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Technology Shock and Employment under Catching up with the Joneses

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Abstract

Following a positive technology shock, a flexible price monetary model with catching up with the Joneses utility function can easily generate a negative and persistent decline in employment. When the effect of relative consumption is large, the model also produces a small short run response of output to a technology shock.

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1 Introduction

A series of papers (see Galí (1999), Basu, Fernald and Kimball (1998), Shea (1998), Francis and Ramey (2003)) document a striking empirical feature in both US economy and other industrialized economies: In response to a positive technology shock, employment falls. These findings cast some doubts about the empirical relevance of the Real Business Cycle (RBC) model and the technology–driven business cycles. Moreover, Galí (1999) shows that these facts are consistent with a class of models with imperfect competition and sticky prices.

In this paper, we argue that a model with flexible prices can account for these empirical findings. The literature already offers models that are able to provide a negative response of hours following a positive technology shock (see Christiano and Todd (1996), Hairault, Langot and Portier (1997), Boldrin, Christiano and Fisher (2001), Wen (2001), Francis and Ramey (2003), Collard and Dellas (2004)). We introduce *catching up with the Joneses* utility function (see Abel (1990)) in a general equilibrium monetary model. The model is identical to Galí (1999), except that it considers price flexibility. It should be noted that the results about employment dynamics can be obtained in a cashless economy. Indeed, the assumption of price flexibility in the Galí's model implies that the real side of the economy (employment, output, consumption) can be solved independently from the nominal side. We essentially use this model for comparison purpose as employment does not react to a technology shock when prices are flexible and relative consumption – *catching up with the Joneses* – does not matters. This theoretical framework is a simplified version of Boldrin, Christiano and Fisher (2001), Wen (2001) and Francis and Ramey (2003), but we make more progress analytically. The model is deliberately stylized in order to deliver an analytical solution of the equilibrium processes for the variables of interest in terms of the technological shock. We show that, when relative consumption – *catching up with the Joneses* – matters, the response of hours worked is negative and persistent. Moreover, when this effect increases, the negative effect on hours in magnified, whereas the short run response of output to technological shock decreases.

2 The Model

We use the general equilibrium monetary model of Galí (1999) in the case of price flexibility. This simple model (no capital accumulation) allows to determine analytically the effect of a positive technology shock on employment and output.

2.1 The representative household

The representative household seeks to maximize

$$E_o \sum_{t=0}^{\infty} \left\{ \log \left(C_t - a\bar{C}_{t-1} \right) + \lambda_m \log \frac{M_t}{P_t} - H\left(N_t, U_t\right) \right\}$$

subject to the budget constraint

$$P_t C_t + M_t = W_t N_t + V_t U_t + M_{t-1} + \Upsilon_t + \Pi_t$$

for $t = 0, 1, 2, ...$ The quantity of good consumed in period t is denoted C_t. We assume that the lagged aggregate consumption $\bar{C}_{t-1}$ enters in utility, therefore accounting for a *catching up with the Joneses*. The parameter $a \in [0, 1)$ represents the sensitivity of household's preferences to lagged aggregate consumption. P_t is the aggregate price level. M_t denotes (nominal) money holdings. The function $H(.,.)$ measures the disutility from work, which is a function of hours (N_t) and effort (U_t). The functional form of $H(.,.)$ is assumed

$$H(N_t, U_t) = \frac{\lambda_n}{1+\sigma_n} N_t^{1+\sigma_n} + \frac{\lambda_u}{1+\sigma_u} U_t^{1+\sigma_u}$$

The monetary transfers and profits are denoted Υ_t and Π_t, respectively. The nominal price of hours and effort are W_t and V_t. The parameter $\beta \in (0, 1)$ is the discount factor and λ_m,λ_n, λ_u, σ_n and σ_u are positive constants.

The first order conditions of the households problem are

$$\frac{1}{C_t - a\bar{C}_{t-1}} = \lambda_m \frac{P_t}{M_t} + \beta E_t \left[\frac{1}{C_{t+1} - a\bar{C}_t} \frac{P_t}{P_{t+1}} \right] \quad (1)$$

$$\frac{W_t}{P_t} = \lambda_n \left(C_t - a\bar{C}_{t-1} \right) N_t^{\sigma_n} \quad (2)$$

$$\frac{V_t}{P_t} = \lambda_u \left(C_t - a\bar{C}_{t-1} \right) U_t^{\sigma_u} \quad (3)$$

As equations (1)–(3) make it clear, a solution for the real variables can be obtained independently from the nominal variables. This is a direct consequence of *i)* the separability of the utility function between consumption and real balances and *ii)* the flexible prices assumption. The solution will be exactly the same in a cashless economy.[1]

2.2 The representative firm

The representative firm produces an homogenous good with a technology

$$Y_t = Z_t L_t^{\alpha}$$

where $\alpha \in (0, 1]$ and L_t represents the quantity of effective labor input used by the firm. This quantity is a function of hours and effort

$$L_t = N_t^{\theta} U_t^{1-\theta}$$

where $\theta \in (0, 1)$. The variable Z_t is the aggregate technology. The growth rate of Z_t is assumed to be *iid* and normally distributed

$$Z_t = Z_{t-1} \exp(\eta_t) \tag{4}$$

where $\eta_t \sim \mathcal{N}(0, \sigma_\eta^2)$. The first order conditions of the firms problem are

$$\alpha\theta Z_t N_t^{\alpha\theta-1} U_t^{\alpha(1-\theta)} = \frac{W_t}{P_t} \tag{5}$$

$$\alpha(1-\theta) Z_t N_t^{\alpha\theta} U_t^{\alpha(1-\theta)-1} = \frac{V_t}{P_t} \tag{6}$$

2.3 The monetary authority

Following Galí (1999), we assume that the monetary authority supplies money according to the simple rule

$$M_t = \mu M_{t-1}$$

where μ is the constant growth rate of money supply.

[1] In this case, we set $\lambda_m = 0$ and the budget constraint rewrites $P_t C_t = W_t N_t + V_t U_t + \Pi_t$. The model can be also extended to the case where (identical) agents can freely trade a complete set of contingent claims. As equilibrium asset prices will adjust such that it is optimal to choose a zero net position in these claims, the solution will remain the same.

2.4 The solution

An equilibrium is a sequence of prices and allocations, such that given prices, allocations maximize profits (equations (5) and (6)) and maximize utility (equations (1)–(3)), and all markets clear $Y_t = C_t = Z_t N_t^{\alpha\theta} U_t^{\alpha(1-\theta)}$. In a symmetric equilibrium, all households have the same consumption and $C_t = \bar{C}_t \;\; \forall t$. The equilibrium conditions are approximated by log–linearization[2] around bout the deterministic steady state (see the appendix). The dynamics hours worked – in relative deviation from steady state – is given by:

$$\widehat{n}_t = \frac{a\varphi}{a\varphi + (1-a)\sigma_n}\widehat{n}_{t-1} - \frac{a}{a\varphi + (1-a)\sigma_n}\eta_t \tag{7}$$

where φ is given by

$$\varphi = \alpha\left(\theta + (1-\theta)\frac{1+\sigma_n}{1+\sigma_h}\right) > 0$$

Some noticeable results emerges from equation (7). First, when $a = 0$ (*no catching up with the Joneses*), hours are constant whatever the other structural parameters are. Second, when $0 < a < 1$, the response of hours to a positive technological shock is negative as $\varphi > 0$ and $a \in [0, 1)$. Third, the negative response of hours is persistent.

The reason of this negative response in hours stems from the fact that consumption does not change as too much following an increase in the labor income, as the effect of relative consumption implies that aggregate consumption rises gradually (the instantaneous response of consumption is a decreasing function of a). It follows that households spend their new income in leisure (see Francis and Ramey (2003)). Equation (7) shows that the response of hours are is larger when a increases. Moreover, *catching up with the Joneses* utility function induces a persistent negative response of hours.

Output – or equivalently consumption – moves persistently in the opposite direction of hours

$$\Delta\widehat{y}_t = \frac{a\varphi}{a\varphi + (1-a)\sigma_n}\Delta\widehat{y}_{t-1} + \frac{(1-a)(1+\sigma_n)}{a\varphi + (1-a)\sigma_n}\eta_t$$

where $\Delta\widehat{y}$ denotes the growth rate of output. Following a positive technology shock, the level of output rises gradually, but permanently. Note that when a is large (close to one), the rise in output is very persistent, but the effect of a technology shock is almost zero in

[2] Unfortunately, the model does not possess a closed–form solution as equilibrium employment is a non–linear function of technology shocks (see the appendix).

the short run. Conversely, the negative response of hours is magnified. In this case, the labor productivity will present a strong negative correlation with employment in the short run. The flexible price model with relative consumption is thus consistent with empirical results.

3 Summary and Conclusions

The purpose of this paper is to assess the effect of a positive technology shock on employment and production in a monetary model with flexible price. We show that the introduction of a *catching up with the Joneses* utility function produces a persistently negative response of employment. Moreover, the response of the output in the short run appears almost insensitive to a technology shock when the effect of relative consumption is large.

It is worth noting that when households have other alternatives than leisure, the negative response of employment disappears. For example, in the a RBC model with habit formation, households put these new ressources into investment. However, when capital adjustment costs is large enough, the RBC model will produce the same response of employment after a technology shock than our simple model.

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Appendix

We report the log–linear representation of hours worked. Dividing (6) by (5) and (3) by (2) yields

$$\begin{aligned} \frac{1-\theta}{\theta}\frac{N_t}{U_t} &= \frac{V_t}{W_t} \\ \frac{\lambda_u}{\lambda_n}\frac{U_t^{\sigma_u}}{N_t^{\sigma_n}} &= \frac{V_t}{W_t} \end{aligned}$$

Using these two equations, the production function rewrites

$$Y_t = Y_o Z_t N_t^{\varphi}$$

where $Y_o = ((1-\theta)\lambda_n/\theta\lambda_u)^{\alpha(1-\theta)/(1+\sigma_u)}$ and $\varphi = \alpha(\theta + (1-\theta)(1+\sigma_n)/(1+\sigma_u))$. From equations (2) and (5), we deduce the dynamics of hours worked:

$$\alpha\theta Y_o Z_t N_t^{\varphi-1-\sigma_n} = \lambda_n \left(Y_o Z_t N_t^{\varphi} - a Y_o Z_{t-1} N_{t-1}^{\varphi}\right)$$

Using the stochastic process (4) of the technology shock Z_t, this equation rewrites:

$$\alpha\theta \exp(\eta_t) Z_t N_t^{\varphi-1-\sigma_n} = \lambda_n \left(\exp(\eta_t) N_t^{\varphi} - a N_{t-1}^{\varphi}\right)$$

This equation admits the following log–linear approximation

$$\eta_t + (\varphi - 1 - \sigma_n)\,\widehat{n}_t = \frac{\varphi}{1-a}\widehat{n}_t + \frac{\varphi}{1-a}\eta_t - \frac{a\varphi}{1-a}\widehat{n}_{t-1}$$

where $\widehat{n} = (\log N - \log N^\star)/\log N^\star$ and $N^\star = (\alpha\theta/\lambda_n(1-a))^{1/(1+\sigma_n)}$ denotes the deterministic steady state value of hours. After some manipulations, we obtain equation (7).

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