# 科技部補助專題研究計畫成果報告
# 期末報告

## 貿易流量與不均度間之庫茲涅茨曲線的理論解釋

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處 理 方 式 ：
1.公開資訊：本計畫可公開查詢
2.「本研究」是否已有嚴重損及公共利益之發現：否
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中 文 摘 要 ： 依循晚近的研究，本文試圖建構貿易與所得不均度間的因果關係。國際貿易學者仍在此議題上有所爭論。類似近幾年的理論及實證上的研究，本文強調貿易與所得不均度間存在著反「U」型的關係。在資本市場存在摩擦的假設下，生產者的異質性以及要素在產業內的重分配產生了上述現象。資本市場的摩擦內生的促成了生產力的異質性。貿易對需求彈性的影響取決於相對生產力，因此當生產者存在異質性時，貿易會非對稱的影響彈性。因為富有且高生產力的生產者的需求彈性較不受競爭程度的影響，貿易迫使低生產力的窮人退出市場，並使要素往高生產力的富人集中。然而，當所有的窮人都退出市場時，競爭對彈性的影響集中於富人身上，因此富人的利潤開始隨開放程度下降，而貿易也開始減少所得的不均度。

中文關鍵詞： 庫茲涅茨曲線、國際貿易、借貸市場摩擦、所得分配不平均、異質生產者

英 文 摘 要 ： We build a model to replicate empirical finding that the relationship between trade liberalization and inequality is hump-shaped. Poor agents are low-productivity producers because they incur higher educational costs due to frictions in the capital market. After trade liberalization, the demand elasticity of low-productivity agents increases more than that of wealthy agents. Therefore, market share is redistributed to wealthy agents, which increases inequality. After all low-productivity agents have exited, further trade liberalization reduces profit of wealthy agents because of the foreign competition, which reduces inequality. This mechanism conforms with empirical findings that trade causes redistribution of factors within industries and trade increases elasticity while reduces dispersion of productivity.

英文關鍵詞： Openness Kuznet Curve, International Trade, Capital Market Frictions, Income Inequality, Heterogeneous Firms

# A Theoretical Explanation of the Openness Kuznets Curve

Tsechien Hsu

March 31, 2014

**Abstract**

We build a model to replicate empirical finding that the relationship between trade liberalization and inequality is hump-shaped. Poor agents are low-productivity producers because they incur higher educational costs due to frictions in the capital market. After trade liberalization, the demand elasticity of low-productivity agents increases more than that of wealthy agents. Therefore, market share is redistributed to wealthy agents, which increases inequality. After all low-productivity agents have exited, further trade liberalization reduces profit of wealthy agents because of the foreign competition, which reduces inequality. This mechanism conforms with empirical findings that trade causes redistribution of factors within industries and trade increases elasticity while reduces dispersion of productivity.

JEL: F12, O16

## 1 Introduction

There is a long debate among trade economists whether there is a causal link between trade and inequality[1] The story begins when economists find evidence of sizable wage gap between skilled and unskilled labor since 1980s. Stolper-Samuelson theorem fails to explain it because the trend happens not only in the developed but developing countries[2]. Actually, trade most likely causes inequality in developing countries[3]. Furthermore, contradicting to the Stolper-Samuelson theorem, trade usually causes reallocation of factors within rather than between industries.[4] However, based on new empiri-

[1]See Krugman (2000), Deardorff (2000), and Leamer (2000).

[2]About the evidence of sizable wage gap between skilled and unskilled labor in the developing countries, see Duryea and Szekely (2000), Behrman et al. (2001), Robbins (1995), Desjounqueres et al. (1999), Hanson and Harrison (1994), Davis (1992), and Goldberg and Pavcnik (2007). For developed countries, see Table 3.1 on page 61-62 of OECD (1996).

[3]See Barro (2000) and Kapstein and Milanovic (2002).

[4]See Bernard and Jensen (2004) and Haltiwanger et al. (2004).

cal findings and new trade models, recent theoretical works show plausible causal links between trade and inequality.[5]

The purpose of this research is to shed some light on this issue based on the knowledge of heterogeneous firms pioneered by Melitz (2003) and Melitz and Ottaviano (2008) and the friction in the capital market frequently observed in developing countries. We show that the relationship between trade and inequality is inverted "U" shape. Inequality first increases with degree of openness and after it reaches the maximum, it decreases as trade is more liberalized. The result replicates recent empirical findings of trade and inequality and is sometimes named as the "Openness Kutznet Curve" (Dobson and Ramlogan, 2009) because it is similar to the graphical representation of Simon Kuznets' hypothesis that inequality and income per-capita is hump shaped. The result also complements with other theoretical and empirical researches replicating the similar pattern (Helpman et al., 2010, 2012).

Therefore, we propose a more optimistic point of view. If there is indeed a causal link between trade and inequality, trade increases inequality because trade liberalization is insufficient. Once trade liberalization reaches a certain level, the inequality decreases when volume of trade increases.

The model is based on the assumption that there are frictions in the capital market generating dispersion of capital costs faced by agents. It is frequently observed in developing countries although evidence also shown it exists in developed countries (Banerjee, 2003; Gilchrist and Zakrajsek, 2012). Specifically, it is caused by the possibility that lenders have to monitor borrowers to prevent default as emphasized by Banerjee (2003). The monitoring costs generate the gap between deposit and lending rate. Because poor agents borrow from capital market and pay higher interest rate, they pay higher fixed entry costs to produce manufacturing goods. Furthermore, when agents have to invest in education to increase productivity, wealthy agents face lower costs so their productivity is higher. Both of them imply that wealthy agents procure higher profit, causing income inequality.

In this model, the elasticity is endogenous. Therefore, similar to Krugman (1979), trade increases competition and elasticity, which reduces profit of producers and forces producers to exit. Specifically, trade has two effects on gross profit of producers. It elevates profit through obtaining demand abroad. It also introduces foreign competitors to increase demand elasticity and to reduce gross profit. The first effect increases gross profit of all producers proportionally. However, since the productivity of poor agents is lower, their elasticity is more sensitive to the change of competition and therefore the second effect forces poor agents to exit the market. The exit of poor agents redistributes the market share to wealthy agents, which increases inequality.

[5]See Feenstra and Hanson (1996), Feenstra and Hanson (1997), Acemoglu (2003), Helpman et al. (2010), Helpman et al. (2012), and Krugman (2008)

On the contrary, when the degree of trade liberalization reaches a certain level, all poor agents exit the market. Since survival producers are homogeneous, similar to Krugman (1979), the increase of competition reduces gross profit of all producers. Therefore further increase of competition caused by trade liberalization reduces wealthy agents' profit, which reduces income inequality.

This research corresponds to Helpman et al. (2010) who theoretically show the possibility that the relationship between inequality and trade liberalization is inverted "U" shape and to Helpman et al. (2012) who empirically confirm it by using Brazil data. However, their mechanism comes from search and matching frictions in the labor maket, the complementarities between workers' abilities, and the results implied by Melitz (2003) that only high-productivity firms export. In this research, the mechanism comes from firm heterogeneity caused by monitoring costs in the capital market and increase of competition after trade. To date, to the best of my knowledge, Helpman et al. (2010) and this research have been the only competing theories. Similar hump-shaped relationship also appears in other developing countries, China for instance (Jalil, 2012). Since the friction in the capital market is more pronounced in the developing countries, this proposal also explains why trade is most likely to cause inequality in the developing countries. Furthermore, inequality is caused by the redistribution of factors within an industry, which accords the mentioned empirical observations. Finally, this research replicates the vast empirical findings that firms are heterogeneous in productivity, which is endogenously generated by the frictions in the capital market.

In the next section, the basic model is introduced. From the basic model, we can observe the intuition that how inequality and heterogeneity in productivity appear when the frictions in the capital market exist. In section 3, we show that trade produces the hump-shaped relationship between inequality and degree of openness. The last section concludes.

## 2 The Basic Model

The economy is populated with continuous number of agents with mass $\overline{L}$. Each agent shares the same utility function,

$$V = \mu \ln u_m + q_a \quad 0 < \mu < 1,$$

where $u_m$ is the subutility derived from consuming differentiated goods in the $M$ secotr, $q_a$ is the consumption of the good from the $A$ sector, and $\mu$ is a parameter that indicates the degree of preference for diferentiated goods. I follow Feenstra (2003), Rodriguez-Lopez (2012) and Hsu (2010) to assume

that $u_m$ satisfies the symmetric translog expenditure function

$$\begin{aligned}\ln x =& \ln u_m + \frac{1}{2\gamma N} + \frac{1}{N}\int_{\omega\in\Omega} \ln p(\omega) d\omega \\ &+ \frac{\gamma}{2N}\int\int_{\omega,\omega'\in\Omega} \ln p(\omega)\left[\ln p(\omega') - \ln p(\omega)\right] d\omega' d\omega,\end{aligned} \tag{1}$$

where $x$ is the total expenditure on $M$, $\Omega$ is the set of available goods in sector $M$, $N$ is the measure of this set, $\omega$ is the index of differentiated goods, $p(\omega)$ is the price of good $\omega$ and $\gamma$ is related to the elasticity of demand as will be explained later.

Capital and labor are only inputs. Each agent endows with one unit of labor. The initial distribution of capital among agents is $G(k)$ where $k \in [0, \infty)$. In the $M$ sector, without loss of generality, we assume that one agent cannot manage more than one firm. To establish a firm, an agent has to invest $f_m$ amount of capital before any unit of production. Then they use one unit of labor to produce one unit of good. Agents can also invest $f_\phi$ amount of capital for education. By doing so, they procure managerial skill to increase productivity by $\phi > 1$. Therefore the marginal cost of production is $\phi^{-1}$ for high productivity firms. One unit of capital or one unit of labor can be used to produce one unit of $q_a$. $q_a$ is treated as a numberaire.

Factor markets are perfectly competitive, however there are frictions in the capital market. Borrowers have the option to renege on the borrowing and lending contract. When $\delta$ amount of capital is invested to monitor borrowers, borrowers inccur $\theta\delta$ when they renege on the contract. When a borrower borrow $d$ amount of capital and the return of capital from sector $A$ is $w_k$, lenders choose the lending rate, $i$, and $\delta$ to satisfy the following incentive compatability and individual rationality constraints:

$$di \leq \theta\delta, \quad di \geq (\delta + d)w_k.$$

Prefect competition and profit maximization gaurantee the equality is established. It implies

$$i = \frac{\theta w_k}{\theta - w_k} > w_k,$$

and we assume $\theta > w_k$. Because $i$ increases as $\theta$ decreases, the lending rate is higher when it is easier for lenders to default.

By utilizing the property of the quasi-linear utility function, we follow the convention to fix $w_k$ and wage to one. We assume that $A$ sector is perfectly competitive. It is also assumed that when $w_k$ is equal to one, there will be excess supply of capital if capital is not allocated to $A$. Similarly, when wage is equal to one, there will be excess supply of labor if labor is not allocated to $A$. These conditions can be satisfied when $\mu$ is small enough.

Since $u_m$ is homothetic, the optimization problem can be divided into two stages. We first calculate how much income will be spent on $M$ sector,

and then calculate the fraction of that income used to buy each good in $M$. The first stage shows that each agent spends $\mu$ amount of income on $M$ sector. The aggregate expenditure on $M$ is therefore $\mu\overline{L}$. The rest of income is spent on $A$. By using Shephard's Lemma, that is, taking derivative of equation (1) with respect to $\ln p(\omega)$, the expenditure share of good $\omega$ in the $M$ sector can be derived as

$$s(\omega) = \gamma \ln \left[ \frac{\hat{p}}{p(\omega)} \right],$$

where $s$ denotes the expenditure share and

$$\hat{p} = exp\left( \frac{1}{\gamma N} + \frac{1}{N} \int_{\omega \in \Omega} \ln p(\omega)' d\omega' \right) \tag{2}$$

is the maximum price that a firm can charge. Because the first term in the parenthesis decreases as $N$ increases and the second term is the average of log price charged by producers, $\hat{p}$ is higher when the level of competition is lower in the $M$ sector. Finally, the revenue reveived by firm $\omega$, denoted as $r(\omega)$, is

$$r(\omega) = s(\omega)\mu\overline{L}.$$

$M$ sector is monopolistically competitive. A firm producing goods in $M$ sector with constant marginal cost $c \in \{1, \phi^{-1}\}$ takes $\hat{p}$ as given and chooses price to maximize its profit. The solution of the optimization problem is

$$p(c) = \left( 1 - \frac{1}{\varepsilon(c)} \right)^{-1} c, \tag{3}$$

where $\varepsilon(c)$ is the elasticity of demand and can be written as

$$\varepsilon(c) = 1 - \frac{\partial \ln r(c)}{\partial p(c)} = 1 + \frac{\gamma}{s(c)}. \tag{4}$$

To assure that the elasticity is greater than one we assume $\gamma$ is greater than zero. Notice that $\varepsilon(c)$ increases as $\hat{p}$ decreases, so the elasticity is larger when the sector is more competitive. This is the key mechanism in this model.

Equation (3) can be rearranged to obtain a closed form solution of $p(c)$,

$$p(c) = \mathcal{W}\left( \frac{\hat{p}}{c} e \right) c, \tag{5}$$

where $\mathcal{W}(\cdot)$ is the Lambert $\mathcal{W}$ function. The term $\mathcal{W}(\cdot)$ in equation (5) is the mark-up charged by firms with marginal cost $c$.

Combining equations (3) and (5) we obtain the closed form solution of elasticity as

$$\varepsilon(c) = \frac{\mathcal{W}\left( \frac{\hat{p}}{c} e \right)}{\mathcal{W}\left( \frac{\hat{p}}{c} e \right) - 1}. \tag{6}$$

Combining equations (6) and (4), we obtain the closed form solution of expenditure share on goods produced by firms with marginal cost $c$.

$$s(c) = \gamma \left[ \mathcal{W}\left( \frac{\hat{p}}{c} e \right) - 1 \right] \tag{7}$$

Then, the gross profit of firms can be calculated as

$$\pi(c) = \mu \overline{L} \frac{s(c)}{\varepsilon(c)} = \frac{\gamma \mu \overline{L} \left[ \mathcal{W}\left( \frac{\hat{p}}{c} e \right) - 1 \right]^2}{\mathcal{W}\left( \frac{\hat{p}}{c} e \right)} \tag{8}$$

Because Lambert $\mathcal{W}$ function has the property that $\mathcal{W}'(\cdot) > 0$, from equations (5), (6) and (8), we can observe that $\varepsilon$ decreases when the economy is less competitive (implied by a higher $\hat{p}$), so that the price and the profit is higher. It can also be observed that $\varepsilon$ increases with $c$, so the profit is lower when the maginal cost is higher. Notice also that because $\mathcal{W}(e) = 1$, for a firm to survive, the marginal cost cannot be greater than $\hat{p}$. Furthermore, it can be shown that

$$\frac{\partial p}{\partial c} = \mathcal{W}\left( 1 - \frac{1}{1 + \mathcal{W}} \right) > 0,$$

so the price is higher when the margainal cost is higher.

Producers compare the gross profit with the fixed cost of entry and education to decide whether to produce or invest in education. If producers also invest in education, the fixed costs are

$$F_\phi = \begin{cases} f_m + f_\phi & \text{if } k \geq f_m + f_\phi \\ i(f_m + f_\phi) + k(1 - i) & \text{if } f_m < k < f_m + f_\phi \end{cases}, \tag{9}$$

If the producers do not invest in education, their fixed costs are

$$F = \begin{cases} f_m & \text{if } k \geq f_m \\ i f_m + k(1 - i) & \text{if } k < f_m \end{cases}, \tag{10}$$

Producers invest in education if and only if the following condition is satisfied

$$\pi\left( \phi^{-1} \right) - \pi\left( 1 \right) \geq F_\phi - F. \tag{11}$$

We assume that the population is large enough, so that the last producers earn zero profit.[6] Therefore, the free entry condition can be written as

$$\pi(c) = I F_\phi + (1 - I) F, \tag{12}$$

where $I = 1$ if the last producer invest in education and $I = 0$ otherwise. Since we are interested in firm heterogeneity, we consider the case that some

[6] It is true if $\left( \overline{L} + \gamma \overline{L}^2 \right)^{-1} < i f_m$

producers do not invest in education. It happens when $\phi$ is not too large so that it is profitable for all producers to invest in education and $\phi$ is not too small such that for all producers, it is unprofitable to invest in education. Therefore the free entry condition can be rewritten as

$$\pi(1) = F. \tag{13}$$

Equations (2) and (13) can be used to determine the entry decisions, the educational investment decisions and $\hat{p}$. For a given $\hat{p}$, let $\underline{k}$ be the capital endowment such that equation (13) is satisfied. Since $\pi(1)$ is monotonic increasing in $\hat{p}$ and $F$ is monotonic decreases in $\underline{k}$, equation (13) implies a monotonic decreasing relationship between $\hat{p}$ and $\underline{k}$. Since $F_\phi - F$ is monotonic decreasing in $k$, once $\hat{p}$ is given, the smallest amount of capital endowment needed to satisfy inequality (11) can also be obtained. Also because $F_\phi - F$ is monotonic decreasing in $k$, a producers tend to be more productive when they own more capital.

Equation (2) implies a positive realtionship between $\hat{p}$ and $\underline{k}$. Because one agent manages only one firm, we have

$$N = \overline{L} \int_{\underline{k}}^{\infty} dG(k). \tag{14}$$

Substitute the $N$ derived from equation (14) and the optimal price we have obtained into equation (2), we derive another relationship between $h$ and $\underline{k}$. Because $N$ is strictly decreasing in $\underline{k}$, the level of competition is lower when $\underline{k}$ is higher. Therefore $\hat{p}$ increases with $\underline{k}$. Specifically, it can be shown that

$$\frac{\partial \hat{p}}{\partial \underline{k}} = \frac{s(k)g(\underline{k})}{\int_{\underline{k}}^{\infty} \frac{\partial s(k)}{\partial \hat{p}} dG(K)} > 0,$$

where $k$ is used as an index since firms productivity is a function of $k$ as described previously. Combining with the monotonic decreasing relationship between $\hat{p}$ and $\underline{k}$, a unique $\underline{k}$ and $\hat{p}$ can be obtain.

## 2.1 Capital Accumulation

Each agent reproduces a new agent and then immediately dies at the end of each period. Therefore, similar to the phisical capital, human capital completely depreciates and has to be reinvested at each point in time. Similar to the Solow model, each agent spends $1 - S$ of income on consumption and the rest of it is left for the next generation. Capital accumulates according to the following equations

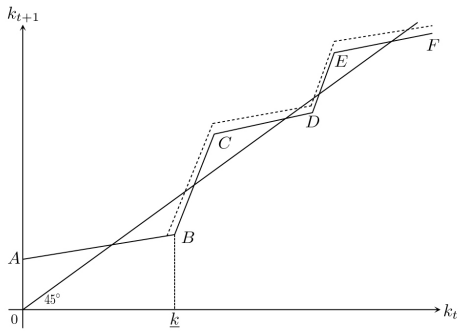


Figure 1: Capital Accumulation

$$k_{t+1} = S\left[1 + k_t\right], \tag{15}$$

$$\begin{aligned} k_{t+1} =& IS\left[1 + \pi_t(k) + (k_t - f_m - f_\phi)i\right] \\ &+ (1-I)S\left[1 + \pi_t(k) + (k_t - f_m)i\right], \end{aligned} \tag{16}$$

$$\begin{aligned} k_{t+1} =& IS\left(1 + \pi_t(k) + k_t - f_m - f_\phi\right) \\ &+ (1-I)S\left(1 + \pi_t(k) + k_t - f_m\right), \end{aligned} \tag{17}$$

where equation (15) is the path of capital accumulation of agents who earn zero profit in $M$ sector or who do not enter $M$ sector, equation (16) is the path for the partial self-financed agents, and the last equation is the path of completely self-financed agents.

These equations imply a relationship between $k_t$ and $k_{t+1}$ and is shown in Figure 2. The figure shows the short-run equilibrium and is drawn based on the assumption that $Si > 1$ and $f_m$ is large enough so that point $B$ is on the right of the 45 degree line. When $f_m$ is small, $B$ is on the left of the 45 degree line, which generates similar result in the long run so we do not analyze that case. Since we focus on the possibility that frictions cause heterogeneity in productivity and income level, we also assume that $f_\phi$ is large enough so that the initial difference in capital endowment generates three different level of capital stock in the long run and not all agents invest in education. The economics content of these assumptions will be explained later.

In the figure, the solid lines show the path of the short run equilibrium and the dotted lines show how the paths when the economy moves toward the long run equilibrium. $\overline{AB}$ corresponds to equation (15). $\overline{BC}$ and $\overline{CD}$ correspond to equation (16) and (17) when $I = 0$ respectively. $\overline{DE}$ and $\overline{EF}$ correspond to equation (16) and (17) when $I = 1$ respectively. For agents whose capital endowment is $\underline{k}$, their capital endowment decreases in the next

period. Therefore, they have to borrow more and face higher fixed costs. It causes exit and increases $\pi$ to restore equilibrium. Hence, $\overline{BCDEF}$ moves toward the upper left as shown by the dotted line in the figure. This process continues until the economy reaches the long run equilibrium.

Figure 2 demonstrates the paths when the economy reaches the long-run equilibrium. Letters with prime describe the paths in the open economy and can be ignored in this section. For agents with small capital endowment, their capital stock is fixed at $k_l$, for agents with intermediate level of capital endowment, their capital stock is fixed at $k_m$, and for agents with a lot of initial capital endowment, their capital stock is fixed at $k_h$. In the following analysis, agents whose capital stock is $k_l$ are refereed to as poor agents, whose capital stock is $k_m$ are referred to as middle class, and agents whose capital stock is $k_h$ are refereed to as wealthy agents.

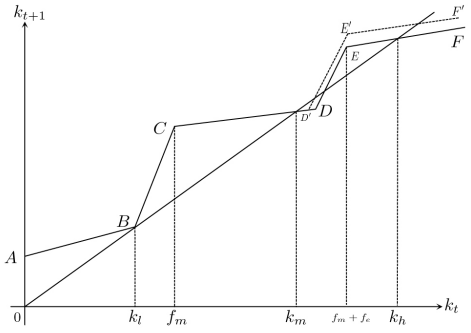


Figure 2: Equilibrium in the Long run

The graph is drawn based on the assumption that $iS > 1$, so that the slope of equation (15) and (17) is smaller than one and the slope of equation (16) is greater than one. The purpose of the assumption is to avoid the result that agents are homogenous in capital stock in the long run. From above equations, we can immediately calculate the long-run equilibrium. For the agents who earn zero profit in the $M$ sector or who do not enter $M$ sector, according to equation (15), we can calculate the fixed point as

$$k_l = \frac{S}{1-S} > 0,$$

where $1 - S > 0$ by assumption. This is their long-run capital stock.

Substituting equation (12) into equation (16) we can observe that the fixed point of equation (16) is $k_l$. As shown by Figure 2, when $iS > 1$, if $k_t > k_l$, the $k_{t+1}$ implies by equation (16) is greater than $k_t$. Therefore, for partially self-financed agents, once their wealth is larger than $k_l$, they start accumulating capital and finally become completely self-financed. On the contrary if the saving rate is so low such that $iS < 1$, they decumulate

capital when $k_t > k_l$ until the capital stock is fixed at $k_l$. We assume that $iS > 1$ so the saving rate is high enough to generate heterogeneity in capital stock in the long run.

Substituting equation (12) into equation (17), we can calculate the fixed point as

$$k_m = \frac{S\left[\left(\frac{S}{1-S} - f_m\right)(1-i)+1\right]}{1-S} > 0$$

when $I = 0$ or

$$k_h = \frac{S\left[\left(\frac{S}{1-S} - f_m - f_e\right)(1-i)+1\right]}{1-S} > 0$$

when $I = 1$. It is the middle class and wealthy agents' long-run capital stock. It can be shown that $k_m > f_m$ and $k_h > f_m + f_e$ if and only if $iS > 1$. Therefore, for the partially self-financed agents whose capital stock is greater than $k_l$, they accumulate capital until they become completely self-financed. Then they follow the path described by equation (17) until the capital stock is fixed at $k_m$ or $k_h$ depending on whether they invest in education.

Therefore when $Si > 1$, there will be inequality in income and wealth. Poor agents have capital stock equal to $k_l$, the middle class have capital stock equal to $k_m$, and wealthy agents have capital stock equal to $k_h$. We have inequality in the long run because when there are frictions in the capital market, fixed entry costs and educational costs are monotonically decreasing in capital endowment. Therefore agents with capital endowment higher than a certain level enjoy positive net profit. It can be confirmed by observing equation (13). Because poor agents incur higher cost of capital, the gross profit is higher than the wealthy agents' fixed entry costs. The extra profit they obtain generates the inequality in the long run.

# 3 Trade Liberalization

There are $C > 1$ symmetric countries and trade is liberalized when countries reach their long run autarkic equilibrium. Introducing foreign competitors increases level of competition and therefore $\hat{p}$ decreases. It reduces $s$ as can be observed from equation (7) and therefore according to equation (6), it increases elasticity. This effect reduces gross profit of firms as implied by equation (8). However, the increase of $C$ also augments the gross profit of firms through increasing the size of market. We can show that for the low-productivity firms, the former effect dominates the latter. Therefore their gross profit decreases. Specifically, we can show that

$$\frac{\partial \pi}{\partial C} > 0 \Leftrightarrow s > E(s)E\left(\frac{\mathcal{W}}{\mathcal{W}+1}\right)^{-1}, \tag{18}$$

where $E(x)$ is the expected value of $x$. Because poor agents charge price higher than average, their $s$ must be smaller than $E(s)$. Therefore their gross profit must decrease when $C$ increases, which forces part or all of them to exit the market. The exit of poor agents helps to restore the gross profit. If the increase of number of competitors is not large enough to force all low-productivity to leave the market, the gross profit of poor agents is restored to its autarkic level.

If gross profit of low-productivity firms is restored to its autarkic level, the gross profit of high-productivity firms must increase. It can be shown that

$$\frac{\partial \pi}{\partial \hat{p}} \frac{\hat{p}}{\pi} = \frac{1}{s},$$

which is higher when $s$ is lower. Because low-productivity firms obtain smaller $s$, their gross profit is more elastic to the change of competition. It implies that the gross profit of wealthy agents increases. Therefore, as shown by Figure 2, $\overline{DEF}$ moves to $\overline{D'E'F'}$. The inequality is enlarged by trade.

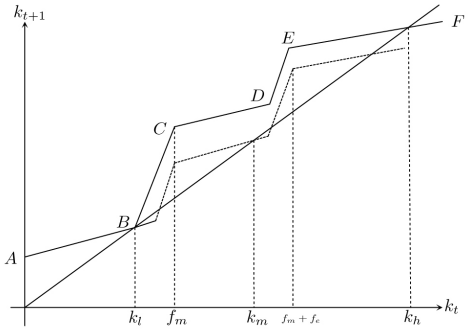


Figure 3: Reduction of Inequality

However, after $C$ increases to a certain level, all poor agents exit, and we have homogeneous firms. The path in the long run corresponding to it is shown by the solid line in Figure 3. Because firms are homogeneous, similar to Krugman (1979), further trade liberalization reduces gross profit of all survival producers. Since s=E(s) for all firms, according to equation (18), their profit must decrease when $C$ increases. $\overline{BCDEF}$ moves down as shown by the dotted line in Figure 3. Inequality starts decreasing when further trade liberalization increases competition. After $C$ increases to a certain level, the net profit for those firms drives down to zero. Since wealthy agents earn zero profit, there is no inequality.

# 4 Conclusion

This research builds a simple model to replicates results of some empirical research showing that the relationship between trade and inequality is inverted "U" shape. Inequality increases with initial trade liberalization and when the degree of openness reaches a certain level, inequality decreases when trade is more liberalized.

The result is based on frictions in capital market and the endogenous elasticity. Because lenders incur monitoring costs to prevent borrowers from reneging on contracts, the entry costs and the costs of education to increase productivity are lower for wealthy agents. Hence, the profit and productivity of wealthy producers are higher. This generates inequality and heterogeneity.

Trade enlarges market size and through introducing foreign producers, trade increases elasticity of demand. Because gross profit of low-productivity firms is more sensitive to the change of competition, for poor agents, the effect of increasing elasticity dominates. Therefore, poor agents exit and market share redistributed to wealthy agents, which increases inequality. After all poor agents exit, profit of wealthy agents starts decreasing because of further increasing elasticity caused by trade liberalization.

This mechanism corresponds to many empirical studies showing that trade liberalization increases elasticity and decreases the dispersion of productivity distribution. It also conforms with the other empirical results showing that trade causes redistribution of market share within industries. Furthermore, it endogenously generates firm heterogeneity which has strong empirical support. Finally, it points out the possibility that frictions in the capital market could be a source of heterogeneity. Confirming it empirically can be a direction for future studies.

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# 科技部補助計畫衍生研發成果推廣資料表

日期:2015/01/30

| | |
|---|---|
| 科技部補助計畫 | 計畫名稱: 貿易流量與不均度間之庫茲涅茨曲線的理論解釋 |
| | 計畫主持人: 徐則謙 |
| | 計畫編號: 102-2410-H-004-238- 學門領域: 國際經濟學 |

無研發成果推廣資料

# 102 年度專題研究計畫研究成果彙整表

| 計畫主持人：徐則謙 | 計畫編號：102-2410-H-004-238- |
|---|---|
| 計畫名稱：貿易流量與不均度間之庫茲涅茨曲線的理論解釋 | |

| 成果項目 | | | 量化 | | | 單位 | 備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等） |
|---|---|---|---|---|---|---|---|
| | | | 實際已達成數（被接受或已發表） | 預期總達成數(含實際已達成數) | 本計畫實際貢獻百分比 | | |
| 國內 | 論文著作 | 期刊論文 | 0 | 0 | 100% | 篇 | |
| | | 研究報告/技術報告 | 1 | 1 | 100% | | |
| | | 研討會論文 | 0 | 0 | 100% | | |
| | | 專書 | 0 | 0 | 100% | | |
| | 專利 | 申請中件數 | 0 | 0 | 100% | 件 | |
| | | 已獲得件數 | 0 | 0 | 100% | | |
| | 技術移轉 | 件數 | 0 | 0 | 100% | 件 | |
| | | 權利金 | 0 | 0 | 100% | 千元 | |
| | 參與計畫人力（本國籍） | 碩士生 | 1 | 1 | 100% | 人次 | |
| | | 博士生 | 0 | 0 | 100% | | |
| | | 博士後研究員 | 0 | 0 | 100% | | |
| | | 專任助理 | 0 | 0 | 100% | | |
| 國外 | 論文著作 | 期刊論文 | 0 | 0 | 100% | 篇 | |
| | | 研究報告/技術報告 | 1 | 1 | 100% | | |
| | | 研討會論文 | 1 | 1 | 100% | | |
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| | 技術移轉 | 件數 | 0 | 0 | 100% | 件 | |
| | | 權利金 | 0 | 0 | 100% | 千元 | |
| | 參與計畫人力（外國籍） | 碩士生 | 0 | 0 | 100% | 人次 | |
| | | 博士生 | 0 | 0 | 100% | | |
| | | 博士後研究員 | 0 | 0 | 100% | | |
| | | 專任助理 | 0 | 0 | 100% | | |

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|---|---|
| 其他成果<br>(無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。) | 無 |

| | 成果項目 | 量化 | 名稱或內容性質簡述 |
|---|---|---|---|
| 科教處計畫加填項目 | 測驗工具(含質性與量性) | 0 | |
| | 課程/模組 | 0 | |
| | 電腦及網路系統或工具 | 0 | |
| | 教材 | 0 | |
| | 舉辦之活動/競賽 | 0 | |
| | 研討會/工作坊 | 0 | |
| | 電子報、網站 | 0 | |
| | 計畫成果推廣之參與（閱聽）人數 | 0 | |

# 科技部補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以 100 字為限）

□實驗失敗

□因故實驗中斷

□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：□已發表 □未發表之文稿 ■撰寫中 □無

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3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

本計畫之目的在於建立一個理論模型，解釋為何貿易與所得分配不均度間有倒 U 型的關係，而實證研究顯示此現象存在於不少國家。有別於過去的解釋方法，本計畫使用異質生產者模型及資本市場的摩擦解釋上述現象。目前研究已初步完成，報告草稿業已撰寫完畢，待修飾後即可投稿。研究成果可提供政府貿易政策上的參考。