Monopsony and Discrimination Against Women in the Labour Market in an Extended Solowian Model

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Abstract

The purpose of this paper is to study interdependence between economic growth and market structure involving the gender division of labour. It makes a unique contribution to modelling economic mechanisms of economic growth involving gender discrimination against woman due to monopsony in the labour market. The labour market for men and capital goods markets are perfectly competitive. The labour market for women is characterised by monopsony. The profits of firms are endogenously determined and equally distributed among households. I build a model, find a computational procedure to plot the movement of the economy, and conduct a comparative static analysis in some parameters. I also compare the economic performance of the model under perfect competition and monopsony. I conclude that monopsony in the labour market for women lowers national output, national wealth, and utility levels for families in comparison to perfect competition.

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1. Introduction

Economic growth is determined by many factors. For instance, one of most important economic indicators, GDP, is determined by the dynamic interdependence of different types of households, different market structures, and different firms with different technologies. Nevertheless, many studies in the literature of theoretical economics explain GDP growth with a single market (perfect competition), a homogeneous labour population, and a single producer (e.g., Burmeister & Dobell 1970; Zhang 2005). In neoclassical growth theory it is commonly assumed that labour markets are perfectly competitive. Nevertheless, different labour markets are characterised by different structures, such as monopolistic competition, oligopoly and perfect competition (e.g., Nikaido, 1975; Mas-Colell, Whinston & Green, 1995). For instance, racial and gender discrimination exist in different institutional forms and market structures (e.g., Bar & Leukhina, 2011; Behrens & Murata, 2017). It should be emphasized that empirical studies in the literature on economic growth are concerned with interactions between heterogeneous households, different market structures, heterogenous firms and different technologies. Mainstream growth theory is generally behind empirical studies with regard to studying the interdependence between various economic forces. The purpose of this paper is to contribute to growth theory by studying the interdependence between economic growth and market structure with the gender division of labour. It makes a unique contribution to modelling mechanisms of economic growth by integrating neoclassical growth theory and monopsony theory within a comprehensive analytical framework.

In *The Economic Approach to Human Behavior*, Becker (1976) provides a unified framework for understanding human behaviour, including social interactions, crime and punishment, marriage, fertility, family, and different forms of discrimination. Before Becker's seminal works, many of these problems were once considered fields of research fields for the sociologist, the anthropologist and the historian. Becker attempts to provide a unification of the social sciences with his analytical approach. Economic rationality in gender issues has been treated in formal and rigorous theories since Becker (1965) published his seminal work (see also, Chiappori, 1992; Gomme, Kydland & Rupert, 2001; Campbell & Ludvigson, 2001; Vendrik, 2003). One major problem with Becker's approach and other studies in the literature is that the analyses are often conducted within partial analytical frameworks. Influenced by Becker's approach, I attempt to integrate the theory of discrimination against woman due to monopsony in the labour market with neoclassical growth theory within a general equilibrium framework. I provide some theoretical insights into economic mechanisms for the entry of women into the labour market and the resulting impact on economic growth. Some empirical studies in economics examine discrimination against woman in labour markets with monopsony (e.g., Hirsch & Schumacher, 1995; Hirsch, Schank & Schnabel, 2010; Ransom & Oaxaca, 2010; Webber, 2016). These studies show that monopsony is an important determinant for explaining gender wage gaps. But in the economic growth literature there are only a few formal economic models of interdependence between economic development and discrimination in labour markets. This paper initiates a formal approach to the interdependence between discrimination against woman and monopsony, the gender distribution of time and growth.

Monopsony implies a market in which there is only a single purchaser. Labour market monopsony exists when firms can exercise power over their labour supply. A common example is a company that requires specific skills which no other companies require. A large company located in a remote town may be the main employer, and this empowers the company to set wages as the workers are powerless in bargaining for better wages or working conditions. The explanation of gender discrimination against woman using monopsony was initiated by Joan Robinson in The *Economics of Imperfect Competition* published in 1933 (Robinson, 1933; see also Thornton, 2004). Monopsony theory is applied to different issues in different markets (e.g., Hirsch & Schumacher, 1995; Boal & Ransom, 1997; Atkinson & Kerkvliet, 1989; Bhaskar, Manning & To, 2002, Manning, 2003, 2010; Ashenfelter, Farber & Ransom, 2010; Muehlemann, Ryan & Wolter, 2013; and Bachmann & Frings, 2017). As far as I am aware, this paper is the first application of monopsony theory to discrimination against woman in neoclassical growth theory via capital accumulation and the gender division of labour. This paper builds a one-sector gender-based growth model using monopsony in the labour market. The model is developed within the framework of neoclassical growth theory (e.g., Solow, 1956; Azariadis, 1993; Zhang, 2008). The paper introduces monopsony to neoclassical growth theory using Zhang's concept of disposable income and utility function. As far as modelling the gender division of labour and growth is concerned, this study is based on Zhang (2012).

The rest of the paper is organized as follows. Section 2 develops the gender-based growth model with monopsony in the labour market. Section 3 examines the dynamic properties of the model and identifies the equilibrium of the national economy. Section 4 carries out a comparative static analysis. Section 5 compares the economic performances of the model under perfect competition and under monopsony. Section 6 concludes the study.

2. The Growth Model with Monopsony in the Labour Market

This section introduces monopsony to the Solow neoclassical gender-based growth model with Zhang's concept of disposable income and a utility function. Most aspects of the model are constructed within the Solow growth model, except for modelling the behaviour of the family and monopsony. The population is classified into men and women. Family is composed of husband and wife. Each gender has a population, $\bar{N}$. An aggregated utility function for family is applied to describe household behaviour. Women are subject to discrimination in the labour market due to monopsony. The labour market for men is perfectly competitive, while for women it is a monopsony. Let subscripts $j = 1$ and $j = 2$ denote, respectively, men and women. Following the Solow model, I consider that there is only one sector which produces capital goods for consumption and investment. Capital is depreciated at a fixed rate δ_k ($0< \delta_k <1$). Assets of the economy are owned by families. Saving is done solely by families. Input factors are fully employed. We measure all prices in terms of capital goods whose price is unity. The wage rate of a worker of gender j and the rate of interest are represented by $w_j(t)$ and $r(t)$respectively. Let $T_j(t)$ stand for the working time for gender j. The total capital stock of the economy is $K(t)$. We use h_j for the fixed human capital of gender j. Total labour supply $N(t)$ is the sum of the labour supply from men and women:

$$N(t) = h_1 T_1(t)\bar{N}_1 + h_2 T_2(t)\bar{N}_1. \tag{1}$$

Current income and disposable income

I apply the approach to the behaviour of households proposed by Zhang (1993, 2005). We use $\bar{k}_t$ to stand for the wealth held by the family. This implies: $\bar{k}(t) = K(t)/\bar{N}$. The total profit of the production sector $\pi(t)$ is distributed equally between families. Each family's share of the profit is $\pi(t)/\bar{N}$. The family's current income is the sum of the interest payment $r(t)\bar{k}(t)$, the profit share $\pi(t)/\bar{N}$, and the wage incomes $h_j T_j(t) w_j(t)$ as:

$$y(t) = r(t)\bar{k}(t) + h_1 T_1(t) w_1(t) + h_2 T_2(t) w_2(t) + \frac{\pi(t)}{\bar{N}}. \tag{2}$$

Disposable income is defined as the sum of the current income $y(t)$ and the value of wealth $\bar{k}$(t):

$$\hat{y}(t) = y(t) + \bar{k}(t). \tag{3}$$

Budget and the family's utility function

The family's disposable income is used in savings $s(t)$ and consumption $c(t)$. The budget constraint is:

$$c(t) + s(t) = \hat{y}(t) = (1 + r(t))\bar{k}(t) + h_2 T_2(t) w_2(t) + \frac{\pi(t)}{\bar{N}}, \tag{4}$$

where we also use (3) and (2). Let T_0 stand for the total available time of each person and $\bar{T}_j(t)$ for the leisure time of gender j. We have:

$$T_j(t) + \bar{T}_j(t) = T_0. \tag{5}$$

Inserting (5) in (4) yields

$$h_1 \bar{T}_1(t) \mathrm{w}_1(t) + h_2 \bar{T}_2(t) \mathrm{w}_2(t) + c(t) + s(t) = \bar{y}(t) \equiv \mathrm{R(t)} + \frac{\pi(t)}{\bar{N}} + h_2 T_0 w_2(t), \tag{6}$$

where

$$\mathrm{R(t)} \equiv (1 + r(t))\bar{k}(t) + h_1 T_0 w_1(t).$$

The family's utility function $U(t)$ is related to the members' leisure hours $\bar{T}_j(t)$ the family's consumption of goods $c(t)$, and the family's savings $s(t)$ as follows:

$$\mathrm{U(t)} = \bar{T}_1^{\sigma_{10}}(t)\bar{T}_2^{\sigma_{20}}(t)\mathrm{c}^{\xi_0}(t)\mathrm{s}^{\xi_0}(t), \quad \sigma_{j0}, \xi_0, \lambda_0 > 0,$$

where σ_{j0} is gender j's propensity to use leisure time, ξ_0 is the family's propensity to consume goods, and λ_0 is the family's propensity to save. This study takes the propensities as fixed.

Optimal household behaviour

Maximizing the utility subject to (6), I get the following marginal conditions:

$$h_j\bar{T}_j(t)w_j(t) = \sigma_j\bar{y}(t),\ c(t) = \xi\bar{y}(t),\ s(t) = \lambda\bar{y}(t), \tag{7}$$

where

$$\sigma_j \equiv \sigma_{j0}\rho,\ \xi \equiv \xi_0\rho,\ \lambda \equiv \lambda_0\rho,\ \ \rho \equiv \frac{1}{\sigma_{10} + \sigma_{10} + \xi_0 + \lambda_0}.$$

Wealth accumulation

According to the definition of $s(t)$, the change in the family's wealth is expressed as:

$$\dot{\bar{k}}(t) = s(t) - \bar{k}(t). \tag{8}$$

This equation states that the change in wealth is savings minus dissaving.

Production sector

The production function $F(t)$ is taken on using the following Cobb-Douglas form:

$$F(t) = AK^{\alpha}(t)N^{\beta}(t),\ \alpha,\beta > 0,\ \alpha + \beta = 1, \tag{9}$$

where A, α and β are positive parameters. For simplicity, the production function is assumed to be constant returns to scale. From Appendix 1, it can be seen that condition $\alpha + \beta = 1$ can be relaxed. Perfect competition in the labour market for men implies that $w_1(t)$ is a given for each firm in the industry. Each firm takes men's wages as a given and decides on women's wage rate. From (7) and (6) we have:

$$w_2(t) = \frac{\sigma_2(R(t) + \pi(t)/\bar{N})}{(\tilde{\sigma} - T_2(t))h_2}, \tag{10}$$

where $\tilde{\sigma} \equiv (1 - \sigma_2)T_0$. The profit is now expressed as:

$$\pi(t) = F(t) - R_\delta(t)K(t) - w_1(t)h_1T_1(t)\bar{N} - w_2(t)h_2T_2(t)\bar{N}. \tag{11}$$

where $R_\delta(t) \equiv r(t) + \delta_k$. Inserting (10) in (11) yields

$$\pi(t) = F(t) - R_\delta(t)K(t) - w_1(t)h_1T_1(t)\bar{N}_1 - \frac{\sigma_2\bar{N}T_2(t)(R(t) + \pi(t)/\bar{N})}{\tilde{\sigma} - T_2(t)} \tag{12}$$

Equation (12) is rewritten as:

$$\pi(t) = F(t) - R_\delta(t)K(t) - w_1(t)h_1T_1(t)\bar{N})\hat{T}(t) - \frac{\bar{\sigma}T_2(t)(R(t)}{T_0 - T_2(t)} \tag{13}$$

where

$$\bar{\sigma} \equiv \frac{\sigma_2 \bar{N}}{1 - \sigma_2}, \quad T(t) \equiv \frac{\tilde{\sigma} - T_2(t)}{(T_0 - T_2(t))(1 - \sigma_2)}$$

The first-order conditions for maximizing the profit imply:

$$\frac{\delta\pi(t)}{\delta K(t)} = \frac{\alpha F(t)}{K(t)} - R_\delta(t) = 0,$$

$$\frac{\delta\pi(t)}{\delta T_1(t)} = \frac{\beta h_1 \bar{N} F(t) \hat{T}(t)}{N(t)} - w_1(t) h_1 \bar{N} \hat{T}(t) = 0,$$

$$\frac{\delta\pi(t)}{\delta T_2(t)} = \frac{\beta h_2 \bar{N} F(t) \hat{T}(t)}{N(t)} - \frac{(F(t) - R\delta(t)K(t) - w_1(t) h_1 t_1(t) \bar{N}) \sigma_2 T0}{(1 - \delta_2)\,(T_0 - T_2(t))^2} - \frac{\sigma\, T_0 R(t)}{(T_0 - T_2(t))^2} = 0. \tag{14}$$

As demonstrated in Appendix 1, the profit satisfying the first-order conditions is positive:

$$\pi(t) = w_1(t) h_2 T_2(t) \bar{N}) \hat{T}(t) - \frac{\bar{\sigma}\, T_2(t)(R(t)}{T_0 - T_2(t)} > 0, \tag{15}$$

in which we use (13), (14) and (1).

Demand and supply of goods

The equilibrium condition that the output of the production sector is equal to the depreciation of capital stock and net savings implies:

$$C(t) + S(t) - K(t) + \delta k K(t) = F(t),$$

where

$$S(t) = s(t)\bar{N}, \quad C(t) = c(t)\bar{N}.$$

The national wealth is owned privately

$$K(t) = \bar{k}(t)\bar{N}. \tag{16}$$

The model is completed. It is structurally general. Some well-known models in economics can be treated as its special cases. For instance, if there is no gender and no monopsony, the model is structurally similar to the Solow model. Endogenous labour supply and gender division of labour are highly influenced by Becker's approach. It is a Walrasian general equilibrium model. As far as I am aware, the model is the first gender-based neoclassical growth model with gender discrimination due to monopsony.

3. Properties of the Economic System

First, we show some properties of the dynamic system. The following Lemma gives a computational procedure for calculating the variables. A variable $z(t)$ is defined as:

$$z(t) \equiv \frac{\mathrm{r}(t) + \delta_k}{w_1(t)}$$

Lemma

The motion of $z(t)$ is given by the following differential equation:

$$\dot{z}(t) = \Lambda(z(t)), \tag{17}$$

in which $\Lambda(t)$ is a function of defined in Appendix 1. The other variables are given as functions of indicated in Appendix 1 as follows: $r(t)$ by (A2) → $w_1(t)$ by (A3) → $\bar{k}(t)$ by (A15) → $T_2(t)$ by (A9) → $\bar{T}_2(t)$ by (5) → $\pi(t)$ by (A10) → $w_2(t)$ by (A11) → $\bar{y}(t)$ by (A12) → $\bar{T}_1(t)$, $c(t)$, and by (7) → $T_1(t)$ by (5) → $N(t)$ by (1) → $K(t)$ by (17) → $F(t)$ by (A5) → $U(t)$ according to the definitions.

The Lemma gives a computational procedure for calibrating the dynamic system. Because of analytical difficulty, the rest of the paper is concerned with equilibrium. To simulate the model, the parameters are taken on the following values:

$$A = 1.3,\ \alpha = 0.34,\ \bar{N} = 50,\ h_1 = 1.4,\ h_2 = 1.3,\ T_0 = 24,$$
$$\delta_k = 0.05, \lambda_0 = 0.8, \xi_0 = 0.12, \xi_{10} = 0.2, \xi_{20} = 0.21. \tag{18}$$

The population is 50. The choice of population size is not important as the main purpose is to provide some insights into economic mechanisms of the system and to conduct comparative static analysis. The total factor productivity is 1.3. The parameter α in the Cobb-Douglas production takes 0.34. In empirical studies the value is often taken on 1/3 (e.g., Miles & Scott, 2005; Abel, Bernanke &Croushore, 2007). The depreciation rate of physical capital is fixed at0.05. Under (18) the system has an equilibrium point given as follows:

$$F = 2152.4,\ K = 10761.8,\ N = 631.3,\ r = 0.018,\ \pi = 36.9,\ w_1 = 2.25,\ w_2 = 2,$$
$$W_1 = 21.8,\ W_2 = 5.87,\ \bar{k} = 215.2,\ c = 32.3,\ T_1 = 692,\ T_2 = 2.26. \tag{19}$$

In (19) is gender total wage income brought to the family. That is

$$W_j(t) \equiv w_j(t) h_j T_j(t).$$

The profit is positive due to monopsony. The wage rate for women is lower than that for men. The monopsony in the female labour market reduces the wage rate for women. Men work much longer than women. Women bring much less income to the family than men.

4. Comparative Statics Analysis

The previous section confirmed the existence of an equilibrium point in the national economy with perfect competition in capital, the male labour market, and goods markets and with monopsony in the labour market for women. It is shown that monopsony makes women's wage rate lower than men's wage rate. It is important to examine how the economic conditions for women are affected when some conditions such as preferences and technologies are changed. I use $\bar{\Delta} x$ to express the change rate of variable x as a percentage due to changes in the value of a parameter.

4.1. Women's Human Capital Enhanced

I first study the changes in the economic system when women's human capital is enhanced as follows: h_2: 1.3 → 1.35. The effects on the variables are listed in (20). A wife spends more hours in the labour market and brings more wage income to the family. The profit of the sector is augmented. The husband spends more time at home and earns less income. The family has more wealth and consumes more. The rate of interest is not affected. The national income, national capital and national labour supply are increased. We conclude that an improvement in women's human capital increases firms' profits and enables men to spend more time at home when the women's labour market is characterised as a monopsony.

$$\bar{\Delta} F = 1.23, \bar{\Delta} K = 1.23, \bar{\Delta} N = 1.23, \bar{\Delta} r = 0, \bar{\Delta} F = 1.23, \bar{\Delta} \pi = 28, \bar{\Delta} w_1 = 0, \bar{\Delta} w_2 = -1.39,$$
$$\bar{\Delta} W_1 = -3.04, \bar{\Delta} W_2 = 13.7, \bar{\Delta} \bar{k} = 1.23, \bar{\Delta} c = 1.23, \bar{\Delta} T_1 = -3, \bar{\Delta} T_2 = 11\,. \quad (20)$$

To compare gender differences in changes of human capital, I now examine the changes in the economic system when men's human capital is enhanced as follows: h_1: 1.4 → 1.45. The effects on the variables are listed in (21). The husband works more hours and brings more wage income to the family. The wife works less hours and brings less wage income to the family. The profit of the industry is reduced. The family has more wealth and consumes more. The rate of interest is not affected. The national income, national capital and national labour supply are increased. We see that the difference between men's and women's human capital is that an improvement in men's human capital reduces profits, while an improvement in women's increases profits. As the husband works more hours due to his increased human capital, the wife spends more hours at home, resulting in a reduction in profit.

$$\bar{\Delta} F = \bar{\Delta} K = \bar{\Delta} N = 2.44, \bar{\Delta} r = 0, \bar{\Delta} \pi = -20, \bar{\Delta} w_1 = 0, \bar{\Delta} w_2 = -1.32,$$
$$\bar{\Delta} W_1 = 6.37, \bar{\Delta} W_2 = -9.4, \bar{\Delta} \bar{k} = \bar{\Delta} c = 2.44, \bar{\Delta} T_1 = 2.7, \bar{\Delta} T_2 = -10.6\,. \quad (21)$$

4.2. Women's Propensity to use Leisure Time is Increased

I now study what happens to the economic system when the women's propensity to stay at home is enhanced as follows: σ_{20}: 0.21 → 0.22. The effects on the variables are listed in (22). The wife spends more hours on leisure at home and brings less wage income to the family. The husband works more hours and brings more wage income to the home. The profit in industry is reduced. The family has less wealth and consumes less. The rate of interest is not affected. The national income, national capital and national labour supply are decreased. A rise in women's propensity to stay at home reduces firms' profits and makes men work more hours in the labour market.

$$\bar{\Delta} F = \bar{\Delta} K = \bar{\Delta} N = -1.2,\ \bar{\Delta} r = 0,\ \bar{\Delta} \pi = -27.8,\ \bar{\Delta} w_1 = 0,\ \bar{\Delta} w_2 = 1.85,$$
$$\bar{\Delta} W_1 = 3.04,\ \bar{\Delta} W_2 = -13.8,\ \bar{\Delta} k = \bar{\Delta} c = -1.23,\ \bar{\Delta} T_1 = 3.04,\ \bar{\Delta} T_2 = -15.3. \tag{22}$$

With regards to the impact of the following change in man's propensity to stay: σ_{10}: 0.2 → 0.21. The effects on the variables are listed in (22). The husband works stays more hours at home and brings less wage income to the family. The wife works more hours and brings more wage income to the family. The profit of the industry is increased. The family has less wealth and consumes less. The rate of interest is not affected. The national income, national capital and national labour supply are reduced.

$$\bar{\Delta} F = \bar{\Delta} K = \bar{\Delta} N = -2.4,\ \bar{\Delta} r = 0,\ \bar{\Delta} \pi = 21,\ \bar{\Delta} w_1 = 0,\ \bar{\Delta} w_2 = -1.3,$$
$$\bar{\Delta} W_1 = -6.2,\ \bar{\Delta} W_2 = 8.9,\ \bar{\Delta} k = \bar{\Delta} c = -2.4,\ \bar{\Delta} T_1 = -6.2,\ \bar{\Delta} T_2 = 10.4. \tag{23}$$

4.3. The Propensity to Save is Increased

I now study what happens to the economic system when the family's propensity to save is enhanced as follows: λ_0: 0.8 → 0.81. The effects on the variables are listed in (24). Both the wife and husband work more hours in labour markets. They bring more income to the family. The profit in industry is increased. The family has more wealth and consumes more. The rate of interest is reduced. The national income, national capital and national labour supply are increased.

$$\bar{\Delta} F = 0.72,\ \bar{\Delta} K = 1.7,\ \bar{\Delta} N = 0.24,\ \bar{\Delta} r = -3.5,\ \bar{\Delta} \pi = 1.2,\ \bar{\Delta} w_1 = 0.48,\ \bar{\Delta} w_2 = 0.45,$$
$$\bar{\Delta} W_1 = 0.67,\ \bar{\Delta} W_2 = 0.85,\ \bar{\Delta} k = 1.65,\ \bar{\Delta} c = 0.4,\ \bar{\Delta} T_1 = 0.19,\ \bar{\Delta} T_2 = 0.41. \tag{24}$$

With regard to the following change in the total factor productivity: A: 1.3 → 1.35, the results are listed in (25). The time distribution, rate of interest and total labour supply are not affected, while the other variables are proportionally changed. The profit is increased.

$$\bar{\Delta} F = \bar{\Delta} K = \bar{\Delta} \pi = \bar{\Delta} w_1 = \bar{\Delta} w_2 = \bar{\Delta} W_1 = \bar{\Delta} W_2 = \bar{\Delta} k = \bar{\Delta} c = 5.9,$$
$$\bar{\Delta} N = \bar{\Delta} r = \bar{\Delta} T_1 = \bar{\Delta} T_2 = 0. \tag{25}$$

With regard to the following change in the population $\bar{N}$: 50 → 51, the results are listed in (26). The national output, national capital, national labour supply, and total profit are proportionally changed. The remaining variables are not affected.

$$\bar{\Delta} F = \bar{\Delta} K = \bar{\Delta} N = \bar{\Delta} \pi = 2,$$
$$\bar{\Delta} r = \bar{\Delta} w_1 = \bar{\Delta} w_2 = \bar{\Delta} W_1 = \bar{\Delta} W_2 = \bar{\Delta} k = \bar{\Delta} c = \bar{\Delta} T_1 = \bar{\Delta} T_2 = 0. \tag{26}$$

5. Comparing with Perfect Competition

This section compares long-term economic equilibrium according to the model with monopsony and the model with perfect competition. When the system is perfectly competitive, firms take prices as given and the equilibrium condition of demand and supply determines prices. In this case, wage rates for women are determined by perfect competition. Each firm takes the wage rate for women as a given. Appendix 2 studies the growth model when all markets are perfectly competitive. One main difference is that profit is zero in perfect competition – $\pi(t)$ In Appendix 2, a computational program is used to calculate the equilibrium values of the competitive model. The comparative result is listed in (27):

$$\tilde{\Delta}F = \tilde{\Delta}K = \tilde{\Delta}N = -5.1, \tilde{\Delta}r = 0, \tilde{\Delta}w_1 = 0, \tilde{\Delta}w_2 = -12.6, \tilde{\Delta}W_1 = 12.6,$$
$$\tilde{\Delta}W_2 = -84.4, \tilde{\Delta}k = \tilde{\Delta}c = -5.1, \tilde{\Delta}T_1 = 12.6, \tilde{\Delta}T_2 = -63.8, \ \tilde{\Delta}U = -4.3, \tag{27}$$

in which

$$\tilde{\Delta}x \equiv \frac{\text{the value of } x \text{ in monopsony} - \text{the value of } x \text{ in perfect competion}}{\text{the value of } x \text{ in monopsony}}.$$

In the case of perfect competition, profit is zero. From (27), it is concluded that the national output, national capital (and thus family wealth), and national labour supply are lower in an economy with monopsony than in an economy with perfect competition. This implies that monopsony reduces macroeconomic performance. The rate of interest and wage rate for men are the same in the two systems. The wage rate for women is lower in the economy with monopsony. As they have monopsony in the labour market for women, firms can set women's wages to maximize profit without the constraints of perfect competition. On the other hand, as shown in equation (10), firms are faced with an upward-sloping labour supply curve (rather than an infinitely elastic labour supply curve as in the case of perfect competition). From standard monopsony theory, we also know that the marginal cost is higher than the current wage rate in the labour market for women. This occurs as all women receive the same wage rate and an extra worker makes firms raise the wage paid to all workers already employed. As our simulation demonstrated, the wage rate for women under monopsony is lower than under perfect competition. If the labour market for women was perfectly competitive, a firm would enter the market and pay a lower wage rate than one under monopsony but higher than or equal to the wage rate under perfect competition, so that the firm would obtain positive profit. Free entry in perfect competition leads to a wage rate where no firm receives a positive profit. Monopoly guarantees that the firms can set the wage rate at a level lower than possible in a perfectly competitive market.

We see that men bring more wage income and women bring less wage income in the economy under monopsony than in the economy under perfect competition. Men work more hours and women work less hours in the economy under monopsony than under perfect competition. The monopsony reduces the family's wealth and consumption. The family has lower utility levels in the economy with monopsony than perfect competition. We see that monopsony harms the microeconomic performances. It should be noted that Stotsky (2006) identifies a number of phenomena related to gender differences and economic behaviour: (1) gender-based differences can influence macroeconomic variables, such as aggregate consumption, savings; (2) women tend to devote a larger share of household resources to the households' basic needs; (3) women tend to have a higher propensity to save; (5) women's lack of education and other economic and social opportunities, both absolutely and relative to men, inhibit economic growth. The comparison of the two systems in this section provides some insights into economic mechanisms of the empirical results.

6. Conclusions

Following the tradition of gender discrimination in the literature of monopsony, this paper is concerned with the impact on economic growth of gender discrimination due to monopsony in the labour market. The paper makes neoclassical economic growth theory more robust in modelling the complexity of market structures. It integrates the basic model of neoclassical growth theory with monopsony theory, which is well-developed in microeconomics. It provides some insights into the dynamics of women's work hours and factor distribution in an imperfectly competitive economy with capital accumulation as the main engine of economic growth. The paper framed the model within the Solow growth model. It conducted comparative static analyses in some parameters. The paper also compared the economic performance of the model under perfect competition and the model under monopsony. It is concluded that monopsony in the labour market for women decreases the national output, national wealth, and utility levels in comparison to the corresponding variables in the economy under perfect competition.

The model is built on many strict assumptions. It uses the Cobb-Douglas technology and has only one sector. It is challenging to further examine gender issues using multiple sectors and more general technologies. There are other forms of imperfect competitive markets (Dixit & Stiglitz, 1977; Krugman, 1979; Zhang, 2018). The possible consequences of monopsony on gender pay gaps imply that the government might use taxation or other policies to reduce gender pay gaps. It is possible to generalise and extend the model in multiple ways. For instance, it is important to introduce heterogeneous households to obtain more insights into issues related to interdependence between growth, income and wealth distribution, and market discrimination. As the model is based on some simple cases of well-developed theories and each theory has its own complicated literature, it is not difficult to conceptually and analytically extend and generalise the model. It is straightforward to generalise the model using more general utility functions.

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Appendix 1: Proving the Lemma

Using (13) the following equations hold:

$$z \equiv \frac{r+\delta_k}{w_1} = \frac{\bar{\beta} N}{K}, \tag{A1}$$

where $\beta \equiv \alpha/\beta$ Inserting (A1) in (13) yields:

$$r(z) = \alpha A \left(\frac{z}{\bar{\beta}}\right)^{\beta} - \delta_k . \tag{A2}$$

Equations (A2) and (A1) imply:

$$w_1 = \frac{r+\delta_k}{z} . \tag{A3}$$

Equations (A1) and (9) imply:

$$F = fN, \ f \equiv A \left(\frac{\bar{\beta}}{z}\right)^{\alpha} . \tag{A4}$$

Using (14) I get:

$$h_2 \bar{N} w_1 \hat{T} = \frac{(F - R_\delta K - w_1 h_1 T_1 \bar{N})\sigma_2 T_0}{(1-\sigma_2)(T_0 - T_2)^2} + \frac{\bar{\sigma} T_0 R}{(T_0 - T_2)^2} . \tag{A5}$$

Using (1), (13) and (9), I have:

$$F = R_\delta K + w_1 h_1 T_1 \bar{N} + w_1 h_2 T_2 \bar{N}. \tag{A6}$$

Inserting (A6) in (A5) yields:

$$h_2 \bar{N} w_1 \hat{T} = \frac{(w_1 h_2 T_2 + R)\bar{\sigma} T_0}{(T_0 - T_2)^2}. \tag{A7}$$

Using (A7) and the definition of , I have:

$$T_2^2 - 2T_0 T_2 + \hat{w} = 0. \tag{A8}$$

where

$$\hat{w} \equiv \left(\sigma - \frac{R\sigma_2}{h_2 w_1}\right).$$

Solving (A8), I have:

$$T_2(z,k) = T_0 - (T_0^2 - w)^{0.5}. \tag{A9}$$

Using (14) I get the total profit as follows:

$$\pi(z,\bar{k}) = \frac{(h_2 T_0 w_1 + R)\bar{\sigma} T_2^2}{(T_0 - T_2)^2}. \tag{A10}$$

Using (10) I determine woman's wage rate as follows:

$$w_2(z,\bar{k}) = \frac{\sigma_2(R + \pi/\bar{N})}{(\tilde{\sigma} - T_2)h_2}. \tag{A11}$$

Using (6), (A10) and (A11) I have:

$$\bar{y}(z,\bar{k}) = R + \frac{\pi}{\bar{N}} + h_2 T_0 w_2. \tag{A12}$$

Using (16) and (A1), I have:

$$\frac{\bar{\beta} N}{z} = \bar{k}\bar{N}. \tag{A13}$$

Inserting (1) in (A13) yields:

$$h_1 \bar{T}_1 + h_2 \bar{T}_2 = h_1 T_0 + h_2 T_0 - \frac{\bar{k} z}{\bar{\beta}}, \tag{A14}$$

where (5) is applied. Inserting (7) in (A14) yields:

$$\left(\frac{\sigma_1}{w_1} + \frac{\sigma_2}{w_2}\right) y = h_1 T_0 + H_2 T_0 - \frac{\bar{k} z}{\bar{\beta}}. \tag{A15}$$

Equation (A15) contains two variables, z and k It is assumed that we can solve k as a function of z, denoted by $\bar{k} = \varphi(z)$ It is straightforward to confirm that all the variables can be expressed as functions of z by the following procedure: r by (A2) → w_1 by (A3) → $\bar{k}$ by (A15) → T_2 by (A9) → $\bar{T}_2$ by (5) → π by (A10) → w_2 by (A11) → $\bar{y}$ by (A12) → $\bar{T}_1$, c and s by (7) → T_1 by (5) → N by (1) → K by (17) → F by (A5) → U by the definition. From this procedure and (8), I have:

$$k = \Lambda 0(z) \equiv \lambda \bar{y} - \varphi . \tag{A16}$$

Taking derivatives of equation (A15) in yields:

$$\dot{\bar{k}}_1 = \frac{\delta \varphi}{\delta z} \dot{z} . \tag{A17}$$

Equalling (A17) and (A16), I have:

$$\dot{z} = \Lambda(z) \equiv \Lambda_0 \left(\frac{\delta \varphi}{\delta z} \right)^{-1} . \tag{A19}$$

The Lemma is confirmed.

Appendix 2: The dynamics when all markets are perfectly competitive

When all markets are perfectly competitive, firms also take the women's wage rate as a given. Profits of firms are zero. Workers are fairly paid so that Equations (1) – (9) still hold (with). The marginal conditions of the industry are now as follows:

$$\frac{\delta \pi(t)}{\delta K(t)} = \frac{\alpha F(t)}{K(t)} - R_\delta(t) = 0,$$

$$\frac{\delta \pi(t)}{\delta N(t)} = \frac{\beta F(t)}{N(t)} - w(t) = 0. \tag{13$'$}$$

An equation with in Appendix 2 corresponds to the equation with the same number in Section 2. With the same utility function and (15), I have the model with perfect competition in all labour markets. Similar to Appendix 1, I have (A1)-(A3). It is straightforward to have:

$$\bar{T}_j = \frac{(h_1 + h_2)\sigma_j T_0}{h_j} + \frac{(1 + r)\sigma_j \bar{k}}{h_j w} . \tag{A20}$$

At equilibrium holds. Inserting (6) and (7) in yields:

$$\bar{k} = (h_1 + h_2) T_0 w \left(\frac{1}{\lambda} - 1 - \mathrm{r} \right)^{-1} . \tag{A21}$$

Using (A13), (1), (A21), and (A20), I have:

$$\Phi(z) \equiv \frac{\bar{\beta} N}{z} - \bar{k}\bar{N} = 0. \tag{A22}$$

As for the Lemma, it is straightforward to find the computational procedure to simulate the model.