The Complementary Role of Microcredit and Microinsurance in Poverty Reduction

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Abstract

This paper explores the role of microcredit and microinsurance in poverty reduction in a framework where capital accumulation and risk are taken into account. We show that low capital accumulation attributes to the occurrence of poverty trap and risk intensifies the possibility that the household falls into poverty trap. In presence of risk, microcredit decreases the possibility that the household falls into the trap, but cannot remove the trap. Combining microinsurance and microcredit is not only able to remove the trap, but also has a potential to improve the efficiency of microcredit and thus increase households' welfare.

Keywords: Poverty trap, Microfinance, Microcredit, Microinsurance

1 Introduction

The topic of poverty traps has attracted a lot of attentions in development economics, see Barrett and Carter (2013) for an excellent review of related literature. As an important remedy to helping households escape the poverty trap, various forms of microcredit programs have been developed (Armendáriz De Aghion and Morduch 2005). Recently, microinsurance also has been proposed as an important tool to intervene in poverty traps (Churchill 2011). However, relative to the real-life rapid development, the theoretical mechanism about both the bright and dark sides of microcredit and microinsurance in the intervention has not been well clarified and this paper aims to fill this gap.

Clarke and Dercon (2009) point out that asset investment (and production efficiency) and risk play a key role in determining the formation of poverty trap. We borrow their idea and take both ingredients into our setup. Instead of modeling the asset accumulation as a exponential growth process as Kovacevic and Pflug (2011), we believe the production efficiency is relatively low in most developing countries and thus assume the production function is concave. We first build up a simple deterministic economic growth model, and show the existence of multiple equilibria, containing two attracting states (rich and poor). Next, we incorporate risk into analysis and elaborate on the role of microcredit and microinsurance in poverty reduction.

We first show in a deterministic growth model that a rural household will fall into poverty trap when her capital investment is low and microcredit can remove the trap by aiding the household with a sufficiently large loan. However, when risk is taken into account, microcredit only play a partially positive role in poverty reduction even if the debt relief is permitted when risk occurs: it can decrease the probability that the household fall into the trap but is unable to eliminate the trap completely. Moreover, when the debt relief is not permitted, the role of microcredit is further weakened. In contrast, microinsurance, combining with microcredit, can remove the poverty trap completely. By considering two forms of microinsurance: the insurance for the output and the one for input, we show that microinsurance has a potential to improve the efficiency of microcredit and make the household achieve a higher stable income and a resulting higher welfare.

The rest of the paper is organized as follows. In section 2, a simple deterministic growth model is introduced and the role of microcredit in poverty reduction is examined. Section 3 takes risk into analysis and the complementary role of microcrdit and microinsurance is studied. Section 4 concludes the paper. All proofs are relegated in Appendix.

2 A Simple deterministic growth Model

This section introduces a simple deterministic growth model and interprets the formation of poverty trap, and then explores the role of microcredit in helping rural households escape the poverty trap.

2.1 Consumption and production

We first consider a representative rural household's consumption and production in the growth model. In the period t, a representative rural household produces the output y_t through rural production, which is also the total revenue of the household in this period. The consumption of the household is considered as a increasing function of income

$$c_t = \begin{cases} y_t & y_t \leq y^c \\ y^c + \alpha(y_t - y^c) & y_t > y^c \end{cases},$$

where y^c is a critical income level and $0 < \alpha < 1$. If the income is smaller than y^c, all of the income is consumed and no saving is left. When there exists saving in the case of $y_t > y^c$, the household will use the saving as the capital investment in the next period. With the riskless interest rate r, the capital investment in the next period becomes

$$k_{t+1} = (1+r)(y_t - c_t) = \begin{cases} 0 & y_t \leq y^c \\ (1+r)(1-\alpha)(y_t - y^c) & y_t > y^c \end{cases}. \tag{1}$$

We assume that a rural household will invest capital and labor for production. Here the household' labor investment is normalized as one, and capital investment k_t and output y_t in period t represent the normalized capital and output respectively. The production function thus writes as

$$y_t = f(k_t), \tag{2}$$

where we assume the function satisfies $f(0) = 0, f'(0+) = \infty, f'(+\infty) = 0$ and $f''(\cdot) < 0$. Note that the rural household can never escape from poverty trap if the production efficiency is sufficiently small. Since we aim at examining the effects of microcredit and microinsurance on poverty reduction, we rule out the above possibility by imposing the following assumption.

Assumption 1: Assume there exists some capital investment k satisfying $f(k) > y^c +$

$\frac{k}{(1+r)(1-\alpha)}$.

We obtain the following lemma (see the Appendix for proof):

Lemma 1. *Under Assumption 1, there exists a critical level of capital investment* $k^c > 0$ *satisfying* $f(k^c) = y^c + \frac{k^c}{(1+r)(1-\alpha)}$ *and* $f'(k^c) > \frac{1}{(1+r)(1-\alpha)}$, *such that the stable income the household can achieve is*

$$y^s = \begin{cases} 0 \quad k_t < k^c \\ f(k^c) \quad k_t = k^c \\ y^* \quad k_t > k^c \end{cases} \tag{3}$$

where y^* *satisfies* $y^* = f((1+r)(1-\alpha)(y^* - y^c))$ *and* $f'((1+r)(1-\alpha)(y^* - y^c)) < \frac{1}{(1+r)(1-\alpha)}$.

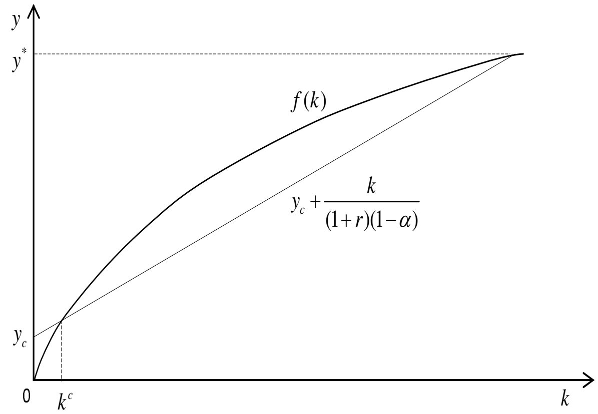
Lemma 1 demonstrates the existence of poverty trap: when the household's income is low such that she only holds a small amount of investment $k_t < k^c$, her stable income will eventually becomes zero, i.e. she moves into the poverty trap. Only if the household holds a large amount of investment $k_t > k^c$, she can achieve a high level of stable income y^*, escaping from the poverty trap. Figure 1 illustrates these results graphically. In this figure, the line $y = y^c + \frac{k}{(1+r)(1-\alpha)}$ intersects with the curve $y = f(k)$ at $(k_c, f(k_c))$ and $((1+r)(1-\alpha)(y^* - y^c), y^*)$, where $(1+r)(1-\alpha)(y^* - y^c) > k^c$. When the household's initial capital $k < k^c$, her income eventually becomes 0. On the other hand, if the initial capital $k > k^c$, her income turns out to achieve y^* at stable state. Note that $k = k^c$ represents an instable state. This result implies the capital accumulation plays a key role in determining whether households enters poverty or not.

2.2 Microcredit

Now we allow microcredit to be available to the household and explore how microcredit helps the household move out of poverty trap. Intuitively, with the help of microcredit, the household can invest the sufficiently large capital such that she can escape from poverty trap. Denote the borrowing money by b_t in period t. we formalize this intuition as the following lemma.

Lemma 2. *Given the household's capital* $k_t < k^c$ *in period* t, *there exists a critical level of*

Figure 1: Poverty trap



In this figure, the horizontal axis and vertical axis represent the capital and output respectively. The line $y = y^c + \frac{k}{(1+r)(1-\alpha)}$ intersects the curve $y = f(k)$ at two points, $(k^c, f(k^c))$ and $((1+r)(1-\alpha)(y^* - y^c), y^*)$, where k^c and y^* represent the critical level of capital investment and the stable income the household can achieve respectively.

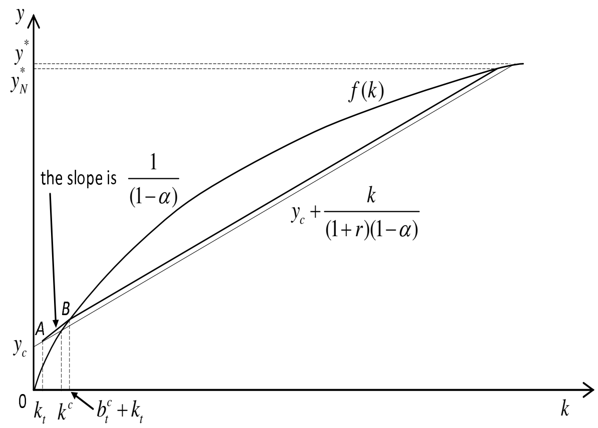
the borrowing amount $b_t^c > 0$ such that the household can achieve a stable income

$$y_N^s = \begin{cases} 0 & b_t < b_t^c \\ f(k_t + b_t^c) & b_t = b_t^c \\ y_N^* & b_t > b_t^c \end{cases}$$

where b_t^c satisfies $f(k_t + b_t^c) = y^c + \frac{b_t^c}{1-\alpha} + \frac{k_t}{(1+r)(1-\alpha)}$ and $f'(k_t + b_t^c) > \frac{1}{1-\alpha}$, and y_N^* satisfies $y_N^* = f((1+r)(1-\alpha)(y_N^* - y^c - rb_t))$ and $f'((1+r)(1-\alpha)(y_N^* - y^c - rb_t)) < \frac{1}{(1+r)(1-\alpha)}$.

Lemma 2 shows the positive role of microcredit: with sufficiently large credit, the household can move out of poverty trap. As shown in Figure 2, given any initial capital $k_t < k^c$, the new critical level of capital becomes $k_t + b_t^c$ and the resulting output is $f(k_t + b_t^c)$, which correspond to the intersection between the line AB with the slope $1/(1-\alpha)$ and the curve $f(k)$. It is easy to see that $k_t + b_t^c$ is larger than k^c, and the smaller k_t the more so. This reflects the impact of credit cost. Indeed, the stable income under the case of microcredit becomes y_N^*, strictly smaller than y^* for any $k_t < k^c$. These results suggest that although credit can help the household to reduce poverty in the case without risk, it still has side effect since the household need to pay interest cost of the debt.

Figure 2: The impact of microcredit on poverty reduction in absence of risk



In this figure, the point A corresponding to the initial capital k_t in period t lies on the line $y = y^c + \frac{k}{(1+r)(1-\alpha)}$. The line AB with the slope $1/(1-\alpha)$ intersects the curve $f(k)$ at the point B, i.e., $(b_t^c + k_t, f(b_t^c + k_t))$. The line through B parallel to the line $y = y^c + \frac{k}{(1+r)(1-\alpha)}$ intersects the curve $y = f(k)$ at the other point, $((1+r)(1-\alpha)(y_N^* - y^c - rb_t), y_N^*)$. Other notations are same as those of Figure 1.

3 Risk, Microcredit and Microinsurance

In production process, a rural household faces various types of shocks, for example, floods or hurricanes. we thus take risk into account and explore how the risk affects the formulation of poverty trap. We next show how microcredit and microinsurance can help the household to escape from the poverty trap in presence of risk.

3.1 Growth with Risk

Assume in the period t, a rural household's production faces a shock, which causes a proportional loss $(1-\eta)y_t$, occurring with probability p. Under the loss shock, the household's revenue becomes

$$\tilde{y}_t = \begin{cases} y_t & \text{when no loss occures} \\ \eta y_t & \text{when loss occures} \end{cases},$$

and the resulting investment in the next period k_{t+1} is

$$k_{t+1} = \begin{cases} 0 & \tilde{y}_t \le y^c \\ (1+r)(1-\alpha)(\tilde{y}_t - y^c) & \tilde{y}_t > y^c \end{cases}$$

We are interested in how risk causes the household to fall into poverty trap. To simplify our analysis and without loss of generality, we impose the following assumption.

Assumption 2: Assume that the scale of loss is large enough such that $\eta y_t \leq y^c$.

This assumption implies that the household, even with high income, has a possibility to fall into poverty trap due to adverse risk. With this assumption, we capture the impact of risk on poverty which is commonplace in the developing countries.

3.2 Microcredit

When loss shock occurs, the household only makes a low income and is unable to repay her debt. As a result, the loaner faces a default risk which occurs with probability p, and he thus at least asks a risk premium $1/p - 1 = \frac{p}{1-p}$ to keep business sustainable. This implies the household need to pay a higher interest for her debt than the riskless rate. Indeed, she need to pay (at least) the interest $\frac{p}{1-p} + r$ for her debt. As a result, the household's borrowing and production become distinct from the case without risk.

Proposition 1. *Under assumption 1 and 2, to make the household with the capital $k_t < k_c$ in period t move out of the poverty trap, the loan b_t must be strictly larger than b_t^d, satisfying*

$$f(k_t + b_t^d) = y^c + (\frac{p}{1-p} + \frac{1}{1-\alpha})b_t^d + \frac{k_t}{(1+r)(1-\alpha)}$$

$$\text{and } f'(k_t + b_t^d) > \frac{1}{(1+r)1-\alpha)} + \frac{p}{1-p},$$

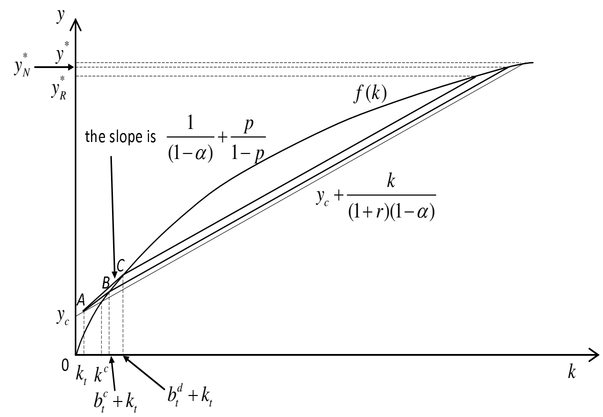
such that the household can achieve a stable income y_R^* satisfying

$$y_R^* = f((1+r)(1-\alpha)[y_R^* - y^c - (\frac{p}{1-p} + r)b_t])$$

$$\text{and } f'((1+r)(1-\alpha)[y_R^* - y^c - (\frac{p}{1-p} + r)b_t]) < \frac{1}{(1+r)(1-\alpha)}.$$

As shown in Figure 3, the new critical level of capital becomes $k_t + b_t^d$, which corresponds to the intersection between the line AC with the slope $1/(1-\alpha) + p/(1-p)$ and the curve $f(k)$, i.e., the point C. This value is larger than $k_t + b_t^c$, reflecting the impact of risk premium asked for the microcredit. That is, for the same k_t, the borrowing money needed to escape poverty trap becomes larger in presence of risk. The existence of risk premium also makes the high stable income the household can achieve with microcredit become lower than that in the case of no risk, i.e., $y_R^* < y_N^*$.

Figure 3: The impact of microcredit on poverty reduction in presence of risk



In this figure, the line AC with the slope $\frac{1}{1-\alpha} + \frac{p}{1-p}$ intersects the curve $f(k)$ at the point C, i.e., $(b_t^d + k_t, f(b_t^d + k_t))$. The line through C parallel to the line $y = y^c + \frac{k}{(1+r)(1-\alpha)}$ intersects the curve $y = f(k)$ at the other point, $((1+r)(1-\alpha)(y_R^* - y^c - (\frac{p}{1-p} + r)b_t), y_R^*)$. Other notations are same as those of Figure 2.

Note that under Assumption 2, the household with the initial state that she moves out of the poverty trap will fall into the trap again once the loss shock occurs with probability p in the next period. On the other hand, without loss of generality, we here assume that microcredit helps the household to escape the trap with probability q. Then we obtain the following probability transition matrix

$$\begin{bmatrix} 1-p & p \\ q & 1-q \end{bmatrix}$$

Let π denote the probability that the household escapes poverty trap at stable state. We thus obtain

$$[\pi \quad 1-\pi] \begin{bmatrix} 1-p & p \\ q & 1-q \end{bmatrix} = [\pi \quad 1-\pi],$$

and then $\pi = \frac{q}{p+q}$. It is easy to see that if $q > 1-p$, the probability of escaping poverty trap at stable state $\pi > 1-p$ and visa versa. This result suggests that microcredit can mitigate the negative effect of risk on driving households into poverty trap. However, it cannot eliminate the trap completely since even in the case of $q = 1$, $\pi = \frac{1}{1+p} < 1$.

Moreover, our analysis allows the household to default when loss shock occurs in every period and the household still can obtain the loan in the next period whenever she defaults or not in the current period. The latter implies that the household's debt is relieved once she experiences a loss shock. In real-life fiance, debt relief may not happen and as a result the role of microcredit in poverty reduction becomes even smaller than our analysis.

3.3 Microinsurance

Now we turn to analyzing the role of microinsurance in poverty reduction. We assume that microinsurance can be used to hedge the household's risk, and consider two forms of insurance with with actuarially fair premium. The first form of insurance is the one for output. That is, the household with the total capital investment $k_t + b_t$ pays the (discounted) premium $P = p(1-\eta)f(b_t + k_t)/(1+r)$ to obtain the insurance coverage $(1-\eta)f(b_t + k_t)$ when loss shock occurs. The following proposition exhibits the role of this form of microinsurance.

Proposition 2. *In presence of output insurance, to help the household with the capital $k_t < k_c$ in period t move out of the poverty trap, the loan b_t must be strictly larger than $b_t^{I_1}$, satisfying*

$$\begin{aligned} f(k_t + b_t^{I_1}) &= \frac{1}{1-p(1-\eta)}\left[y^c + \frac{b_t^{I_1}}{1-\alpha} + \frac{k_t}{(1+r)(1-\alpha)}\right] \\ \textit{and } f'(k_t + b_t^{I_1}) &> \frac{1}{(1-p(1-\eta))(1-\alpha)}, \end{aligned}$$

such that the household can achieve a stable income $y_{I_1}^*$ satisfying

$$\begin{aligned} y_{I_1}^* &= f((1+r)(1-\alpha)[(1-p(1-\eta))y_{I_1}^* - y^c - rb_t]) \\ \textit{and } f'((1+r)(1-\alpha)&[(1-p(1-\eta))y_{I_1}^* - y^c - rb_t]) < \frac{1}{(1+r)(1-\alpha)}. \end{aligned}$$

Proposition 2 shows that combining output microinsurance with microcredit can help the household move out of poverty trap: with the loan larger than $b_t^{I_1}$, the household will eventually achieve the statable income $y_{I_1}^*$. It is worth noting that the loan amount needed for removing poverty trap depends on the insured loss. If the potential loss is so large that $\eta < \alpha$, one can easily obtain $b_t^{I_1} > b_t^d$ for any capital k_t. In other words, if the loss shock is sufficiently large, the loan amount needed for removing poverty trap becomes larger with output insurance than the case without insurance. In this situation, the stable income $y_{I_1}^*$ the household can achieve is lower than that in the case without insurance, y_R^*. If, instead, the insured loss is small, the loan amount becomes lower than the case without insurance and the efficiency of microcredit is improved due to the existence of micorinsurance. In the meanwhile, micorinsurance makes the stable income higher and thus increases the welfare of the household.

The second form of insurance is the input insurance that the household with the total capital investment $k_t + b_t$ pays the (discounted) premium $P = p(b_t + k_t)/(1+r)$ to obtain the insurance coverage $b_t + k_t$ when loss shock occurs.

Proposition 3. *In presence of output insurance, to help the household with the capital $k_t < k_c$*

in period t move out of the poverty trap, the loan b_t must be strictly larger than $b_t^{I_2}$, satisfying

$$f(k_t + b_t^{I_2}) = y^c + p(b_t^{I_2} + k_t) + \frac{b_t^{I_2}}{1-\alpha} + \frac{k_t}{(1+r)(1-\alpha)}$$
$$\text{and } f'(k_t + b_t^{I_2}) > \frac{1}{(1-\alpha)} + p,$$

such that the household can achieve a stable income $y^*_{I_2}$ satisfying

$$y^*_{I_2} = f((1+r)(1-\alpha)[y^*_{I_2} - y^c - p(b_t^{I_2} + k_t) - rb_t])$$
$$\text{and } f'((1+r)(1-\alpha)[y^*_{I_2} - y^c - p(b_t^{I_2} + k_t) - rb_t]) < \frac{1}{(1+r)(1-\alpha)}.$$

Similarly, Proposition 3 also shows that combining output microinsurance with microcredit can remove poverty trap. Moreover, it is easy to obtain that if the probability of risk p or the initial capital k_t is sufficiently small, the loan amount needed to escape poverty trap with input insurance, $b_t^{I_2}$ is smaller than that without insurance, b_t^d. In this situation, the stable income the household achieve, $y^*_{I_2}$, is larger than that without insurance, y^*_R. These results imply that micorinsurance with the form of input insurance not only can remove poverty trap, but also has a potential to improve the efficiency of microcredit and increase the permanent welfare of the household.

4 Conclusion

This paper builds up a growth model in which asset accumulation and risk are taken into account. We identify the condition for the occurrence of poverty trap and show both asset investment and risk play a key role in its occurence. In presence of risk, we show that microcredit can partially reduce households' poverty but cannot remove poverty trap. In contrast, microinsuance, combining with microcredit, is not only able to remove the trap, but also has a potential to improve the efficiency of microcredit and makes households to achieve a higher stable income and a resulting higher welfare.

Appendix

Proof of Lemma 1. Define $g(k) = y^c + \frac{k}{(1+r)(1-\alpha)}$. We have $g(0) = y^c > 0$ and $g'(k) = \frac{1}{(1+r)(1-\alpha)}$. Note that $f(k)$ is a concave function. With Assumption 1, the curve $f(k)$ must

intersect with the line $g(k)$ only twice. That is, there exist k^c satisfying $f(k^c) = g(k^c)$ and $f'(k^c) > g'(k^c) = \frac{1}{(1+r)(1-\alpha)}$, and k^* satisfying $f(k^*) = g(k^*)$ and $f'(k^*) < g'(k^*) = \frac{1}{(1+r)(1-\alpha)}$.
Now we consider three cases of k_t:
(1) If $k_t < k^c$, $y_t < f(k^c) = y^c + \frac{k^c}{(1+r)(1-\alpha)}$ holds. We first consider $y_t \leq y^c$. In this case, $k_{t+1} = 0$ and $y_{t+1} = f(0) = y_{t+2} = \cdots = 0$. Therefore $y^s = 0$.
Now we consider $y^c < y_t < y^c + \frac{k^c}{(1+r)(1-\alpha)}$. In this case, $k_{t+1} = (1+r)(1-\alpha)(y_t - y^c) < k_c$. Hence $y_{t+1} = f(k_{t+1}) < f(k_c)$. We thus obtain

$$
\begin{aligned}
y_{t+1} - (y^c + \frac{k_c}{(1+r)(1-\alpha)}) &= f((1+r)(1-\alpha)(y_t - y^c)) - f(k_c) \\
&= f'(\xi)(1+r)(1-\alpha)(y_0 - y^c - \frac{k_c}{(1+r)(1-\alpha)})
\end{aligned}
$$

where $(1+r)(1-\alpha)(y_t - y^c) \leq \xi < k_c$. Then $f'(\xi) > \frac{1}{(1+r)(1-\alpha)}$ since $f'' < 0$ and $f'(k^c) > g'(k^c) = \frac{1}{(1+r)(1-\alpha)}$. Note that $y_t < y^c + \frac{k_c}{(1+r)(1-\alpha)}$. It follows that

$$
y_{t+1} - (y^c + \frac{k_c}{(1+r)(1-\alpha)}) < y_t - (y^c + \frac{k_c}{(1+r)(1-\alpha)})
$$

Then $y_{t+1} < y_t$. By the similar reasoning, we establish $y_{t+2} < y_{t+1}$, $y_{t+3} < y_{t+2}$ and so on until $y_{t+i} \leq y^c$, then $y_{t+i+1} = f(0) = y_{t+i+2} = \cdots = y^s = 0$.
(2) Consider the case $k_t > k_c$. Define k^* satisfying $f(k^*) = y^*$. For the case $k_t > k^*$, by the similar reasoning as (1), it establishes $y_{t+1} < y_t$, $y_{t+2} < y_{t+1}$ and so on until the output reduces to y^*. Now we consider the case $k^c < k_t \leq k^*$. Notice that $f(k^*) - f(k^c) = f'(\eta)(k^* - k^c) = \frac{1}{(1+r)(1-\alpha)}(k^* - k^c)$. That is, $f'(\eta) = \frac{1}{(1+r)(1-\alpha)}$. For any k_t satisfying $k^c < k_t \leq k^*$, we have $f(k_t) - f(k^c) = f'(\xi)(k_t - k^c)$ with $\xi < \eta$. Thus there must be $f'(\xi) > \frac{1}{(1+r)(1-\alpha)}$ since $f''(k) < 0$. As a result, with the similar reasoning as (1), it establishes $y_{t+1} > y_t$, $y_{t+2} > y_{t+1}$ and so on until the output increases to y^*. Taking both cases together, we obtain that the stable output y^* will be achieved when $k_t > k^c$.
(3) For the case $k_t = k_c$, it is easy to verify that the output will kept at the level $f(k_c)$.

The proofs of Lemma 2, Proposition 1-3 are analogue to that of Lemma 1 and are omitted in this proposal.

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