Offshore Production, Student Effort, and Income Inequality

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Abstract This paper presents a simple model to show that, in addition to technological development and global outsourcing, heterogeneous lifetime preferences for leisure are essential to income inequality. Allocating leisure time to studying is viewed as suffering in exchange for future comfort, and income inequality in a country arises when some prefer the leisure trade-off but others prefer smooth leisure over the lifetime. I also argue that, in a country where residents feel less suffering in the leisure trade-off, greater income inequality is incurred. This model implies that low latitude countries generally suffer from greater income inequality than high latitude countries.

Keywords: Global outsourcing, offshore production, student effort

JEL Classification: F14, F16, I20, J31

1. Introduction

Feenstra and Hanson (1997) have argued that the North applies more offshore production to shift the labor-intensive parts of processing to the low-cost South, after the South adopts an open policy. Offshore production reshuffles the factor composition and leads to an increase in the relative demand for skilled labor in the North, worsening its income inequality between skilled and unskilled laborers. Feenstra and Hanson (1996) further estimated that expenditures on high-technology capital (a proxy of technological improvement) lead to an increase in the relative income of skilled labor, explaining about 60% of the actual change of the rising income inequality from 1979 to 1990 in the U.S., while offshore production can account for 31%-51% of the increase. Their findings support the argument that technology improvement and offshore production are underlying contributors to income inequality between skilled and unskilled labor in a country.
Nevertheless, I argue that, in addition to technological improvement and offshore production, a heterogeneous preference for leisure is essential to income inequality between skilled and unskilled workers within a nation. In corresponding to technological improvements, students are required to achieve greater educational attainments to process increasingly sophisticated skills, advanced knowledge, and deep know-how in order to become productive skilled workers later. The exchange of leisure for study is a sacrifice made in hopes of a later gain. Students accumulate a skill premium by allotting part of their current leisure time to studying in exchange for future comfort (i.e., more leisure time), which is additional to endowed leisure time and is measured in equivalent service goods. That is, they feel more comfort with more leisure time later (e.g., more vacation or more entertainments) during their increased spare time saved in service creation after completing their education, while unskilled workers must provide such services themselves. However, the trade-off between current and future leisure is based on individuals’ leisure preferences along the lifetime spectrum. Heterogeneous leisure sensitivity gives rise to lifetime income inequality.

Findlay and Kierzkowski (1983) assumed that each individual in an economy has equal potential to become a skilled worker if he or she is determined to receive an “education”. They applied a skill-formation function to transform students into skilled workers after a fixed length of school time, with the only required input being country-endowed educational resources. In a long-run competitive equilibrium, their model implies identity of real income over the life cycle between skilled and unskilled workers. However, in the real world, it has been widely observed that a significant lifetime skill premium exists. An additional important factor, which is overlooked in their argument, is student academic effort.

The American inventor Thomas Edison once said, "Genius is one percent inspiration and ninety-nine percent perspiration." Empirically, Loury and Garman (1995) documented that, in addition to school years, student performance and college selectivity significantly affect earnings inequality. Martins and Pereira (2004) found that schooling has a positive impact on within-group income inequality, with that impact conditioned on students’ ability and schools’ quality. Generally, both student performance and college selectivity are highly determined by student ability and effort, where the latter generally plays a larger role.

Given that skill returns depend not so much on ingenuity as on hard work, I take only the latter into account in my analysis. That is, the return on education depends not only on educational intensity, as mentioned in Findlay and Kierzkowski (1983), but also on student study effort, as
implied in both Loury and Garman (1995) and Martins and Pereira (2004). Students must devote themselves to studying in order to effectively absorb the “education” leading to skill formation.

This paper serves to develop a simple model, where student study effort is added to Findlay and Kierzkowski’s (1983) skill formation function, to show how heterogeneous preferences for leisure along the lifetime spectrum are essential to lifetime income inequality between skilled and unskilled workers. A service sector is introduced into this model. Skilled workers take advantage of their rising skill premium to purchase services instead of relying on self-production, creating increased demand for various personal services. The service sector absorbs unskilled manufacturing workers made redundant from offshore production, which in turn provides increased support for the expansion of personal services to meet the rising demand from skilled workers in the manufactured sector. However, the sacrifice of current leisure to studying is viewed as study “suffering”, requiring a skill premium for returns to exchange for future comfort that measured in equivalent service good. I argue that income inequality in a country arises when some individuals prefer to the leisure tradeoff but the others prefer to smooth leisure over lifetime.

This model also implies that a low latitude country generally suffers from greater income inequality than a high latitude country. Endowed with longer sunshine hours, inhabitants in the low latitude countries find less “suffering” to allocate time to studying while inhabitants in high latitude countries are relatively “inactive” (e.g., sleeping is a kind of leisure) for keeping warm in their wintry climate. Climate affects leisure preferences because frigid weather generally adds “suffering” of studying, deterring trade of current leisure for future comfort. By contrast, warm climate generally leaves more breathing space to the leisure tradeoff. I then argue that individuals in a low latitude country, all other things equal, who are relatively inclined to allocate more leisure to studying, form higher skill premium than that in a high latitude country. This gives rise to greater income inequality in the low latitude country. The argument finds support from the data in Figure 1, which shows that, where Japan is an outlier, the Gini coefficients of OECD countries are negatively related to their capital cities’ latitudes. That is, a low latitude country generally suffers a greater income inequality than a high latitude country.

In Section 2, I present the idea that those who prefer to sacrifice current leisure for future comfort enroll as students, while the remaining become unskilled workers hereafter. The trade-off between current leisure and future comfort is deterred while the required length of learning for accumulating sufficient skills increases due to technological improvements, adding “suffering” of studying. However, an increase in educational resources can reduce the threshold
of student academic efforts, helping students upgrade their productivity with less study “suffering”. Further, I show how the skill premium’s purchasing power for service goods affects the optimal study effort, determining the extent of income inequality. In Section 3, I conclude with a discussion of these findings.

2. The Model

The seminal model of Findlay and Kierzkowski (1983), who defined skill formation as a function of educational resources, provides the basic structure for my analysis. Based on the empirical work from both Loury and Garman (1995) and Martins and Pereira (2004), I partition the returns to education into two parts: returns to educational resources and returns to student study effort.

2.1 Augmented Skill Formation Function

Suppose that in a world of North and South, the North consists of unskilled workers, skilled workers, and students. Let the unit factor returns to an unskilled worker be $w_2$, and the returns to a skilled worker be $w_1$, where $w_1 \geq w_2$. Each individual consumes manufactured goods, services, and leisure. The manufactured goods are internationally tradable, while service is tradable only domestically, and leisure cannot be traded at all. Individuals have similar preferences for both goods and services, but preferences for leisure differ between unskilled and skilled workers. All individuals, laboring to earn their goods and services, are assumed to be similarly endowed with a unit of leisure time. Students must allot some part of their leisure time to studying while other workers relax during their leisure time. People feel more comfort with more leisure time.

The population is stationary because the “birth” of $N$ new individuals is exactly offset by the “death” of $N$ old individuals at each instant of time. Every individual has a lifetime $T$, choosing whether she/he goes to school for a fixed length of time $\theta$, to acquire skills right after his/her birth. Suppose that $E$ individuals, among the $N$ new-born individuals, tend to acquire education, while the remaining $L = N - E$ individuals remain unskilled for the duration of their lives. Those who choose to acquire education become skilled workers after the $\theta$ length of learning at school, earning an income rate with a skill premium for the rest of their lifetime.\(^9\)

There is a fixed exogenous supply of education inputs, denoted as $K$, which can be thought of as
a composite of teachers, laboratories, libraries, and so on (Findlay and Kierzkowski, 1983), which make up the educational resources. In my model, the output of skills of each student, measured in efficiency, is not only positively related to educational resource intensity, \( k = \frac{K}{E} \), but is also positively related to student study effort, \( a \). Here \( a \) denotes the share of a student’s leisure time that has been allotted to studying: the more time a student allots to studying, the more skills the student can acquire. Supposed that the “birth” of \( N \) new individuals has been randomly assigned a leisure preference so that individuals’ study effort \( a \) has a probability density function \( g(a) \) and a corresponding cumulative distribution function is given by \( G(a) \).

A student’s skill formation function is then given by

\[
q = f(a,k;\theta),
\]

where \( f'(k) > 0 \), and \( f''(k) < 0 \); that is, with given \( \theta \) length of learning at school, skill formation increases with educational resource intensity in diminishing returns. A student can prolong the length of learning to upgrade his skill level, that is, \( f'(\theta) > 0 \).

It is widely believed that an individual has the potential to become a skilled laborer if she intends to because humans have an unlimited capacity to learn (Eccles, 1974).\(^{10}\) Clinical findings support this theory and also show that human intellectual development remains constant up to death (Lewin, 1980).\(^{11}\) Therefore, it is feasible to presume that returns for student efforts in skill formation are not diminished with study effort within a finite lifetime, that is \( f'(a) > 0 \) and \( f''(a) \geq 0 \).\(^{12}\) Given the fact that the powers of human brain are endless (Eccles, 1974), I argue that it is heterogeneous preferences for leisure rather than heterogeneous students’ capabilities that are essential to skill formation.

With exogenous educational resources \( K \) and at a given \( \theta \) length of learning at school, a student cannot acquire sufficient skills without minimum aggregate study efforts. That is, with a given length of learning \( \theta \) and with exogenous educational resources, there exists a threshold of study effort, say \( a \), which I will derive in Section 2.3. The \( N \) new born individuals are then detached into two groups: individuals with \( a \geq a \) enroll as students and the others remain unskilled workers. Being relatively scarce in educational resources, individuals in the South must allocate more study efforts in comparison to those in the North to obtain equivalent skills.

As in Feenstra and Hanson’s (1997) outsourcing model, there is one single manufactured good
which is assembled with a continuum of intermediate inputs, indexed by \( z \in [0,1] \). The production factor of each of the intermediate inputs is a composition of unskilled and skilled workers. The labor-intensive intermediate inputs require more unskilled workers, and the skill-intensive intermediate inputs require more skilled workers. The intermediate input \( z \) employs \( S(z) \) units of skilled labor and \( U(z) \) units of unskilled labor, with productivity \( q(a,k) \) and one, respectively. Supposed that the composition of production factors \( \frac{S(z)}{U(z)} \) increases with \( z \), indicating that the input \( z_1 \) is more labor-intensive than input \( z_2 \) if \( z_1 < z_2 \). The production function of each intermediate input is given by \( x(z) = \min\{U(z), qS(z)\} \). The only manufactured final-good has a Cobb-Douglas production function as \( \ln Y = \int_0^1 \alpha(z) \ln x(z) dz \) with \( \int_0^1 \alpha(z) dz = 1 \), incorporating all of these intermediate inputs into one final good.

The unskilled workers in the North can be substituted for through outsourcing trade, while relatively labor-intensive inputs are relocated to the South. This leads to an “oversupply” of Northern unskilled labor because this relocation leads to relatively less demand for unskilled labor in the North, and then reshuffles the factor composition in favor of the skilled labor in terms of both the wage rate and employment. In my model, I argue that, with no skill barriers, unskilled workers can move freely between service and manufactured-goods sectors. A full employment condition holds, so this “oversupply” of unskilled workers drops out of the manufactured goods sector, shifting frictionlessly to the service sector.

### 2.2 Student Effort and Leisure Allocation

All individuals are assumed to have the same preferences and tastes for both goods and services, but skilled workers can purchase services from market and enjoy more leisure time (i.e., more comfort) in later life from their increased spare time saved in service creation. Unskilled workers, in contrast, must perform such services for themselves. For example, persons with high income can afford to buy various services, such as eating out at restaurants, having laundry done, child care, spa, and housekeeping, and so on. Comparatively, persons with low income must generally perform these necessary tasks on their own.

I argue that, without having earnings during the period of study, students also perform all services for themselves. Students use student loans from the capital market in order to pay for their education and basic living (i.e., the manufactured goods). The capital market charges an
interest rate $r$ and expects full returns with good confidence after the students become skilled laborer. If students like to use consumer loans to purchase services, the risk related to students’ ability to fulfill future payments increases because the students might allocate the increased spare time saved in service creation to leisure rather than to study. Considering the uncertainty that students might not accumulate sufficient skills to fulfill the loan payment, the capital market will charge a risk premium in addition to the underlying interest rate $r$ for the consumer loan. Since the risk premium is substantially high, I presume that all students use only the student loan in this model.¹³

While both skilled and unskilled workers enjoy their leisure time, students must study hard after class during the education period in order to productively absorb the specialized knowledge. A student’s “sacrifice” in studying is rewarded with $af(a,k)$ skill premium units. One can argue that the “price” of a leisure hour is $w_1$ for skilled workers, and $w_2$ for both unskilled workers and students (Owen, 1971). The opportunity cost of allotting leisure time to studying is then equivalent to the value of the corresponding increased skill premium from studying:

$$C(a) = \int_{\theta}^{T} w_1 af_a e^{-rt} dt,$$

which also indicates the suffering of study that can be rewritten as

$$C(a) = \frac{1}{r} \left[ f_a w_1 (e^{-r\theta} - e^{-rT}) \right].$$

As unskilled workers, students must also create services for themselves, while skilled workers use the associated rise in the skill premium derived from their previous study efforts, to purchase personal services in the market. Then the benefit of studying, namely, future comfort, is given by

$$B(a) = \frac{s(a,z)LT}{E(T-\theta)} \int_{\theta}^{T} w_2 e^{-rt} dt,$$

which is the value of services a skilled worker can purchase by his/her skill premium.¹⁴ Here, $s(a,z)$ denotes the share of unskilled labor work in the service sector, increasing with international outsourcing trade, that is, $s_z(a,z) > 0$. Obviously, a greater skill premium is created when more study effort is devoted, which then leads to a larger demand for services. It is feasible to assume that the $s(a,z)$ increases with the study effort but with a diminishing returns, that is, $s_\theta(a,z) > 0$ and $s_{\alpha}(a,z) < 0$.

However, with a given length of learning $\theta$ and exogenous educational resources $K$, there exists a threshold of study effort, $\theta$, required for a student to become an effective skilled worker.
Without reaching the aggregate threshold of study effort for a certain period of learning, a student cannot successfully become a skilled worker. Generally, with given educational resources \( K \), a student must allot not less than a share of leisure to studying for a period of time \( \theta \) in order to productively absorb the associated skills. In the real world, few, if any, students can pass exams and graduate with a degree without a minimum level of study, and the formal degree usually functions as a signal to employers that whether the candidate is a qualified skilled worker. Therefore, with exogenous \( K \) and \( \theta \), I assume \( s(a,0) = 0 \) if \( 0 < a < a \).

In equilibrium, the net reward of future comfort from studying equals the skill premium created from studying. Market clears in the service sector:

\[
\int_{0}^{\tau} w_{1}af_{a}e^{-\alpha}dt = \frac{s(a,z)LT}{E(T-\theta)} \int_{0}^{\tau} w_{2}e^{-\alpha}dt, \quad \text{when} \quad a \geq a, \quad (3)
\]

As mentioned above, the “births” of \( N \) new individuals are randomly assigned a student academic effort \( a \), which has a probability density function \( g(a) \). Let’s presume further that people adjust their leisure preferences right after “birth” with the cost and benefit analysis in accordance with the leisure trade-off along the lifetime spectrum, following \( a = B(a) - C(a) \).

This equation of motion for \( a \) leads to two steady states as in Figure 2: \( a = 0 \) and \( a = a^* \) respectively. Here \( a^* \) denotes the actual study effort a student makes. Here, we exclude the condition of \( a > a^* \) because it will lead to \( C(a) > B(a) \) for all \( a \), implying that there is no student who devotes to any level of studying (with steady state \( a = 0 \) only), contradicting observations in the real world. I also rule out the condition where \( B(a) > C(a) \) for all \( a \), because this implies that all students will allot all of their leisure time to studying (with steady state \( a = 1 \) only), which also contradicts actual observations. Therefore, the study effort threshold in accumulating skills has a relation to actual study effort as \( 0 < a \leq a^* < 1 \).

Individuals with \( a < a < a^* \) find it beneficial to increase their study effort to \( a^* \) and individuals with \( a \geq a^* \) also find a study effort of \( a^* \) be the optimal choice; however, individuals with \( a < a \) reduce their study effort to 0. In the former steady state, all students allocate \( a^* \) share of leisure time to studying. In the latter steady state, individuals prefer to consume leisure smoothly throughout the lifetime. The number of students is then given by \( E^* = N \int_{a}^{1} g(e)de = N(1 - G(a)) \), which grows with a reduce in the study effort threshold \( a \).
the next section, I will derive the optimal study effort threshold \( a \) in order to obtain the equilibrium school enrollment \( E^*(a) \).

2.3 Equilibrium

The productivity of each skilled worker is augmented by a factor of \( f(a^*, k) \), so that the income of a skilled worker is given by \( w_i f(a^*, k) \). We obtain the present value of the gross lifetime income of a skilled worker as

\[
\int_0^T w_i f(a^*, k)e^{-rt} dt = \frac{W_i}{r} f(a^*, k)(e^{-rT} - e^{-r0}).
\]  
(4)

The aggregate cost of education in present value from (2) and (3) is given by

\[
\int_0^T w_i k e^{-rt} dt + \int_0^T w_2 e^{-rt} dt + \int_0^T w_2 e^{-rt} dt + C(a^*) \\
= \frac{1}{r} \left[w_1 (k f_k + a^* f_a) (e^{-r0} - e^{-rT}) + w_2 (1 - e^{-rT}) \right].
\]  
(5)

The first term in (5) is the “tuition” payment from 0 to \( \theta \) for each student, which equals the sum of the skill formation function’s discounted marginal products over the working life of the student (Findlay and Kierzkowski, 1983). The second and third terms are the opportunity costs of enrolling as a student. The fourth term is aggregate study “suffering” for the \( \theta \) length of time.

Subtracting (5) from (4), we obtain the net benefit from education as

\[
\pi = \frac{1}{r} \left[w_1 (f - k f_k - a^* f_a) (e^{-r0} - e^{-rT}) - w_2 (1 - e^{-rT}) \right].
\]  
(6)

Individuals like to acquire education until the marginal benefit of education equals the marginal cost of education. The optimal solution is derived from the first order condition of (6) with respect to educational resource intensity (i.e., \( k \)):

\[
\frac{\partial \pi}{\partial k} = \frac{1}{r} \left[-w_1 (k f_{kk} + a^* f_{ak}) (e^{-r0} - e^{-rT}) \right] = 0.
\]  
(7)
From (7), we obtain the equilibrium \(-k^* f_{kk}(a^*, k^*) = a^* f_{ak}(a^*, k^*)\). Rewrite it as

\[ k^* = \frac{a^* f_{ak}(a^*, k^*)}{-f_{kk}(a^*, k^*)}, \]

(8)

where the optimal educational intensity \(k^* = \frac{K}{E^*}\) reduces with an increase in the actual study effort \(a^*\). This is because that the skill formation function is non-diminish returns to study effort. The term \(-k^* f_{kk}(a^*, k^*)\) in (8) represents the marginal benefit of education resource intensity net of marginal costs of educational resource intensity. The term \(a^* f_{ak}(a^*, k^*)\) represents the marginal cost of studying “suffering” with respect to educational resource intensity. Corporately, (8) implies a substitution between educational resource intensity and study effort in skill formation.

With the exogenous educational resources \(K\), we can find optimal student enrollment as \(E^*(a) = N(1 - G(a))\), where school enrollment is encouraged with a lower threshold of study effort (i.e., \(a\)) so that \(E^*(a) < 0\). However, these enrolled students will allocate \(a^*\) share of leisure time to studying based on the leisure trade-off between current leisure and future comfort as discussed in the previous section, where \(a \leq a^*\).

In the long run, the net benefit from education must be zero. We obtain a long-term equilibrium from (3) and (6) as

\[ \omega = 1 + \frac{s(a^*, z)T(N - E^*(a))}{E^*(a)(T - \theta)}, \]

(9)

where \(\omega\) denotes the lifetime income inequality between skilled and unskilled workers as

\[ \omega = \frac{w_1(f - kf_k)(e^{-r_0} - e^{-rT})}{w_1(1 - e^{-rT})}. \]

Here the nominator term is the lifetime income of a skilled worker net of the “tuition” payment and the denominator term is the lifetime income of an unskilled worker. The equilibrium (9) illustrates how heterogeneous preferences on leisure affect the lifetime income inequality between skilled and unskilled labor, which not only increases with an
increase in the actual study effort $a^*$ but also increases with an increase in the threshold of study effort $a$.\(^{16}\)

The model of Findlay and Kierzkowski (1983) implies identity of lifetime income because they assume that each individual has equal potential to become skilled. However, I argue that the lifetime income inequality arises while there are heterogeneous preferences for leisure along lifetime spectrum. The study effort threshold is basically dependent on a country’s educational resources while the actual study effort is mainly determined by a country’s lifetime leisure preferences. Individuals with leisure preference $a \geq a$ enroll as students but the others remain unskilled throughout the lifetime. These enrolled students devote $a^*$ share of leisure time for $\theta$ periods to studying in exchange for more future leisure. Note that we argue above that $s(a, z) = 0$, that is, there is no lifetime income inequality while $a^* = a$. It is interesting to note that if $z = 0$ and $a^* = a$, we return to Findlay and Kierzkowski’s model, where the skill premium is just sufficient to pay back the student loans.

### 2.4 Technological Development, Offshore Production, and Educational Resources

An exogenous improvement in technology requires upgrades in labor skills to pressure students to prolong the length of studying (i.e., a larger $\theta$) in order to accrue the associated advanced skills. This increases opportunity costs while prolonging the length of studying, requiring a higher skill premium for compensation.\(^{17}\) As shown in Figure 3, the increase in the length of studying $\theta$ gives rise to actual study effort $a^*$, implying a widening income inequality as implied in equilibrium (9).

An increased in $a^*$ leads to a smaller $a$, which attracts more school enrollment (i.e., a larger $E^*$). I argue that the increase in school enrollment is to partially but not fully compensate for the rising income inequality in the long run. This is because that an increasing in actual study effort gives rise to not only skill premium but also study suffering, the former encourages school enrollment but the latter discourages school enrollment. On net, technological development leads to a greater income inequality, although giving rise to supply of skilled laborers. Note that in this model, the lifetime income exists provided that $a^* > a$.\(^{18}\)

Next, we come to the discussion on offshore production, which has never been so frequently covered in the media with growing concerns on rising inequality between skilled and unskilled
laborers. Offshore production expands the service sector while the North relocates its relatively labor-intensive inputs to the South, making some unskilled laborers oversupply. The remaining intermediate inputs reshuffle their production factors compositions so that each intermediate input becomes more skilled-labor intensive hereafter. Offshore production then reduces the relative demand for unskilled labor, resulting in a higher skill premium. The rising skill premium gives rise to more demand for services. Note that the rising skill premium in turn attracts more student enrollment as implied in (8): an increase in $z$ leads to an increase in $a^*$ and an reduction in the threshold of study effort $a$. The illustration is shown as in Figure 4.

While the “oversupply” of unskilled workers in the manufacturing-good sector freely shifts to the service sector, markets clear in the service sector. It requires that the rising demand for services should equal the rising supply of services made by the “oversupply” of unskilled workers due to offshore production. Similar to technological development, an increase in offshore production generates a disproportionate inequality, favoring skilled workers in terms of not only income but also employment. The argument is in line with that of Feenstra and Hanson (1997).

However, although offshore production exacerbates income inequality, governmental efforts should focus on an educational infrastructure that can train a sufficient qualified labor force rather than resorting to trade protectionism. In equilibrium (8), with the optimal $k^*$ and $a^*$, an increase in educational resources encourages more student enrollment (i.e., a larger $E^*$) as illustrated in Figure 5. This increasing student enrollment leads to an increase in the relative supply of skilled workers, exerting downward pressure on the skill premium. This implies that a country with higher levels of educational resources suffers less wage inequality than countries with fewer educational resources as implied in (9).

The policy implication for an economy caught in the rising tide of offshore production is clear. As Alan Greenspan (2000) has urged, a government should place increased emphasis on education and offer more retraining programs for career changes, rather than to fight outsourcing through protectionism. In the era of globalization, worsening income inequality is not necessarily inescapable if sufficient educational investment exists. Miller (2001) also argued that, in the case of the U.S., halting globalization would do little to offset the rising wage inequality that has already occurred, unless U.S. firms could reverse the outsourcing activities back home, however, which would do much more damage than trade restriction alone.
2.5 Current Leisure versus Future Comfort

In my model, skilled workers use $\int_0^T w_i(f - kf) e^{-rt} dt$ to pay for tradable manufactured goods and use $\int_0^T w_i a f a e^{-t} dt$ to exchange for untradeable service goods as measured by $\int_0^T w_i z a s e^{-rt} dt$, and the later constructs the lifetime income inequality. The market clearing for the untradeable service goods requires the equilibrium (3) as

$$\int_0^T w_i a f a e^{-t} dt = \frac{s(a, z) LT}{E(T - \theta)} \int_0^T w_i z a s e^{-rt} dt,$$

where a country-specific parameter $\varepsilon = \frac{ds}{da} > 0$ exists to equate the demand and supply sites of the service market. The parameter $\varepsilon$ can be considered as an elasticity of purchasing power for future comfort with respect to current study effort.

The less inclined the individuals in an economy are to make the leisure tradeoff for future comfort, the lower is the relative demand for the supply of service goods, and the larger the purchasing power elasticity is. Allocating leisure time to studying is viewed as suffering by all individuals, where the larger is this purchasing power for service goods, the less current leisure students need to sacrifice in order to exchange for sufficient future comfort, that is, $\hat{a} < a^i$ if $\hat{\varepsilon} > \varepsilon$, as illustrated in Figure 6. The decrease in actual study effort, although leading to a higher threshold of study effort as $\hat{a} > a^i$, reduces income inequality, as implied in (9).

On the contrary, the more inclined the individuals in an economy are to make the leisure tradeoff for future comfort, the larger is the relative demand for the supply of service goods, and the lower purchasing power elasticity is. In a country where the skill premium’s purchasing power for service goods is lower, more study efforts are required to accumulate a sufficient skill premium, leading to a higher income inequality.

This model implies that climate affects the preferences for leisure because frigid climate, comparing to warm climate, generally makes allocating leisure time to studying more painful, deterring the leisure tradeoff. Low latitude countries enjoy longer hours of sunshine than the high latitude countries, and human are more active in warm climates compared to in frigid climates. Endowed with longer hours of sunshine, inhabitants in low latitude countries find less “suffering” in allocating more time to studying while inhabitants in high latitude countries are relatively “inactive” to keep warm in their wintery climate. I therefore argue that warm weather...
leaves a low latitude country, all other things equal, with more breathing space to allocate to studying in comparison to a high latitude country. As illustrated in Figure 6, this leads to a larger study effort \( a^* \) and lower study threshold \( a \) in the low latitude country than a high latitude country. As implied in (9), low latitude countries should have higher income inequality than high latitude countries. The data in Figure 1 supports this argument.

3. Conclusions

In line with Feenstra and Hanson (1997), both an increase in technological development and an increase in global outsourcing lead to a worsening inequality in terms of income and employment between skilled and unskilled workers within a nation. However, my model also shows that an increase in educational resources can reduce threshold of academic efforts, encouraging school enrollment. In turn, this increase leads to a greater supply of skilled workers, exerting downward pressure on income inequality, which gives rise to the policy implication that a government should allocate more resources to its educational infrastructure rather than resorting to trade protection.

In my model, there are heterogeneous preferences for leisure along the lifetime spectrum of people, where some individuals enroll as students and allocate part of their leisure time to studying to exchange for future comfort. However, those who prefer to consume leisure smoothly over the lifetime become unskilled workers. After education, the students become skilled workers with a skill premium and use the skill premium to purchase service goods from markets but unskilled workers must create service goods themselves. The more leisure time is allocated to studying, the larger the skill premium skilled laborers acquire, and the greater the income inequality in a country is. This is the main conclusion in this paper: in addition to technological development and global outsourcing, heterogeneous lifetime preferences for leisure lead to income inequality between skilled and unskilled workers within a nation.

I also argue that the more residents in a country like to make the leisure tradeoff for future comfort, the smaller is the elasticity of purchasing power for service goods, leading to greater lifetime income inequality in this country. This model implies that low latitude countries generally suffer from greater income inequality than high latitude countries. Endowed with longer hours of sunshine, residents of a low latitude country, all other things equal, generally feel less suffering in allocating leisure time to studying in comparison to those in a high latitude country, incurring a larger income inequality. This is the second conclusion in this model.
Endnotes

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1. In Section 2.1, I presume each individual is endowed with a unit of leisure time at any instant of time.

2. Investigating the welfare consequences of income inequality in the U.S., over the last 30 years, Krueger and Perri (2003) found that skilled workers enjoy sizable welfare gains at a similar magnitude to the losses of the poorest agents.

3. Blankenau and Camera (2001) argued that student effort is necessary for skill formation during education.


5. Barron et al. (2003) found that more than half of the return on college education is associated with student effort rather than student ability.

6. Among others, Sahin (2004) found that students respond to lower tuition policy in the U.S. by decreasing their level of study effort, resulting in a potential loss of human capital of around 15%. Her findings confirm the conventional wisdom that student academic effort plays a key role in future earnings.

7. While foreign direct investment leads to a bias effect favorable to “a small indigenous elite” in less developed countries, Fiala (1983) argued that “such an increase in equality, in the context of restricted occupational opportunities for industrial employment, would create an environment favorable to the expansion of service and informal sector employment.”

8. The Gini coefficient data are available for 28 OECD countries, which are estimated by the United Nation in different years. Most are surveyed in one of the following years: 2000, 2001, 2002, and 2003. The remaining are surveyed in any year from 1993 to 1999. The latitude information is from “Look-up Latitude and Longitude” found at http://www.bcca.org/misc/qiblih/latlong.html.

9. The population census of the economy is given by $LT + E\theta + E(T - \theta) = NT$ (Findlay and Kierzkowski, 1983).

10. John Eccles was an Australian neurophysiologist, who won the 1963 Neurology Nobel Laureate.

11. Lewin (1980) reported the studies of Dr. John Lorber on cerebral cortex losses. Among
several similar cases, a young Sheffield University student had an IQ of 126 and a first class honors degree in mathematics, although over 90% of his brain tissue was lost. In other words, he had “virtually no brain”.

12. As implied in Figure 2, it wouldn’t alter my results if $f''(a)$ is slightly less than zero.

13. In the U.S. as in many other countries, the interest rates of consumer loans (e.g., credit card rates) are currently about three times larger than student loan interest rates, where the former are about 18% and the latter are about 6%.

14. The nominator term of $B(a)$ denotes the entire service sector size and the denominator term represents the total supply of skilled workers. Note that the lifetime incomes of unskilled workers, either working in the goods or service sector, must be the same, while unskilled workers can freely move across the two sectors.

15. Take derivative of the right-hand site of (8) with respect to $a^*$, we obtain
\[
\frac{-f_{kk}[f_{ak} + af'_{kk} - f'_{kk}]}{f_{kk}^2} < 0, \quad \text{where} \quad f_{ak} > 0, \quad f'_{kk} = \frac{\partial f_{kk}}{\partial a} < 0 \quad \text{and} \quad f''_{ak} = \frac{\partial^2 f_{ak}}{\partial a^2} \geq 0.
\]

16. Note that $s_a > 0$ and $E_a < 0$.

17. As Greenspan (2000) has put it, “The completion of high school used to equip the average worker with sufficient skills to last a lifetime. That is no longer true, as evidenced by community colleges being inundated with workers returning to school to acquire new skills and on-the-job training being expanded and upgraded by a large proportion of American business.”

18. See the definition of $S(a, z)$ in Section 2.3.

19. It is because of $1 > a > 0$.

20. Again, a higher threshold of study effort, although increases in the school enrollment, is to partially compensate for the reducing income inequality.

21. I argue that people generally allocate time to fight against not only bitter cold but also boiling hot climate, so that the latter also deters the leisure tradeoff in this model. However, the OECD countries in Figure 1 are sufficient away from the Equator.
References


Eccles, J. C. 1974. “The brain indicates its powers are endless’, a lecture at University of Colorado,” University Memorial Center Boulder.


Figure 1. Gini Index v.s. Latitude

Figure 2. Leisure Allocation Equilibrium
Figure 3. With Technological Development

Figure 4. When Outsourcing Increases
Figure 5. When Educational Resource Increases

Figure 6. Current Leisure v.s. Future Comfort