpha^2+4\alpha^3 c+2\alpha^4 c^2}$$

$$\frac{-2\overline{Q}-4\alpha c\overline{Q}-2\alpha^2 c^2\overline{Q}}{2\alpha^2+4\alpha^3 c+2\alpha^4 c^2} - \frac{\alpha^2 cS-\overline{Q}-2\alpha c\overline{Q}}{2\alpha^2+4\alpha^3 c+2\alpha^4 c^2}$$

$$\frac{-2\overline{Q}-4\alpha c\overline{Q}-2\alpha^2 c^2\overline{Q}-\alpha^2 cS+\overline{Q}+2\alpha c\overline{Q}}{2\alpha^2+4\alpha^3 c+2\alpha^4 c^2}$$

$$\frac{-\overline{Q}-2\alpha c\overline{Q}-2\alpha^2 c^2\overline{Q}-\alpha^2 cS}{2\alpha^2+4\alpha^3 c+2\alpha^4 c^2} < 0$$

It is not clear if this effect is bigger in model 1 or model 2. Thus, both derivatives are equated:

$$\frac{-\overline{Q}-2\alpha c\overline{Q}-2\alpha^2c^2\overline{Q}-\alpha^2cS}{2\alpha^2+4\alpha^3c+2\alpha^4c^2} < \frac{-cS-c^2\overline{Q}}{(1+\alpha c)^2}$$

$$\frac{-\overline{Q}-2\alpha c\overline{Q}-2\alpha^2c^2\overline{Q}-\alpha^2cS}{2\alpha^2+4\alpha^3c+2\alpha^4c^2} < \frac{-cS-c^2\overline{Q}}{1+2\alpha c+\alpha^2} * \frac{2\alpha^2}{2\alpha^2}$$

$$\frac{-\overline{Q}-2\alpha c\overline{Q}-2\alpha^2c^2\overline{Q}-\alpha^2cS}{2\alpha^2+4\alpha^3c+2\alpha^4c^2} < \frac{-2\alpha^2cS-2\alpha^2c^2\overline{Q}}{2\alpha^2+4\alpha^3c+2\alpha^4c^2}$$

$$-\overline{Q} - 2\alpha c\overline{Q} - 2\alpha^2c^2\overline{Q} - \alpha^2cS < -2\alpha^2cS - 2\alpha^2c^2\overline{Q}$$

$$-\overline{Q} - 2\alpha c\overline{Q} < -\alpha^2cS$$

$$-\overline{Q} - 2\alpha c\overline{Q} + \alpha^2cS < 0$$

$$-\overline{Q} - \alpha c\overline{Q} - \alpha c(\overline{Q} - \alpha S) < 0$$

Effect of c:

$$P = \frac{\overline{Q}}{\alpha} - \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2c}$$

$$P = \frac{\overline{Q}}{\alpha} - (\overline{Q} - \alpha S)(2\alpha + 2\alpha^2c)^{-1}$$

$$\frac{dP}{dc} = -(\overline{Q} - \alpha S) * -1(2\alpha + 2\alpha^2c)^{-2} * 2\alpha^2$$

$$\frac{dP}{dc} = \frac{(\overline{Q}-\alpha S)2\alpha^2}{(2\alpha+2\alpha^2c)^2}$$

$$\frac{dP}{dc} = \frac{2\alpha^2\overline{Q}-2\alpha^3S}{4\alpha^2+8\alpha^3c+4\alpha^4c^2}$$

$$\frac{dP}{dc} = \frac{\overline{Q}-\alpha S}{2+4\alpha c+2\alpha^2c^2}$$

Appendix C

Calculations of the third model: perfect competition with altruism

Standard functions:

$Q = \overline{Q} - \alpha P$

$Q = N$

$W = S + cN$

$\pi = PQ - WN$

$\pi = PQ - (S + cN)N$

$\pi = PQ - SN - cN^2$

$U_p = \pi + \gamma U_a N$

$U_p = PQ - SN - cN^2 + \gamma U_a N$

$U_p = PN - SN - cN^2 + \gamma U_a N$

$U_p = 0\ gives$:

$U_p = PN - SN - cN^2 + \gamma U_a N = 0$

$PN = SN + cN^2 - \gamma U_a N$

$P = S + cN - \gamma U_a$

$P = W - \gamma U_a$

$Q = N$ gives:

$P = S + cQ - \gamma U_a$

A different calculation of P:

$\alpha P = - Q + \overline{Q}$

$P = \frac{\overline{Q} - Q}{\alpha}$

$P = \frac{1}{\alpha}\overline{Q} - \frac{1}{\alpha}Q$

To calculate the equilibrium price, these two P functions are equated:

$S + cQ - \gamma U_a = \frac{\overline{Q} - Q}{\alpha}$

$S + cQ - \gamma U_a = \frac{\overline{Q}}{\alpha} - \frac{Q}{\alpha}$

$cQ + \frac{Q}{\alpha} = \frac{\overline{Q}}{\alpha} + \gamma U_a - S$

$\alpha cQ + Q = \overline{Q} + \alpha\gamma U_a - \alpha S$

$Q(1 + \alpha c) = \overline{Q} + \alpha\gamma U_a - \alpha S$

$Q = \frac{\overline{Q}+\alpha\gamma U_a - \alpha S}{1+\alpha c}$

$N = \frac{\overline{Q}+\alpha\gamma U_a - \alpha S}{1+\alpha c}$

Effect of $\overline{Q}$:

$\frac{dQ}{d\overline{Q}} = \frac{1}{1+\alpha c}$

Effect of S:

$\frac{dQ}{dS} = \frac{-\alpha}{1+\alpha c}$

Effect of α:

$\frac{dQ}{d\alpha} = \frac{(1+\alpha c)(\gamma U_a - S) - (\overline{Q}+\alpha\gamma U_a - \alpha S)c}{(1+\alpha c)^2}$

$\frac{dQ}{d\alpha} = \frac{\gamma U_a + \gamma U_a \alpha c - S - \alpha c S - (c\overline{Q} + \alpha\gamma U_a c - \alpha c S}{(1+\alpha c)^2}$

$\frac{dQ}{d\alpha} = \frac{\gamma U_a - S - c\overline{Q}}{(1+\alpha c)^2}$

$\frac{\gamma U_a - S - c\overline{Q}}{(1+\alpha c)^2} > \frac{-S - c\overline{Q}}{(1+\alpha c)^2}$

We know that in this model the utility of the employees exists only out of wage. So the wage function can be substituted into the numerator.

$\gamma U_a - S - c\overline{Q}$

$\gamma(S + cQ) - S - c\overline{Q}$

$\gamma S - S + \gamma c Q - c\overline{Q} < 0$

Effect of c:

$Q = (\overline{Q} + \alpha\gamma U_a - \alpha S)(1 + \alpha c)^{-1}$

$\frac{dQ}{d\alpha} =- 1(\overline{Q} + \alpha\gamma U_a - \alpha S)(1 + \alpha c)^{-2}\alpha$

$\frac{dQ}{d\alpha} = \frac{-\overline{Q}\alpha - \alpha^2\gamma U_a + \alpha^2 S}{(1+\alpha c)^2}$

$-\overline{Q}\alpha - \alpha^2\gamma U_a + \alpha^2 S$

$\alpha(-\overline{Q} - \alpha\gamma U_a + \alpha S)$

$\alpha(-(\overline{Q} - \alpha S) - \alpha\gamma U_a) < 0$

Effect of γ:

$\frac{dQ}{d\gamma} = \frac{\alpha U_a}{1+\alpha c}$

Effect of U_a:

$\frac{dQ}{dU_a} = \frac{\alpha\gamma}{1+\alpha c}$

Now W can be calculated, by substituting N:

$W = S + cN$ and $N = \frac{\overline{Q}+\alpha\gamma U_a - \alpha S}{1+\alpha c}$

$W = S + c(\frac{\overline{Q}+\alpha\gamma U_a - \alpha S}{1+\alpha c})$

$W = S + \frac{c\overline{Q}+\alpha c\gamma U_a - \alpha cS}{1+\alpha c}$

Effect of $\overline{Q}$:

$\frac{dW}{d\overline{Q}} = \frac{c}{1+\alpha c}$

Effect of S:

$\frac{dW}{dS} = 1 + \frac{-\alpha c}{1+\alpha c}$

Effect of α:

$\frac{dW}{d\alpha} = \frac{(1+\alpha c)(c\gamma U_a - cS) - (c\overline{Q}+\alpha c\gamma U_a - \alpha cS)c}{(1+\alpha c)^2}$

$\frac{dW}{d\alpha} = \frac{c\gamma U_a + \alpha c^2\gamma U_a - cS - \alpha c^2 S - (c^2\overline{Q}+\alpha c^2\gamma U_a - \alpha c^2 S)}{(1+\alpha c)^2}$

$\frac{dW}{d\alpha} = \frac{c\gamma U_a - cS - c^2\overline{Q}}{(1+\alpha c)^2}$

And the wage function is described as: $W = S + cN$.
This is substituted into the numerator.

$c\gamma(S + cN) - cS - c^2\overline{Q}$

$c\gamma S + c^2\gamma Q - cS - c^2\overline{Q}$

$\gamma(cS + c^2 Q) - (cS + c^2\overline{Q})$

$\gamma cS - cS + \gamma c^2 Q - c^2\overline{Q} < 0$

Effect of c:

$\frac{dW}{dc} = \frac{(1+\alpha c)(\overline{Q}+\alpha\gamma U_a - \alpha S) - (c\overline{Q}+\alpha c\gamma U_a - \alpha cS)\alpha}{(1+\alpha c)^2}$

$\frac{dW}{dc} = \frac{\overline{Q}+\alpha\gamma U_a - \alpha S + \alpha c\overline{Q} + \alpha^2 c\gamma U_a - \alpha^2 cS - \alpha c\overline{Q} - \alpha^2 c\gamma U_a + \alpha^2 cS}{(1+\alpha c)^2}$

$\frac{dW}{dc} = \frac{\overline{Q} - \alpha S + \alpha\gamma U_a}{(1+\alpha c)^2}$

Effect of γ:

$\frac{dW}{d\gamma} = \frac{\alpha cU_a}{1+\alpha c}$

Effect of U_a:

$\frac{dW}{dU_a} = \frac{\alpha c\gamma}{1+\alpha c}$

Earlier, it was found that $P = W - \gamma U_a$, so P can also be written as:

$$P = S + \frac{c\bar{Q}+\alpha c\gamma U_a - \alpha cS}{1+\alpha c} - \gamma U_a$$

To see if the price is higher or lower compared to the first model both P functions are equated:

$$S + \frac{c\bar{Q}-\alpha cS}{1+\alpha c} > S + \frac{c\bar{Q}+\alpha c\gamma U_a - \alpha cS}{1+\alpha c} - \gamma U_a$$

$$S * \frac{1+\alpha c}{1+\alpha c} + \frac{c\bar{Q}-\alpha cS}{1+\alpha c} > S * \frac{1+\alpha c}{1+\alpha c} + \frac{c\bar{Q}+\alpha c\gamma U_a - \alpha cS}{1+\alpha c} - \gamma U_a * \frac{1+\alpha c}{1+\alpha c}$$

$$\frac{1S+\alpha cS}{1+\alpha c} + \frac{c\bar{Q}-\alpha cS}{1+\alpha c} > \frac{1S+\alpha cS}{1+\alpha c} + \frac{c\bar{Q}+\alpha c\gamma U_a - \alpha cS}{1+\alpha c} - \frac{\gamma U_a + \alpha c\gamma U_a}{1+\alpha c}$$

$$S + \alpha cS + c\bar{Q} - \alpha cS > S + \alpha cS + c\bar{Q} + \alpha c\gamma U_a - \alpha cS - \gamma U_a - \alpha c\gamma U_a$$

$$0 >- \gamma U_a$$

There is only a difference in the derivatives of γ and U_a compared to Wage function:

The effect of γ:

$$\frac{dP}{d\gamma} = \frac{\alpha c\gamma}{1+\alpha c} - \gamma$$

$$\frac{dP}{d\gamma} = \frac{\alpha cU_a}{1+\alpha c} - \frac{(1+\alpha c)U_a}{1+\alpha c}$$

$$\frac{dP}{d\gamma} = \frac{\alpha cU_a}{1+\alpha c} - \frac{U_a + \alpha cU_a}{1+\alpha c}$$

$$\frac{dP}{d\gamma} = \frac{\alpha cU_a - U_a - \alpha cU_a}{1+\alpha c}$$

$$\frac{dP}{d\gamma} = \frac{-U_a}{1+\alpha c}$$

The effect of U_a:

$$\frac{dP}{dU_a} = \frac{\alpha c\gamma}{1+\alpha c} - \gamma$$

$$\frac{dP}{dU_a} = \frac{\alpha c\gamma}{1+\alpha c} - \frac{(1+\alpha c)\gamma}{1+\alpha c}$$

$$\frac{dP}{dU_a} = \frac{\alpha c\gamma}{1+\alpha c} - \frac{\gamma+\alpha c\gamma}{1+\alpha c}$$

$$\frac{dP}{dU_a} = \frac{\alpha c\gamma-\gamma-\alpha c\gamma}{1+\alpha c}$$

$$\frac{dP}{dU_a} = \frac{-\gamma}{1+\alpha c}$$

That profit will be zero in the situation of perfect competition can be proven in the next steps:

$$TR = PQ + \gamma U_a N$$

Given that $Q = N$, it follows that:

$$TR = PQ + \gamma U_a Q$$

$\frac{dTR}{dQ} = MR = P + \gamma U_a$

$TC = NW$

since $Q = N$, it follows that:
$TC = QW$
$\frac{dTC}{dQ} = MC = W$

So π is at its maximum if $MR = MC$ gives:
$P + \gamma U_a = W$
$P = W - \gamma U_a$

Substituting this into the profit function:
$\pi = (W - \gamma U_a)Q - Q(W - \gamma U_a) = 0$

Appendix D

Calculations of the fourth model: Monopoly and monopsony with altruism
Standard functions:

$Q = \overline{Q} - \alpha P$

$Q = N$

$W = S + cN$

$\pi = PQ - WN$

$\pi = PQ - (S + cN)N$

$\pi = PQ - SN - cN^2$

$U_p = \pi + \gamma U_a N$

$U_p = PQ - SN - cN^2 + \gamma U_a N$

First, we need the price and profit expressed in terms of Q:

$\alpha P = - Q + \overline{Q}$

$P = \frac{\overline{Q} - Q}{\alpha}$

$U_p = PQ - SN - cN^2 + \gamma U_a N$ with $Q = N$ gives:

$U_p = PQ - SQ - cQ^2 + \gamma U_a Q$

Substituting P into the utility function of the principal gives:

$U_p = (\frac{\overline{Q} - Q}{\alpha})Q - SQ - cQ^2 + \gamma U_a Q$

$U_p = \frac{\overline{Q}Q - Q^2}{\alpha} - SQ - cQ^2 + \gamma U_a Q$

$U_p = \frac{1}{\alpha}\overline{Q}Q - \frac{1}{\alpha}Q^2 - SQ - cQ^2 + \gamma U_a Q$

The first order condition gives us:

$\frac{dU_p}{dQ} = \frac{1}{\alpha}\overline{Q} - \frac{2}{\alpha}Q - S - 2cQ + \gamma U_a = 0$

$\frac{2}{\alpha}Q + 2cQ = \frac{1}{\alpha}\overline{Q} + \gamma U_a - S$

$\frac{2}{\alpha}Q + 2cQ = \frac{1}{\alpha}\overline{Q} + \gamma U_a - S$

$Q(\frac{2}{\alpha} + 2c) = \frac{1}{\alpha}\overline{Q} + \gamma U_a - S$

$Q = \frac{\frac{1}{\alpha}\overline{Q} + \gamma U_a - S}{\frac{2}{\alpha} + 2c} * \frac{\alpha}{\alpha}$

$Q = \frac{\overline{Q} + \alpha\gamma U_a - \alpha S}{2 + 2\alpha c}$

$N = \frac{\overline{Q} + \alpha\gamma U_a - \alpha S}{2 + 2\alpha c}$

Effect of $\overline{Q}$:

$\frac{dQ}{d\overline{Q}} = \frac{1}{2+2\alpha c}$

Effect of S:

$\frac{dQ}{dS} = \frac{-\alpha}{2+2\alpha c}$

Effect of α:

$\frac{dQ}{d\alpha} = \frac{(2+2\alpha c)(\gamma U_a - S) - (\overline{Q} + \alpha\gamma U_a - \alpha S)2c}{(2+2\alpha c)^2}$

$\frac{dQ}{d\alpha} = \frac{2\gamma U_a + 2\alpha c\gamma U_a - 2S - 2\alpha cS - 2c\overline{Q} - 2\alpha c\gamma U_a + 2\alpha cS}{(2+2\alpha c)^2}$

$\frac{dQ}{d\alpha} = \frac{2\gamma U_a - 2S - 2c\overline{Q}}{(2+2\alpha c)^2}$

$\frac{dQ}{d\alpha} = \frac{2\gamma U_a - 2S - 2c\overline{Q}}{4+8\alpha c+4\alpha^2 c^2}$

$\frac{dQ}{d\alpha} = \frac{\gamma U_a - S - c\overline{Q}}{2+4\alpha c+2\alpha^2 c^2}$

$\gamma U_a - S - c\overline{Q}$

$\gamma(S + cQ) - S - c\overline{Q}$

$\gamma S - S + \gamma cQ - c\overline{Q} < 0$

Effect of c:

$(\overline{Q} + \alpha\gamma U_a - \alpha S)(2 + 2\alpha c)^{-1}$

$\frac{dQ}{dc} =- 1(\overline{Q} + \alpha\gamma U_a - \alpha S)(2 + 2\alpha c)^{-2} * 2\alpha$

$\frac{dQ}{dc} = \frac{-2\alpha(\overline{Q} + \alpha\gamma U_a - \alpha S)}{(2+2\alpha c)^2}$

$\frac{dQ}{dc} = \frac{-2\alpha\overline{Q} - 2\alpha^2\gamma U_a + 2\alpha^2 S}{(2+2\alpha c)^2}$

$\frac{dQ}{dc} = \frac{-2\alpha\overline{Q} - 2\alpha^2\gamma U_a + 2\alpha^2 S}{4+8\alpha c+4\alpha^2 c^2}$

$\frac{dQ}{dc} = \frac{\alpha^2 S - \alpha\overline{Q} - \alpha^2\gamma U_a}{2+4\alpha c+2\alpha^2 c^2}$

In order to see the sign, the numerator is described differently:

$\alpha^2 S - \alpha\overline{Q} - \alpha^2\gamma U_a$

$- \alpha^2(\frac{1}{\alpha}\overline{Q} - S + \gamma U_a) < 0$

Effect of γ:

$\frac{dQ}{d\gamma} = \frac{\alpha U_a}{2+2\alpha c}$

Effect of U_a:

$\frac{dQ}{dU_a} = \frac{\alpha\gamma}{2+2\alpha c}$

Now that we know Q and N, we can determine the wage by substituting N into the wage function:

$W = S + cN$

$W = S + c(\frac{\overline{Q}+\alpha\gamma U_a-\alpha S}{2+2\alpha c})$

$W = S + \frac{c\overline{Q}+\alpha c\gamma U_a-\alpha cS}{2+2\alpha c}$

Effect of $\overline{Q}$:

$\frac{dW}{d\overline{Q}} = \frac{c}{2+2\alpha c}$

Effect of S:

$\frac{dW}{dS} = 1 + \frac{-\alpha c}{2+2\alpha c}$

Effect of α:

$\frac{dW}{d\alpha} = \frac{(2+2\alpha c)(c\gamma U_a-cS)-(c\overline{Q}+\alpha c\gamma U_a-\alpha cS)2c}{(2+2\alpha c)^2}$

$\frac{dW}{d\alpha} = \frac{2c\gamma U_a+2\alpha c^2\gamma U_a-2cS-2\alpha c^2S-2c^2\overline{Q}-2\alpha c^2\gamma U_a+2\alpha c^2S}{(2+2\alpha c)^2}$

$\frac{dW}{d\alpha} = \frac{2c\gamma U_a-2cS-2c^2\overline{Q}}{(2+2\alpha c)^2}$

$\frac{dW}{d\alpha} = \frac{2c\gamma U_a-2cS-2c^2\overline{Q}}{4+8\alpha c+4\alpha^2c^2}$

$\frac{dW}{d\alpha} = \frac{c\gamma U_a-cS-c^2\overline{Q}}{2+4\alpha c+2\alpha^2c^2}$

To determine the sign of the effect the wage function is substituted into the formula and the numerator is written down in a different way:

$c\gamma U_a - cS - c^2\overline{Q}$

$c\gamma(S + cQ) - cS - c^2\overline{Q}$

$\gamma cS - cS + \gamma c^2Q - c^2\overline{Q} < 0$

Effect of c:

$\frac{dW}{dc} = \frac{(2+2\alpha c)(\overline{Q}+\alpha\gamma U_a-\alpha S)-(c\overline{Q}+\alpha c\gamma U_a-\alpha cS)2\alpha}{(2+2\alpha c)^2}$

$\frac{dW}{dc} = \frac{2\overline{Q}+2\alpha c\overline{Q}+2\alpha\gamma U_a+2\alpha^2c\gamma U_a-2\alpha S-2\alpha^2cS-2\alpha c\overline{Q}-2\alpha^2c\gamma U_a-2\alpha^2cS}{(2+2\alpha c)^2}$

$\frac{dW}{dc} = \frac{2\overline{Q}+2\alpha\gamma U_a-2\alpha S}{(2+2\alpha c)^2}$

$\frac{dW}{dc} = \frac{2\overline{Q}+2\alpha\gamma U_a-2\alpha S}{4+8\alpha c+4\alpha^2c^2}$

$\frac{dW}{dc} = \frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2+4\alpha c+2\alpha^2 c^2}$

Effect of γ:

$\frac{dW}{d\gamma} = \frac{\alpha c U_a}{2+2\alpha c}$

Effect of U_a:

$\frac{dW}{dU_a} = \frac{\alpha c\gamma}{2+2\alpha c}$

In order to make profit, the price should be higher than the wage. So this is tested:

$P > W$

$P = \frac{\bar{Q}}{\alpha} - \frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2\alpha+2\alpha^2 c} > S + \frac{c\bar{Q}+\alpha c\gamma U_a-\alpha c S}{2+2\alpha c}$

$\frac{\bar{Q}}{\alpha} * \frac{2+2\alpha c}{2+2\alpha c} - \frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2\alpha+2\alpha^2 c} > S * \frac{2\alpha+2\alpha^2 c}{2\alpha+2\alpha^2 c} + \frac{c\bar{Q}+\alpha c\gamma U_a-\alpha c S}{2+2\alpha c} * \frac{\alpha}{\alpha}$

$\frac{2\bar{Q}+2\alpha c\bar{Q}}{2\alpha+2\alpha^2 c} - \frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2\alpha+2\alpha^2 c} > \frac{2\alpha S+2\alpha^2 cS}{2\alpha+2\alpha^2 c} + \frac{\alpha c\bar{Q}+\alpha^2 c\gamma U_a-\alpha^2 cS}{2\alpha+2\alpha^2 c}$

$\frac{2\bar{Q}+2\alpha c\bar{Q}}{2\alpha+2\alpha^2 c} - \frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2\alpha+2\alpha^2 c} > \frac{2\alpha S+2\alpha^2 cS}{2\alpha+2\alpha^2 c} + \frac{\alpha c\bar{Q}+\alpha^2 c\gamma U_a-\alpha^2 cS}{2\alpha+2\alpha^2 c}$

$2\bar{Q} + 2\alpha c\bar{Q} - \bar{Q} + \alpha\gamma U_a + \alpha S > 2\alpha S + 2\alpha^2 cS + \alpha c\bar{Q} + \alpha^2 c\gamma U_a - \alpha^2 cS$

$2\bar{Q} + 2\alpha c\bar{Q} - \bar{Q} + \alpha\gamma U_a + \alpha S - 2\alpha S - 2\alpha^2 cS - \alpha c\bar{Q} + \alpha^2 c\gamma U_a + \alpha^2 cS > 0$

$\bar{Q} + \alpha c\bar{Q} + \alpha\gamma U_a - \alpha S - \alpha^2 cS + \alpha^2 c\gamma U_a > 0$

$\bar{Q} - \alpha S + \alpha\gamma U_a + \alpha c(\bar{Q} - \alpha S + \alpha\gamma U_a) > 0$

$(\bar{Q} - \alpha S + \alpha\gamma U_a)(1 + \alpha c) > 0$

Another way of describing P is as follows:

$P = \frac{\bar{Q}}{\alpha} - \frac{Q}{\alpha}$ with $Q = \frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2+2\alpha c}$

$P = \frac{\bar{Q}}{\alpha} - \frac{\frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2+2\alpha c}}{\alpha}$

$P = \frac{\bar{Q}}{\alpha} - \frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2\alpha+2\alpha^2 c}$

This yields the following criteria:

$\frac{\bar{Q}}{\alpha} - \frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2\alpha+2\alpha^2 c} > 0$

$\frac{\bar{Q}}{\alpha} > \frac{\bar{Q}+\alpha\gamma U_a-\alpha S}{2\alpha+2\alpha^2 c}$

Because the monopolist can choose his own price and the perfect competition employer cannot, it would be logical if the price of the monopolist is higher. This is tested:

$P_{monopoly} > P_{perfect\ competition}$

$\frac{\overline{Q}}{\alpha} - \frac{\overline{Q}+\alpha\gamma U_a - \alpha S}{2\alpha+2\alpha^2 c} > S + \frac{c\overline{Q}+\alpha c\gamma U_a - \alpha cS}{1+\alpha c} - \gamma U_a$

$\frac{\overline{Q}}{\alpha} * \frac{2+2\alpha c}{2+2\alpha c} - \frac{\overline{Q}+\alpha\gamma U_a - \alpha S}{2\alpha+2\alpha^2 c} > S * \frac{2\alpha+2\alpha^2 c}{2\alpha+2\alpha^2 c} + \frac{c\overline{Q} - \alpha cS}{1+\alpha c} * \frac{2\alpha}{2\alpha} - \gamma U_a * \frac{2\alpha+2\alpha^2 c}{2\alpha+2\alpha^2 c}$

$\frac{2\overline{Q}+2\alpha c\overline{Q}}{2\alpha+2\alpha^2 c} - \frac{\overline{Q}+\alpha\gamma U_a - \alpha S}{2\alpha+2\alpha^2 c} > \frac{2\alpha S+2\alpha^2 cS}{2\alpha+2\alpha^2 c} + \frac{2\alpha c\overline{Q} - 2\alpha^2 cS}{2\alpha+2\alpha^2 c} - \frac{2\alpha\gamma U_a + 2\alpha^2 c\gamma U_a}{2\alpha+2\alpha^2 c}$

$2\overline{Q} + 2\alpha c\overline{Q} - \overline{Q} - \alpha\gamma U_a + \alpha S - 2\alpha S - 2\alpha^2 cS - 2\alpha c\overline{Q} - 2\alpha^2 c\gamma U_a + 2\alpha^2 cS + 2\alpha\gamma U_a + 2\alpha^2 c\gamma U_a > 0$

$\overline{Q} - \alpha S + \alpha\gamma U_a > 0$

Effect of $\overline{Q}$:

$\frac{dP}{d\overline{Q}} = \frac{1}{\alpha} - \frac{1}{2\alpha+2\alpha^2 c}$

To discover if the effect is bigger in the third or fourth model, the effects are equated:

$\frac{1}{\alpha} - \frac{1}{2\alpha+2\alpha^2 c} > \frac{c}{1+\alpha c}$

$\frac{1}{\alpha} * \frac{2+2\alpha c}{2+2\alpha c} - \frac{1}{2\alpha+2\alpha^2 c} > \frac{c}{1+\alpha c} * \frac{2\alpha}{2\alpha}$

$\frac{2+2\alpha c}{2\alpha+2\alpha^2 c} - \frac{1}{2\alpha+2\alpha^2 c} > \frac{2\alpha c}{2\alpha+2\alpha^2 c}$

$2 + 2\alpha c - 1 > 2\alpha c$

$1 + 2\alpha c > 2\alpha c$

Effect of S:

$\frac{dP}{dS} = \frac{\alpha}{2\alpha+2\alpha^2 c}$

To see which effect is bigger, the third or fourth model effect, both effects are equated:

$\frac{\alpha}{2\alpha+2\alpha^2 c} < 1 + \frac{-\alpha c}{1+\alpha c}$

$\frac{\alpha}{2\alpha+2\alpha^2 c} < 1 * \frac{2\alpha+2\alpha^2 c}{2\alpha+2\alpha^2 c} + \frac{-\alpha c}{1+\alpha c} * \frac{2\alpha}{2\alpha}$

$\frac{\alpha}{2\alpha+2\alpha^2 c} < \frac{2\alpha+2\alpha^2 c}{2\alpha+2\alpha^2 c} + \frac{-2\alpha^2 c}{2\alpha+2\alpha^2 c}$

$\alpha < 2\alpha + 2\alpha^2 c - 2\alpha^2 c$

$\alpha < 2\alpha$

Effect of α:

$\frac{dP}{d\alpha} = -\frac{\overline{Q}}{\alpha^2} - \frac{(2\alpha+2\alpha^2 c)(\gamma U_a - S) - (\overline{Q}+\alpha\gamma U_a - \alpha S)(2+4\alpha c)}{(2\alpha+2\alpha^2 c)^2}$

$\frac{dP}{d\alpha} = -\frac{\overline{Q}}{\alpha^2} - \frac{2\alpha\gamma U_a + 2\alpha^2 c\gamma U_a - 2\alpha S - 2\alpha^2 cS - (2\overline{Q} - 2\alpha\gamma U_a - 2\alpha S + 4\alpha c\overline{Q} + 4\alpha^2 c\gamma U_a - 4\alpha^2 cS)}{4\alpha^2 + 8\alpha^3 c + 4\alpha^4 c^2}$

$\frac{dP}{d\alpha} = -\frac{\overline{Q}}{\alpha^2} - \frac{2\alpha^2 cS - 2\alpha^2 c\gamma U_a - 2\overline{Q} - 4\alpha c\overline{Q}}{4\alpha^2 + 8\alpha^3 c + 4\alpha^4 c^2}$

$\frac{dP}{d\alpha} = -\frac{\overline{Q}}{\alpha^2} - \frac{\alpha^2 cS - \alpha^2 c\gamma U_a - \overline{Q} - 2\alpha c\overline{Q}}{2\alpha^2 + 4\alpha^3 c + 2\alpha^4 c^2}$

$\frac{dP}{d\alpha} = -\frac{\overline{Q}}{\alpha^2} * \frac{2+4\alpha c+2\alpha^2 c^2}{2+4\alpha c+2\alpha^2 c^2} - \frac{\alpha^2 cS - \alpha^2 c\gamma U_a - \overline{Q} - 2\alpha c\overline{Q}}{2\alpha^2 + 4\alpha^3 c + 2\alpha^4 c^2}$

$$\frac{dP}{d\alpha} = \frac{-2\overline{Q}-4\alpha c\overline{Q}-2\alpha^2c^2\overline{Q}}{2\alpha^2+4\alpha^3c+2\alpha^4c^2} - \frac{\alpha^2cS-\alpha^2c\gamma U_a-\overline{Q}-2\alpha c\overline{Q}}{2\alpha^2+4\alpha^3c+2\alpha^4c^2}$$

Now, the utility of the employers is substituted by the wage function, since their utility exists out of their wage:

$$-\overline{Q} - 2\alpha c\overline{Q} - 2\alpha^2c^2\overline{Q} - \alpha^2cS + \alpha^2c\gamma(S + cQ)$$

$$-\overline{Q} - 2\alpha c\overline{Q} - 2\alpha^2c^2\overline{Q} + \alpha^2c^2\gamma Q - \alpha^2cS + \alpha^2c\gamma S$$

We know that $0 < \gamma < 1$, so it will only make a value smaller, never bigger.
And we know that $\overline{Q} > Q$. This means that:

$-2\alpha^2c^2\overline{Q} + \alpha^2c^2\gamma Q < 0$ and $-\alpha^2cS + \alpha^2c\gamma S < 0$

To discover if the effect is bigger or smaller than in the third model, the effects are equated:

$$\frac{-\overline{Q}-2\alpha c\overline{Q}-2\alpha^2c^2\overline{Q}-\alpha^2cS+\alpha^2c\gamma U_a}{2\alpha^2+4\alpha^3c+2\alpha^4c^2} < \frac{c\gamma U_a-cS-c^2\overline{Q}}{1+2\alpha c+\alpha^2c^2}$$

$$\frac{-\overline{Q}-2\alpha c\overline{Q}-2\alpha^2c^2\overline{Q}-\alpha^2cS+\alpha^2c\gamma U_a}{2\alpha^2+4\alpha^3c+2\alpha^4c^2} < \frac{c\gamma U_a-cS-c^2\overline{Q}}{1+2\alpha c+\alpha^2c^2} * \frac{2\alpha^2}{2\alpha^2}$$

$$\frac{-\overline{Q}-2\alpha c\overline{Q}-2\alpha^2c^2\overline{Q}-\alpha^2cS+\alpha^2c\gamma U_a}{2\alpha^2+4\alpha^3c+2\alpha^4c^2} < \frac{2\alpha^2c\gamma U_a-2\alpha^2cS-2\alpha^2c^2\overline{Q}}{2\alpha^2+4\alpha^3c+2\alpha^4c^2}$$

$$-\overline{Q} - 2\alpha c\overline{Q} - 2\alpha^2c^2\overline{Q} - \alpha^2cS + \alpha^2c\gamma U_a < 2\alpha^2c\gamma U_a - 2\alpha^2cS - 2\alpha^2c^2\overline{Q}$$

$$-\overline{Q} - 2\alpha c\overline{Q} + \alpha^2cS - \alpha^2c\gamma U_a < 0$$

$$-\overline{Q} - \alpha c\overline{Q} - \alpha c(\overline{Q} - \alpha S + \alpha\gamma U_a) < 0$$

Effect of c:

$$P = \frac{\overline{Q}}{\alpha} - \frac{\overline{Q}-\alpha S}{2\alpha+2\alpha^2c}$$

$$P = \frac{\overline{Q}}{\alpha} - (\overline{Q} + \alpha\gamma U_a - \alpha S)(2\alpha + 2\alpha^2c)^{-1}$$

$$\frac{dP}{dc} =- (\overline{Q} + \alpha\gamma U_a - \alpha S) *- 1(2\alpha + 2\alpha^2c)^{-2} * 2\alpha^2$$

$$\frac{dP}{dc} = \frac{(\overline{Q}+\alpha\gamma U_a-\alpha S)2\alpha^2}{(2\alpha+2\alpha^2c)^2}$$

$$\frac{dP}{dc} = \frac{2\alpha^2\overline{Q}+2\alpha^3\gamma U_a-2\alpha^3S}{4\alpha^2+8\alpha^3c+4\alpha^4c^2}$$

$$\frac{dP}{dc} = \frac{\overline{Q}+\alpha\gamma U_a-\alpha S}{2+4\alpha c+2\alpha^2c^2}$$

Effect of γ:

$$\frac{dP}{d\gamma} =- \frac{\alpha U_a}{2\alpha+2\alpha^2c}$$

To discover if the effect is bigger or smaller than in model three, the effects are equated:

$$-\frac{\alpha U_a}{2\alpha+2\alpha^2c} > \frac{-U_a}{1+\alpha c}$$

$$-\frac{\alpha U_a}{2\alpha+2\alpha^2 c} > \frac{-U_a}{1+\alpha c} * \frac{2\alpha}{2\alpha}$$
$$-\frac{\alpha U_a}{2\alpha+2\alpha^2 c} > \frac{-2\alpha U_a}{2\alpha+2\alpha^2 c}$$
$$-\ \alpha U_a >-\ 2\alpha U_\alpha$$

Effect of U_a:

$$\frac{dP}{dU_a} =- \frac{\alpha\gamma}{2\alpha+2\alpha^2 c}$$

To discover if the effect is bigger or smaller than in model three, the effects are equated:

$$-\frac{\alpha\gamma}{2\alpha+2\alpha^2 c} > \frac{-\gamma}{1+\alpha c}$$
$$-\frac{\alpha\gamma}{2\alpha+2\alpha^2 c} > \frac{-\gamma}{1+\alpha c} * \frac{2\alpha}{2\alpha}$$
$$-\frac{\alpha\gamma}{2\alpha+2\alpha^2 c} > \frac{-2\alpha\gamma}{2\alpha+2\alpha^2 c}$$
$$-\ \alpha\gamma >-\ 2\alpha\gamma$$