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# Habit formation, work ethics, and technological progress

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**Abstract:** Work ethics affects labor supply. This idea is modeled assuming that work is habit forming. This paper introduces working habits in a neoclassical growth model and compares its outcomes with a model without habit formation. In addition, it analyzes the impact of different forms of technical progress. The findings are that i) labor supply in the habit formation case is higher than in the neoclassical case; ii) unlike in the neoclassical case, labor supply in the presence of habit formation will depend on the kind of technical progress experienced by the economy and iii) the kind of technical progress will hence affect the steady state levels of consumption, capital stock and output.

**Keywords:** labor supply, habit formation, work ethics, technological progress.

**JEL Classification Numbers:** D99, J22, O33, Z13.

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# Habit formation, work ethics, and technological progress

## 1. Introduction

The existence of habit formation due to factors such as social interactions may lead agents to supply labor beyond the normal number of hours. Factors such as culture or religion may affect the labor supply pattern of agents because they provide social incentives that produce habits in the number of hours supplied. Woittiez and Kapteyn (1998) find evidence that social interactions and habit formation are crucial factors in determining female labor supply in The Netherlands. On the other hand, growth empirics literature finds evidence that religious variables [see Grier, 1997], type of economic organization and past colonial history [see Sala-i-Martin, 1997] are important determinants of economic development. Another example is Blum and Dudley (2001) that provide a culture-based explanation of historical wage differentials between Catholic and Protestant cities in Europe.<sup>1</sup>

In this paper we assume that social incentives create a work ethic that affects the number of hours worked by a representative worker, encouraging the worker to supply overtime labor. This is modeled by assuming that work is habit forming. The idea is quite intuitive: past work forms a stock of habits that increase worker's satisfaction. This idea captures the social dimension of a hard-worker society, a concept that is subjacent in Weber's (1958) analysis on Protestant ethics. The habit formation hypothesis has been widely used to explain consumption patterns [e.g., Duesenberry, 1949] and it has been applied in a variety of different problems such as aggregate savings [Alessie and Lusardi,

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<sup>1</sup> Indeed, much emphasis has been also placed in cultural and work attitude factors as important explanatory factors of the Japanese economic success up to the 1990's. See Temin (1997).

1997], growth [Carrol et al., 2000], demand for money [Faria, 2001] and job satisfaction [Clark, 1999], to quote a few.

In this paper we introduce working habits in a neoclassical growth model<sup>2</sup> and compare its outcome in terms of labor supply, consumption, capital stock, and output with a model without habit formation. In addition, we analyze the impact of different forms of technical progress – i.e. Harrod, Hicks and Solow neutral – on these variables.<sup>3</sup> Given that the impact of these different forms of technical progress will affect the marginal productivity of labor differently and that labor is habit forming, innovations may also affect working habits that, in turn, can change the outcome of the model. Our findings show that i) labor supply in the habit formation case is higher than in the neoclassical case; ii) unlike in the neoclassical case, labor supply in the presence of habit formation will depend on the kind of technical progress experienced by the economy and iii) the kind of technical progress will hence affect the steady state levels of consumption, capital stock and output. These results are important, since they imply that, in societies where overtime working habits are encouraged, the kind of technical progress will have consequences for the determination of employment, consumption and output.

The paper is organized as follows. Next section presents the basic model. Section 2 analyses the impact of technical progress and section 3 concludes.

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<sup>2</sup> See Kubin (2002) and Vendrik (1993) for further analysis of habit formation on labor supply.

<sup>3</sup> See Karni and Zilcha (1995) for an analysis of the impact of these kinds of technical progress on income inequality.

## 2. The Model

In this model agents prefer to work longer hours ( $l$ ) because they get social recognition from it.<sup>4</sup> Here the representative agent has control of his time, and is totally absorbed in a professional task. In a sense, agents become addicted to work due to the presence of positive social incentives. In other words, work is habit forming and past work forms a stock of habits that increases current utility<sup>5</sup>. That is, past work forms a stock of habits ( $H$ ):

$$\dot{H} = \rho(l - H) \quad (1)$$

where  $\rho$  represents the relative weights of work at different times. The smaller is  $\rho$  the less important is work done in the recent past in the formation of working habits. In order to capture the structure of economic incentives [see, for instance, Idson and Robins, 1991], such as higher wages or overtime premium, one can assume  $\rho$  as being an increasing function of real wages ( $w$ ):

$$\rho = \rho(w), \rho'(w) > 0 \quad (2)$$

The budget constraint is given by:

$$\dot{k} = wl + rk - c \quad (3)$$

where consumption ( $c$ ) and investment ( $\dot{k}$ ) is limited by his income from labor ( $l$ ) and capital ( $k$ ) and  $r$  is the rental rate of capital.

The instantaneous utility function of any worker increases with consumption ( $c$ ) and leisure ( $L = 1 - l$ ). However, working habits ( $H$ ) brings satisfaction as well because

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<sup>4</sup> In this paper we will treat the case where incentives are positive. The same analysis can be carried out if social attitudes towards work are negative and the results will simply reverse.

<sup>5</sup> This idea bears some similarity with the hypothesis of rational addiction [e.g., Becker and Murphy, 1988].

of the aforementioned social recognition gained. Therefore, the instantaneous utility function is:  $U=U(c,L,H)$ <sup>6</sup>. As usual, it is assumed that it is strictly concave in all arguments.

The worker's problem is to maximize the discounted sum of instantaneous utilities  $U(c,L,H): \text{Max}_{c,L} \int_0^{\infty} U(c, L, H) e^{-\theta t} dt$ , subject to equations (1), (2) and (3).

The Hamiltonian corresponding to this constrained maximization problem is:

$$H=U(c,1-l,H)+\lambda[wl+rk-c]+\mu \rho(w)[l-H] \quad (4)$$

where  $\lambda$  and  $\mu$  are, respectively, the shadow prices of capital and working habits. The first order conditions are:

$$H_c=0 \Rightarrow U_c(c,1-l,H)-\lambda=0 \quad (5)$$

$$H_{1-l}=0 \Rightarrow U_{1-l}(c,1-l,H)+\lambda w+\mu \rho(w)=0 \quad (6)$$

$$\dot{\lambda}-\theta \lambda=-H_k \Rightarrow \dot{\lambda}-\theta \lambda=-\lambda r \quad (7)$$

$$\dot{\mu}-\theta \mu=-H_H \Rightarrow \dot{\mu}-\theta \mu=-[U_H(c,1-l,H)-\mu \rho(w)] \quad (8)$$

plus the transversality conditions:  $\lim_{t \rightarrow \infty} \lambda k = \lim_{t \rightarrow \infty} \mu H = 0$

It is important to notice that this model collapses into the neoclassical model when there is no formation of working habits:  $H=\mu=0$ . Using this and equations (5) and (6), one can obtain the neoclassical labor supply that states that the rate of substitution of income for leisure equals the wage rate:

$$\frac{-U_{1-l}(c,1-l)}{U_c(c,1-l)}=w \quad (9)$$

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<sup>6</sup> Clark (1999) uses an overall utility function that captures a vector of job characteristics.

Firms maximize profits at each point in time. The output ( $y$ ) is assumed to be produced by a Cobb-Douglas production function:

$$y = k^b l^{1-b} \quad (10)$$

where  $b \in (0,1)$ .

The first order conditions for profit maximization imply that:

$$r = b \left( \frac{l}{k} \right)^{1-b} \quad (11)$$

$$w = (1-b) \left( \frac{k}{l} \right)^b \quad (12)$$

In order to find an explicit labor demand and solve the model, let us assume that the instantaneous utility function takes the form:

$$U = U(c, L, H) = \log(c) + A \log(1-l) + \gamma \log H \quad (13)$$

where  $\gamma$  is the psychological gratification of working habits in the utility function. Moreover, let us assume that the relative weight of work at different times is a linear function of the wage rate:

$$\rho(w) = \rho w \quad (14)$$

By considering equations (1) (3), (5), (6), (7), (8), (10), (11), (12), (13), (14) one can find the steady state solutions [denoted by an asterisk] of the model by setting  $\dot{\lambda} = \dot{\mu} = \dot{k} = \dot{H} = 0$  [see derivation in the appendix].

The labor supply ( $l^*$ ) is:

$$l^* = \frac{(1-b)}{(1+A\Omega^{-1}-b)} \quad (15)$$

where  $\Omega$  is defined as  $\Omega \equiv 1 + \frac{\gamma \rho \left(\frac{b}{\theta}\right)^{\frac{b}{1-b}}}{(\theta + (1-b)\rho \left(\frac{b}{\theta}\right)^{\frac{b}{1-b}})} > 1$  (16)

From equations (15) and (16) it is easy to see that labor supply increases with the importance of working habits ( $\gamma$ ) and with the relative weights ( $\rho$ ) of labor at different

times:  $\frac{dl^*}{d\gamma} > 0, \frac{dl^*}{d\rho} > 0$ .

As seen before, when  $H = \mu = 0$ , the model collapses to the neoclassical model.

The labor supply derived from the neoclassical model ( $l_N$ ) is:

$$l_N = \frac{(1-b)}{(1+A-b)} \quad (17)$$



By contrasting the habit formation labor supply with its neoclassical counterpart an important result is derived: the habit formation labor supply is greater than the neoclassical labor supply  $l^* > l_N$ . Since by equation (16) we have  $\Omega > 1$  which implies

$$\text{that: } l^* - l_N = \frac{(1-b)}{(1+A\Omega^{-1}-b)} - \frac{(1-b)}{(1+A-b)} > 0.$$

As regards the remaining steady state solutions of the model, we have stocks of habits, consumption, capital stock and output given, respectively, by the following expressions:

$$H^* = l^* \quad (18)$$

$$c^* = \left( \frac{b}{\theta} \right)^{\frac{b}{1-b}} l^* \quad (19)$$

$$k^* = \left( \frac{b}{\theta} \right)^{\frac{1}{1-b}} l^* \quad (20)$$

$$y^* = k^{*b} l^{*1-b} \quad (21)$$

Given that  $l^* > l_N$  it is clear that the consumption, capital stock and output in steady state of the habit formation model are greater than their neoclassical counterpart. That is, the formation of working habits owing to social incentives for overtime work leads to a higher level of labor supply, consumption capital stock and income than in a society with no overtime work habits as in the standard neoclassical model.

### 3. Technological progress

In order to study the impact of technological progress in the model, let us analyze three different types of production functions presenting capital augmenting [Solow neutral], labor augmenting [Harrod neutral] and Hicks neutral technological progress, respectively:

$$y_s = (Bk)^b l^{1-b} \quad (22)$$

$$y_H = k^b (Bl)^{1-b} \quad (23)$$

$$y_h = B k^b l^{1-b} \quad (24)$$

where  $B$  is an index of the technology.

Solving the model with each one of these production functions yields the following labor supply curves. The labor supply curve for a Solow neutral innovation is:

$$l_s = \frac{(1-b)}{(1 + A\Omega_s^{-1} - b)} \quad (25)$$

$$\text{where } \Omega_s \text{ is defined as } \Omega_s \equiv 1 + \frac{\gamma \rho \left( \frac{b}{\theta} \right)^{\frac{b}{1-b}} B^{\frac{b}{1-b}}}{(\theta + (1-b)\rho \left( \frac{b}{\theta} \right)^{\frac{b}{1-b}} B^{\frac{b}{1-b}})} > 1 \quad (26)$$

The labor supply curve for a Harrod neutral innovation is:

$$l_H = \frac{(1-b)}{(1 + A\Omega_H^{-1} - b)} \quad (27)$$

$$\text{where } \Omega_H \text{ is defined as } \Omega_H \equiv 1 + \frac{\gamma \rho \left( \frac{b}{\theta} \right)^{\frac{b}{1-b}} B}{(\theta + (1-b) \rho \left( \frac{b}{\theta} \right)^{\frac{b}{1-b}} B)} > 1 \quad (28)$$

The labor supply curve for a Hicks neutral innovation is:

$$l_h = \frac{(1-b)}{(1 + A\Omega_h^{-1} - b)} \quad (29)$$

$$\text{where } \Omega_h \text{ is defined as } \Omega_h \equiv 1 + \frac{\gamma \rho \left( \frac{b}{\theta} \right)^{\frac{b}{1-b}} B^{\frac{1}{1-b}}}{(\theta + (1-b) \rho \left( \frac{b}{\theta} \right)^{\frac{b}{1-b}} B^{\frac{1}{1-b}})} > 1 \quad (30)$$

As we can see from (25), (27) and (29), labor supply is not independent of the type of technical progress affecting the economy, in contrast with the neoclassical case where the labor supply function is independent of the type of innovations. In order to compare these labor supply curves, notice that  $B > 1$  and  $b \in (0,1)$ . We have two cases of interest: i)  $b \geq (1-b)$ , and ii)  $b < (1-b)$ .

In the first case:  $b \geq (1-b)$  implies that  $\frac{b}{(1-b)} \geq 1$ , and as  $b \in (0,1)$  it follows that

$1-b < 1 \Rightarrow 1 < \frac{1}{1-b}$ , therefore we have:  $1 \leq \frac{b}{1-b} < \frac{1}{1-b}$ . This inequality implies that

$B \leq B^{\frac{b}{1-b}} < B^{\frac{1}{1-b}}$ , which yields:  $l_h > l_s \geq l_H$ . That is, the labor supply with Hicks neutral technology is greater than the labor supply with Solow neutral technology, which is greater than the labor supply with Harrod neutral technology.

In the second case:  $b < (1-b)$  implies that  $\frac{b}{(1-b)} < 1$ , therefore we have:

$\frac{b}{1-b} < 1 < \frac{1}{1-b}$ , as a consequence we have:  $B^{\frac{b}{1-b}} < B < B^{\frac{1}{1-b}}$ , which yields:  $l_h > l_H > l_s$ .

That is, the Hicks neutral labor supply is greater than the Harrod neutral, which is greater than the Solow neutral.

These results show that, when labor supply is habit forming, individuals' decisions on working hours are affected by the kind of technical progress. Innovations that increase the productivity of labor alone, such as improvements in firms' internal organization of tasks, would have a different impact on labor supply depending on the output elasticities of capital and labor. If the labor elasticity is higher than that of capital, i.e.  $b < (1-b)$ , as is usually the case in aggregate data, habit formation will lead to a higher labor supply than in capital-saving innovations.

Given these results, it is easy to compare the steady state solutions for capital stock, consumption and output.

In the Hicks neutral technology we have:

$$c_h = B^{\frac{1}{1-b}} \left( \frac{b}{\theta} \right)^{\frac{b}{1-b}} l_h \quad (31)$$

$$k_h = B^{\frac{1}{1-b}} \left( \frac{b}{\theta} \right)^{\frac{1}{1-b}} l_h \quad (32)$$

$$y_h = B k_h^b l_h^{1-b} \quad (33)$$

In the Solow neutral case we have:

$$c_s = B^{\frac{b}{1-b}} \left( \frac{b}{\theta} \right)^{\frac{b}{1-b}} l_s \quad (34)$$

$$k_s = B^{\frac{b}{1-b}} \left( \frac{b}{\theta} \right)^{\frac{1}{1-b}} l_s \quad (35)$$

$$y_s = (B k_s)^b l_s^{1-b} \quad (36)$$

Finally, for the Harrod neutral technology case we obtain:

$$c_H = B \left( \frac{b}{\theta} \right)^{\frac{b}{1-b}} l_H \quad (37)$$

$$k_H = B \left( \frac{b}{\theta} \right)^{\frac{1}{1-b}} l_H \quad (38)$$

$$y_H = k_H^b (B l_H)^{1-b} \quad (39)$$

The comparison is quite clear.

In the first case:  $b \geq (1-b)$  we know that  $B \leq B^{\frac{b}{1-b}} < B^{\frac{1}{1-b}}$ , and  $l_h > l_S \geq l_H$ . These inequalities imply that:

$$c_h > c_S \geq c_H,$$

$$k_h > k_S \geq k_H$$

$$y_h > y_S \geq y_H$$

That is, in the steady state, the consumption, capital stock and output of Hicks neutral technology is greater than the Solow neutral, which can be greater than the Harrod neutral.

In the second case:  $b < (1-b)$  we know that  $B^{\frac{b}{1-b}} < B < B^{\frac{1}{1-b}}$ , and  $l_h > l_H > l_S$ . These inequalities imply that:

$$c_h > c_H > c_S,$$

$$k_h > k_H > k_S$$

$$y_h > y_H > y_S$$

That is, in the steady state, the consumption, capital stock and output of Hicks neutral technology is greater than the Harrod neutral, which is greater than the Solow neutral.

#### **4. Conclusions**

In this paper we have analyzed the impact of introducing overtime work due to habit formation in labor supply in a neoclassical growth model and compared its outcome in terms of labor supply, consumption, capital stock, and output with a model without habit formation. Furthermore, we have analyzed the impact of 3 different forms of technological progress on these variables. Our results are important since they help to explain differences in the long run performance of economies with different social incentives towards work owing to cultural, religious, and economic organization factors as evidenced in the empirical literature.

Our main results are as follows. First, labor supply in the habit formation case is higher than in the neoclassical case. Second, unlike in the neoclassical case, labor supply in the presence of habit formation will depend on the kind of technical progress experienced by the economy, i.e. whether Hicks, Solow or Harrod neutral. In other words, in societies with positive incentives towards work, agents' decisions on labor supply will be influenced by the way technical progress takes place. We find that Hicks neutral innovations always generate a higher labor supply, whereas the impact of Solow neutral and Harrod neutral innovations will depend on the shares of capital and labor in income. Finally, and derived from the latter conclusion, the kind of technical progress will affect the steady state levels of consumption, capital stock and output. Our results imply that, in societies where overtime working habits are encouraged, the kind of technical progress will have consequences for the determination of employment, consumption and output.

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## Appendix:

In the steady state defined as:  $\dot{\lambda} = \dot{\mu} = \dot{k} = \dot{H} = 0$ , we have from equations (1), (3), (7) and (8) [using equations (10)-(12)] the following:

$$l = H \quad (1')$$

$$c = wl + rk = y = k^b l^{1-b} \quad (3')$$

$$\theta \lambda = \lambda r \Rightarrow \theta = b \left( \frac{l}{k} \right)^{1-b} \quad (7')$$

$$\theta \mu = [\gamma H^{-1} - \mu \rho (1-b) \left( \frac{k}{l} \right)^b] \quad (8')$$

From equation (7') follows:

$$k = l \left( \frac{b}{\theta} \right)^{\frac{1}{1-b}} \quad (7'')$$

using (7'') in (3') yields:

$$c = l \left( \frac{b}{\theta} \right)^{\frac{b}{1-b}} \quad (3'')$$

Taking equation (6) into account:

$$A(1-l)^{-1} = [\lambda + \mu \rho](1-b) \left( \frac{k}{l} \right)^b \quad (6')$$

noticing that from equation (5) follows:

$$c^{-1} = \lambda \quad (5')$$

And noticing that from equations (8'), (7'') and (1') follows:

$$\mu = \gamma \left[ l \left( \theta + \rho(1-b) \left( \frac{b}{\theta} \right)^{\frac{b}{1-b}} \right) \right]^{-1} \quad (8'')$$

by substituting (8'') and (5') into (6') yields the habit formations labor supply  $l^*$  [equation (15)]. Then by substituting equation (15) into equation (1') we find the steady state value of stock of working habits [equation (18)]. In the same vein, by substituting equation (15) into equations (3''), (7'') and (10), we find the steady state values of consumption, capital and output, respectively [equations (19), (20), (21)].