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A Monetary Economic Growth Model with Gender Division of Labor

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Abstract. The purpose of this study is to propose a monetary growth model with capital accumulation and gender labor supply. The real aspects of the model are based on the neoclassical growth theory and monetary aspects of the model are based on the money-in-utility (MIU) approach. We show that the dynamics of the economy can be described by 2 -dimensional differential equations. We simulate equilibrium and motion of the economy with specified monetary policies, household preference and technology. As the monetary economic system is unstable, the perfectly competitive economy may either experience unlimited growth or economic crisis. We also examine effects of changes in some parameters on the economic equilibrium. For instance, we demonstrate that as the woman raises her propensity to stay at home, the woman tends to stay longer at home than before and the total labor supply is reduced, which also leads to a reduction in the total capital is also reduced. The capital intensity is increased. Hence the rate of interest is reduced and the wage rate is increased. The total capital, the total output, the wealth and consumption levels per-capita are all reduced. The fall in the rate of interest reduces the cost of holding money, leading to the rise in the real money per capita.

Keywords: monetary growth model, elastic gender labor supply, capital accumulation, money, inflation policy

1. Introduction

This study proposes a monetary growth model with capital accumulation and elastic gender labor supply. The supply side is basically the same as the Solow growth model. We introduce gender and money into the neoclassical growth theory. Gender differences had been largely neglected in the literature of economic growth. Most studies of gender economics tend to be concerned with the analysis at the microeconomic level. It is only recently that gender issues have been examined in macroeconomic issues. In the neoclassical approach, it is generally believed that gender inequalities resulting from disparities in human capital will wither away in association with economic development [e.g., 1, 2, 3]. According to Boserup [4], there will be a curvilinear relationship between economic growth and the status of women. Boserup argued that initial stages of economic growth are characterized of a widening gap between men and women. Although productivity differences between men and women at low levels of economic development are not large, as economic conditions are improved, productivity differences tend to widen and a polarization and hierarchization of men's and women's work roles tend to ensure. Furthermore, the roles may be 'locked in' and possibly propagated by discrimination. Nevertheless, further economic growth will bring about a closing of the gap. The pace at which the gap is closed is dependent on many cultural, institutional, as well as economic factors. Over the years there have been a number of attempts to modify neoclassical consumer theory to deal with economic issues about endogenous labor supply, family structure, working hours and the valuation of traveling time with endogenous sexual division of labor and consumption [5, 6, 7]. Nevertheless, one might argue that the contemporary economics has failed to develop analytical frameworks to properly introduce sexual division of labor into economic growth theory with capital accumulation, public goods and different fiscal policies.

This study is also concerned with effects of money on economic growth. A monetary economy is characterized by that prices are expressed in money, transactions require money, and financial wealth can be

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held in the form of money or financial instruments competing with money. It is well known that modern analysis of dynamic interaction of inflation and capital formation begins with Tobin's seminal contribution in 1965. Tobin [8] studies an isolated economy in which outside money competes with real capital in the portfolios of agents within the framework of the Solow model. In the Tobin model there is also a real sector exactly like that in the Solow growth model. We introduce money into the gender growth model with the money in the utility (MIU) function approach, which assumes that money is held because it yields some services and the way to model it is to enter real balances directly into the utility function. Eden [9, Chap. 2] provides the reasons why money is introduced into the utility function. The approach was used initially by Patinkin [10], Sidrauski [11] and Friedman [12]. Sidrauski made a benchmark contribution to monetary economics, challenging Tobin's non-neutrality result. He found that money is superneutral in steady state comparison and changes in the inflation rate have no effect on all the real variables in the economy. Here, superneutrality of money means that the growth rate of money has no effect on the real equilibrium. Nevertheless, it has become evident that his results are dependent on the specific set-up of the model. There are many other issues and models related to interactions between monetary policy and economic growth [e.g., 13]. It should be noted that this paper synthesizes some models by Zhang. The gender division of labor and the utility function used in this study is based on Zhang [14]. The endogenous time and the MIU approach are respectively based on Zhang [15, 16]. The paper is organized as follows. Section 2 defines the model. Section 3 analyzes the properties of the model. Section 4 carries out comparative static analysis with regard to some parameters. Section 5 concludes the study.

2. The Monetary Growth Model

The production aspects of the economic system under consideration are similar to the one-sector neoclassical growth model proposed. Production is generally described as combination of multiple production factors such as natural resources, labor, and capital. Time is represented continuously by a numerical variable which takes on all values from zero onwards. As our model exhibits constant returns to scale, the dynamics (in terms of per capita) will not be affected if we allow the population of all the groups to change in a constant growth rate over time. Let subscripts $j = 1$ and $j = 2$ stand for man and woman respectively. Let $T_j(t)$ stand for the work time of a representative household of group j and $N(t)$ for the flow of labor services used at time t for production. There is only a single production sector in the economy and labor is always fully employed. We measure $N(t)$ as follows

$$N(t) = \sum_{j=1}^{2} h_j N_0 T_j(t) \tag{1}$$

where h_j are the level of human capital of group j. We assume h_j to be fixed.

We use the conventional production function to describe a relationship between inputs and output. The function $F(t)$ defines the flow of production at time t. The production process is described by a neoclassical production function, $F(t) = F(K(t), N(t))$. We assume that the output good serves as a medium of exchange and is taken as numeraire. The rate of interest r and wage rates are determined by markets. The production sector chooses the two variables K and N to maximize its profit. Let δ_k $(0 \le \delta_k < 1)$ denote the depreciation rate of physical capital. The marginal conditions are given by

$$r(t) + \delta_k = f'(k(t)), \quad w_j(t) = h_j w(t), \quad w(t) \equiv f(k(t)) - k(t) f'(k(t)). \tag{2}$$

Let $\bar{k}(t)$ $(\equiv K(t)/N_0)$ stand for per capita physical wealth. According to the definition of $k(t)$ and $\bar{k}(t)$, we have

$$\bar{k}(t) = (h_1 T_1(t) + h_2 T_2(t))k(t). \tag{3}$$

Money is introduced by assuming that a central bank distributes at no cost to the population a per capita amount of fiat money $M(t) > 0$. The scheme according to which the money stock evolves over time is deterministic and known to all agents. With μ being the constant net growth rate of the money stock, $M(t)$ evolves over time according to $\dot{M}(t) = \mu M(t)$, $\mu > 0$. The government expenditure in real terms per capita, $\tau(t)$, is given by

$$\tau(t) = \frac{\dot{M}(t)}{P(t)} = \frac{\mu M(t)}{P(t)} = \mu m(t). \tag{4}$$

The representative household receives $\mu m(t)$ units of paper money from the government through a "helicopter drop", also considered to be independent of his money holdings. We now describe behavior of consumers on the basis of Zhang's approach to household behavior [16]. A representative household's current income $y(t)$ is given by

$$y(t) = r(t)\bar{k}(t) + w_1(t)T_1(t) + w_2(t)T_2(t) - \pi(t)m(t) + \tau(t),$$

where $\pi(t)$ is inflation rate. The total value of wealth that a household can sell to purchase goods and to save is equal to $a(t)$, where $a(t) \equiv \bar{k}(t) + m(t)$. Here, we do not allow borrowing for current consumption. We assume that selling and buying wealth can be conducted instantaneously without any transaction cost. The disposable income is the sum of the current income and the wealth available for purchasing consumption goods and saving, $\hat{y}(t) = y(t) + a(t)$. That is

$$\hat{y}(t) = r(t)\bar{k}(t) + w_1(t)T_1(t) + w_2(t)T_2(t) - \pi(t)m(t) + \tau(t) + a(t).$$

Denote $\bar{T}_q(t)$ the leisure time at time t and the (fixed) available time for work and leisure by T_0. The time constraint is expressed by

$$T_q(t) + \bar{T}_q(t) = T_0, \quad q = 1, 2.$$

Substituting this time constraint into the disposable income yields

$$\hat{y}(t) = r(t)\bar{k}(t) + w_1(t)T_0 + w_2(t)T_0 - w_1(t)\bar{T}_1(t) - w_2(t)\bar{T}_2(t) - \pi(t)m(t) + \tau(t) + a(t). \tag{5}$$

We assume that at each point of time the household's utility function for holding money, consuming leisure and goods, and making saving is be represented by the following utility function

$$U(t) = m^{\varepsilon_0}(t)T_1^{\sigma_{01}}(t)T_2^{\sigma_{02}}(t)c^{\xi_0}(t)s^{\lambda_0}(t), \quad \varepsilon_0, \sigma_0\ \xi_0, \lambda_0 > 0,$$

where ε_0 is called propensity to hold money, σ_{01} and σ_{02} the husband and wife's propensities to use leisure, ξ_0 propensity to consume goods, and λ_0 propensity to own wealth. The budget constraint is given by

$$(1 + r(t))m(t) + c(t) + s(t) = \hat{y}(t).$$

Insert (5) in the budget constraint

$$(r+\pi)m + w_1 \bar{T} + w_2 \bar{T}_2 + c + s = \bar{y} \equiv (1+r)\bar{k} + h_\varepsilon w + \tau, \tag{6}$$

where $h_\varepsilon \equiv (h_1 + h_2)T_0$. Here, we may interpret the variable $\bar{y}(t)$ as the potential disposable income as it is the disposable income $\hat{y}(t)$ when all the available time is spent on work (i.e., $T = T_0$). The consumer problem is to choose current money, consumption, and savings so that the utility is maximized. Maximizing $U(t)$ subject to (6) yields

$$(r+\pi)m = \varepsilon \bar{y}, \quad w_1 \bar{T}_1 = \sigma_1 \bar{y}, \quad w_2 \bar{T}_2 = \sigma_2 \bar{y}, \quad c = \xi\bar{y}, \quad s = \lambda\bar{y}, \tag{7}$$

Where

$$\varepsilon \equiv \rho\varepsilon_0, \quad \sigma_1 \equiv \rho\sigma_{01}, \quad \sigma_2 \equiv \rho\sigma_{02}, \quad \xi \equiv \rho\xi_0, \quad \lambda \equiv \rho\lambda_0, \quad \rho \equiv \frac{1}{\varepsilon_0 + \sigma_{01} + \sigma_{02} + \xi_0 + \lambda_0}.$$

The real wealth changes as follows

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

This equation simply says that the change in wealth is equal to saving minus dissaving. We have thus built the model.

3. The Motion and Equilibrium of the Economic System

A First, we need to find equations which describe motion of the dynamic system. From the definition of $\bar{y}$, $\pi = \mu - \dot{m}/m$ and $(r+\pi)m = \varepsilon\bar{y}$, we obtain

$$\dot{m} = (r + \mu - \varepsilon\mu)m - (1+r)\varepsilon\bar{k} - h_\varepsilon \varepsilon w, \tag{9}$$

where we use (3) and $\tau = \mu m$. According to the definition of $s(t)$, the change in the household's physical wealth is given by

$$\dot{\bar{k}} = \lambda\bar{y} - \bar{k} - m - \dot{m}. \tag{10}$$

From the definition of $\bar{y}(t)$ and $\tau = \mu m$, we obtain

$$\bar{y} = (1+r)\bar{k} + h_\varepsilon w + \mu m. \tag{11}$$

By (7) and (2), we have

$$\bar{T}_2 = \sigma\bar{T}_1, \quad T_2 = \sigma T_1 + (1-\sigma)T_0, \tag{12}$$

where we use $T_q + \bar{T}_q = T_0$ and $\sigma \equiv (\sigma_2 h_1)/(\sigma_1 h_2)$. From (3) and 12), we get

$$\bar{k} = \left[hT_1 + (1-\sigma)h_2 T_0\right]k, \tag{13}$$

where $h \equiv h_1 + h_2 \sigma$. Substituting (11) and (13) into $h_1 wT_1 = \sigma_1 \bar{y}$ yields

$$T_1 = \Phi_1(k, m), \quad T_2 = \Phi_2(k, m), \tag{14}$$

Where

$$\Phi_1(k, m) \equiv \frac{(1-\sigma)h_2 T_0 (1+r)k + h_\varepsilon w + \mu m}{h_1 w/\sigma_1 - h(1+r)k}, \quad \Phi_2(k, m) \equiv \sigma \Phi_1(k, m) + (1-\sigma)T_0,$$

in which Φ_1 is considered as a function of k and m because r and w are functions of k. Equation (14) shows that we can express explicitly the time distribution as functions of k and m. We should require that for any meaningful positive k, $0 \le T_q(t) \le T_0$. We will not examine the conditions in detail as the expressions are tedious.

From equation (13) and (14), we have

$$\bar{k} = \Phi(k, m) \equiv \left[h\Phi_1(k, m) + (1-\sigma)h_2 T_0\right]k. \tag{15}$$

Hence, we can express explicitly the time distribution as functions of k and m. Take derivatives of (15) with respect to time

$$\dot{\bar{k}} = \left(\frac{\Phi}{k} + hk\frac{\partial \Phi_1}{\partial k}\right)\dot{k} + hk\frac{\partial \Phi_1}{\partial m}\dot{m}. \tag{16}$$

From (11) and (15), we have

$$\bar{y}(k, m) = (1+r)\Phi(k, m) + h_\varepsilon w + \mu m. \tag{17}$$

From (10), and (15)-(17), we get

$$\left(\frac{\Phi}{k} + hk\frac{\partial \Phi_1}{\partial k}\right)\dot{k} + hk\frac{\partial \Phi_1}{\partial m}\dot{m} = \lambda \bar{y}(k, m) - \Phi - m - \dot{m}. \tag{18}$$

From (9), (15) and (18), we have the following two differential equations containing two variables, $k(t)$ and $m(t)$

$$\dot{m} = \Lambda_m(k, m) \equiv (r + \mu - \varepsilon\mu)m - (1+r)\varepsilon\Phi(k, m) - h_\varepsilon \varepsilon w,$$

$$\dot{k} = \Lambda_k(k, m) \equiv \left[\lambda\bar{y}(k, m) - \Phi - m - \left(1 + hk\frac{\partial \Phi_1}{\partial m}\right)\Lambda_m(k, m)\right]\left(\frac{\Phi}{k} + hk\frac{\partial \Phi_1}{\partial k}\right)^{-1}. \qquad (19)$$

The following lemma confirms that for any meaning solution of equations (19), all the other variables in the dynamic system are uniquely determined as functions of $k(t)$ and $m(t)$.

Lemma 1

The motion of $m(t)$ and $k(t)$ is determined by two differential equations (19). For any positive $m(t)$ and $k(t)$, all the other variables are uniquely determined at any point of time by the following procedure: $\bar{k}(t)$ by (15) $\rightarrow T_q(t)$ by (14) $\rightarrow \bar{T}_q(t) = T_0 - T_q(t) \rightarrow f(t) = f(k(t)) \rightarrow r(t)$ and $w_q(t)$ by (2) $\rightarrow \bar{y}(t)$ by (17) $\rightarrow$ $\pi(t)$, $c(t)$ and $s(t)$ by (7) $\rightarrow \tau(t) = \mu m(t) \rightarrow N(t)$ by (1) $\rightarrow a(t) = \bar{k}(t) + m(t) \rightarrow F(t) = f(t)N(t)$.

The lemma is important as it tells us how to follow the motion of the economic system, given proper initial conditions. As the expressions are too tedious, we cannot easily interpret the analytical results. For illustration, we specify the parameter values as follows

$$\alpha = \frac{1}{3},\ A = 1.2,\ N_0 = 10,\ h_1 = 1.5,\ h_2 = 0.9,\ T_0 = 24,\ \mu = 0.03,\ \varepsilon_0 = 0.02,$$
$$\xi_0 = 0.09,\ \lambda_0 = 0.84,\ \sigma_{01} = 0.3,\ \sigma_{02} = 0.4,\ \delta_k = 0.05, \qquad (20)$$

With the initial conditions, $k(0) = 2.2$ and $m(0) = 7$, the variables change as in Figure 1.

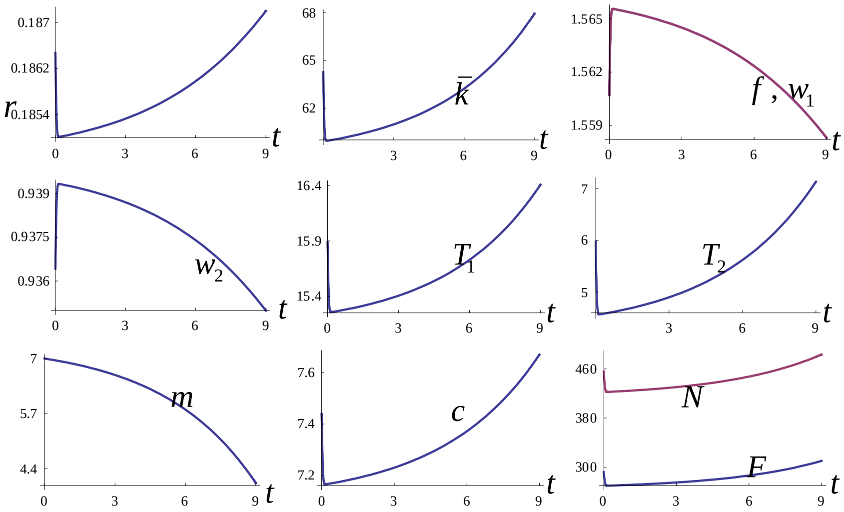

Fig. 1: The motion of the system with money and division of labor

The initial conditions are specified at the levels higher than their equilibrium points. The per capital real money and capital intensity fall over time. The rate of interest rises in association in the fall of per work time product. We see that the wage rates fall over time, but the work times are increased. As the work times are increasing over time, the national product, total labor supply, and per capita consumption level are all increased. It should be noted that if we simulate the economy longer, some variables will become negative. The reason is that the monetary economy is unstable.

A steady state of the dynamic system is determined by

$$(r + \mu - \varepsilon\mu)m - (1+r)\varepsilon\,\Phi(k,\, m) - h_\varepsilon\, \varepsilon\, w = 0,$$
$$\lambda\bar{y}(k,\, m) - \Phi - m = 0. \tag{21}$$

We now try to determine equilibrium points. First, we note that at steady state $\pi = \mu$ and $s = a$. From $s = a$, $a = m + \bar{k}$, $s = \lambda\bar{y}$, and (11), we have

$$\bar{k} = \frac{h_\varepsilon\, w + (\mu - 1/\lambda)m}{(1/\lambda - 1 - r)}. \tag{22}$$

From $(r + \mu)m = \varepsilon\,\bar{y}$ and $a = \lambda\bar{y}$, we solve

$$\bar{k} = \left(r + \mu - \frac{\varepsilon}{\lambda}\right)\frac{\lambda m}{\varepsilon}. \tag{23}$$

From this equation and (22), we get

$$m = \Lambda_0(k) \equiv \left(\left((r + \mu)\frac{\lambda}{\varepsilon} - 1\right)\left(\frac{1}{\lambda} - 1 - r\right) - \mu + \frac{1}{\lambda}\right)^{-1} h_\varepsilon\, w. \tag{24}$$

This equation expresses m as a function of k. Substituting (23) and (24) into (15) yields

$$\Psi(k) \equiv \left(r + \mu - \frac{\varepsilon}{\lambda}\right)\frac{\lambda\Lambda_0}{h\varepsilon k} - \frac{(1-\sigma)h_2 T_0 (1+r)k + h_\varepsilon\, w + \mu\Lambda_0}{h_1 w/\sigma_1 - h(1+r)k} - (1-\sigma)\frac{h_2 T_0}{h} = 0. \tag{25}$$

We have thus proved the following lemma.

Lemma 2

Equation (25) determines an equilibrium point of k. For a given k, all the other variables are uniquely determined by the procedure: m by (24) $\to$ $\bar{k}$ by (23) $\to$ T_q by (14) $\to$ $\bar{T}_q = T_0 - T_q$ $\to$ $f = f(k) \to r$ and w_q by (2) $\to$ $\bar{y}$ by (17) $\to$ $\pi = \mu$ $\to$ c and s by (7) $\to$ $\tau = \mu m \to$ N by (1) $\to$ $a = \bar{k} + m \to$ $F = f\,N$.

With the parameter values specified as in (20), we find a unique meaningful solution of (25) as illustrated in Figure 2.

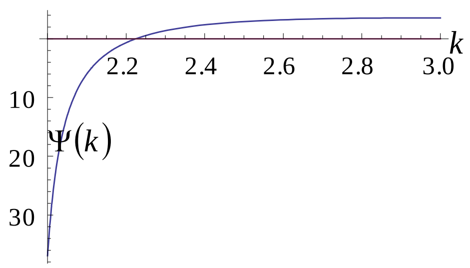

Fig.2: The existence of a unique equilibrium point

Following Lemma 2, we calculate the equilibrium values of the variables as follows

$$r = 0.185,\ k = 2.23,\ f = 1.57,\ w_1 = 1.57,\ w_2 = 0.94,\ T_1 = 15.11,\ T_2 = 4.23,$$
$$m = 7.35,\ \bar{k} = 58.93,\ c = 7.10,\ N = 289.29,\ K = 589.29,\ F = 414.90. \tag{26}$$

We see that the system does not converge to its long term equilibrium with the initial state.

4. Comparative Static Analysis

The previous section identifies the unique equilibrium of the global economy and demonstrates that the global economy is unstable. The monetary economic growth may suffer global crisis without government intervention. It is straightforward to show that if the role of money is neglected and the economy includes only "real variables", then the economic growth model is characterized of a unique stable equilibrium. The introduction of money causes instabilities in the model. This section examines impact of changes in some parameters on the long term equilibrium point. It is important to examine impact of changes in parameters on dynamic processes of the system. As the system is unstable, we are concerned only with comparative static analysis. First, we examine the case that all the parameters, except the woman's propensity to stay at home are the same as in (20). We increase σ_{02} from 0.4 to $0.41.$ The simulation results are listed in (27). Here, symbol $\bar{\Delta}$ stands for the change rate due to the parameter change. As the woman raises her propensity to stay at home, the rate of interest falls. As the woman raises her propensity to stay at home, the woman tends to stay longer at home than before. As the work hours fall, the total labor supply is reduced. As the total labor supply is reduced, the total capital is also reduced. The net result is that the capital intensity is increased. Hence the rate of interest is reduced and the wage rate is increased. The total capital, the total output, the wealth and consumption levels per-capita are all reduced as the woman likes more to stay at home. The fall in the rate of interest reduces the cost of holding money, leading to the rise in the real money per capita.

$$\bar{\Delta} r = -5.30,\ \bar{\Delta} k = 6.60,\ \bar{\Delta} f = \bar{\Delta} w_1 = \bar{\Delta} w_2 = 2.15,\ \bar{\Delta} T_1 = -2.85,\ \bar{\Delta} T_2 = -34.79,$$
$$\bar{\Delta} m = 3.98,\ \bar{\Delta} \bar{k} = -1.36,\ \bar{\Delta} c = -0.76,\ \bar{\Delta} N = -7.46,\ \bar{\Delta} K = -1.36,\ \bar{\Delta} F = -5.47. \tag{27}$$

We now increase the woman's human capital level, h_2, from 0.9 to $1.1.$ The results are listed in (28). As the human capital is increased, the rate of interest rises. As the woman is more educated, the man's wage rate is reduced and the woman's wage rate is increased. A rise in the woman's human capital leads to a fall in the capital intensity which tends to reduce both the woman's and man's wage rate. For the woman, the net result of the rise due to the human capital improvement and the fall due to the reduced capital intensity makes the woman's wage rate to rise. The rise of the rate of interest makes the holding of money more costly, leading to the fall in the real money. As the work hours are increased and woman's human capital is improved, the total labor supply is increased. In the association of the rise in the total labor supply, the total capital is also increased. The net result is that the capital intensity is reduced. The total capital, the total output, the wealth and consumption levels per-capita are all increased as the woman gets more education.

$$\bar{\Delta} r = 35.77,\ \bar{\Delta} k = -31.07,\ \bar{\Delta} f = \bar{\Delta} w_1 = -11.66,\ \bar{\Delta} w_2 = 7.97,\ \bar{\Delta} T_1 = 20.35,\ \bar{\Delta} T_2 = 216.36,$$
$$\bar{\Delta} m = -18.71,\ \bar{\Delta} \bar{k} = 9.43,\ \bar{\Delta} c = 6.31,\ \bar{\Delta} N = 58.75,\ \bar{\Delta} K = 9.43,\ \bar{\Delta} F = 40.24. \tag{28}$$

The effects of a rise in propensity to hold money, $\varepsilon_0 : 0.02 \Rightarrow 0.03$, are summarized. As the propensity to hold money is increased, the rate of interest falls. Both man and woman reduces their work time, the woman reduces more than the man. A rise in the propensity to hold money leads to a rise in the capital intensity which tends to raise both the woman's and man's wage rate. The rise of the propensity to hold money makes the household to have more money, which reduces the capital stock as predicted in the Tobin model. The total capital, the total output, the wealth and consumption levels per-capita are all reduced.

$$\begin{aligned}&\overline{\Delta} r = -3.87,\ \overline{\Delta} k = 4.75,\ \overline{\Delta} f = \overline{\Delta} w_1 = \overline{\Delta} w_2 = 1.56,\ \overline{\Delta} T_1 = -8.88,\ \overline{\Delta} T_2 = -70.27, \\ &\overline{\Delta} m = 43.59,\ \overline{\Delta} \bar{k} = -13.83,\ \overline{\Delta} c = -7.46,\ \overline{\Delta} N = -17.73,\ \overline{\Delta} K = -13.83,\ \overline{\Delta} F = -16.45. \end{aligned} \tag{29}$$

We now increase the inflation policy, μ, from : 0.03 to 0.04. The rate of interest is increased and the capital intensity reduces which also leads to the falls in the wage rates. Both woman and man raise their work time. The rest results are given in (30).

$$\begin{aligned}&\overline{\Delta} r = 0.31,\ \overline{\Delta} k = -0.38,\ \overline{\Delta} f = \overline{\Delta} w_1 = \overline{\Delta} w_2 = -0.12,\ \overline{\Delta} T_1 = 0.84,\ \overline{\Delta} T_2 = 6.67, \\ &\overline{\Delta} m = -4.01,\ \overline{\Delta} \bar{k} = 1.31,\ \overline{\Delta} c = 0.72,\ \overline{\Delta} N = 1.68,\ \overline{\Delta} K = 1.31,\ \overline{\Delta} F = 1.56. \end{aligned} \tag{30}$$

5. Conclusions

This paper proposed a monetary growth model with capital accumulation and endogenous labor supply. We also simulated the motion of model with the Cobb-Douglas production function and demonstrated effects of changes in the parameters. As the monetary economic system is unstable, the perfectly competitive economy may either experience unlimited growth or economic crisis. Because of the choice of the initial conditions and the parameters, our simulation demonstrates a situation of economic declination. It should be noted that the economy without money will converge to its long-term equilibrium. The introduction of endogenous money makes the system unstable. We also carry out comparative static analysis with regard to some parameters. It is well known that one-sector growth model has been generalized and extended in many directions. It is not difficult to generalize our model along these lines. It is straightforward to develop the model in discrete time. We may analyze behavior of the model with other forms of production or utility functions. There are multiple production sectors and households are not homogenous.

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7. References

[1] L. Beneria. Toward a greater integration of gender in economics. *World Development*. 1995, **23** (11): 1839-50.

[2] N. Forsythe, R.P. Korzeniewicz, and V. Durrant. Gender inequalities and economic growth: A longitudinal evaluation. *Economic Development and Cultural Chang*, 2000, **48** (3): 573-617.

[3] J.G. Stotsky. Gender and its relevance to macroeconomic policy: A survey. *IMF Working Paper*, WP/06/233.

[4] E. Boserup. *Woman's Role in Economic Development*. London: Allen & Unwin, 1970.

[5] G. S. Becker. *The Economic Approach to Human Behavior*. Chicago: The University of Chicago Press, 1976.

[6] P.A. Chiappori. Introducing household production in collective models of labor supply. *Journal of Political Economy*, 1994, **105** (1): 191-209.

[7] E.V. Tassel. Household bargaining and microfinance. *Journal of Development Economics*, 2004, **74** (2): 449-68.

[8] J. Tobin. Money and economic growth. *Econometrica*, 1965, **33** (4): 671-84.

[9] F. Eden. *A Course in Monetary Economics: Sequential Trade, Money, and Uncertainty*. Malden: Blackwell Pub., 2005.

[10] D. Patinkin. *Money, Interest, and Prices: An Integration of Monetary and Value Theory*, 2nd edition. New York: Harper & Row, 1965.

[11] Sidrauski. Rational choice and patterns of growth in a monetary economy. *American Economic Review*, 1967, **57** (2): 534-44.

[12] M. Friedman. The optimum quantity of money. *The Optimum Quality of Money and Other Essays*, edited by Friedman, M. Chicago: Aldine, 1969.

[13] J. Handa. *Monetary Economics*. London: Routledge, 2009.

[14] W.B. Zhang. A woman's labor participation and economic growth: creativity, knowledge utilization and family preference. *Economics Letters*, 1993, **42** (1): 105-110.

[15] W.B. Zhang. A two-sector growth model with labour supply. *Australian Journal of Labour Economics*, 2005, **8** (3): 245-60.

[16] W.B. Zhang. A multi-regional monetary growth model with the miu approach-Inflation policy, capital accumulation and economic geography. *Indian Economic Review*, 2012, **47** (2): 223-45.