How Do the Better Educated Earn More? Evidence from Rural China

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Abstract

This study seeks a better understanding on how education is rewarded. Drawing on the recent experiences of reforms in rural China, I estimate household net profit function using China Household Income Project (CHIP) for 2002. I find strong support that education influences household net profits through two channels: (1) education improves allocation of factor inputs and hence increases net profits; (2) education directly increases profits. It is estimated that an additional year of education is associated with 2.5 percent increase in net profits: 1.1 percent comes from more efficient allocation of labor; 0.35 percent comes from better utilization of capital investment; 1.09 percent comes directly from increasing profits. The study has potentially important policy implications for completing China's market reforms. It also sheds light on how schooling should be financed, particularly focusing on a few rather than universal provision of schooling may have direct impact on income.

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1 Introduction

The question of whether and how education affect income are basic concerns for development economists and policy makers. The fact that education improves one's living perspectives is also a strong argument for the desirability of undertaking substantial schooling investments in low-income countries and rural areas, in particular. All these initiatives points to a consideration of one more fundamental question: How do the educated farm households earn more? This study evaluates the effect of education on earnings in rural China during market liberalization (1988-2002). In 2005, nominal per capita income in rural China was 3255 RMB (roughly 626 CAD) (China Yearbook of Rural Household Survey 2006), 1.5 percent that of Canada in the same year. Despite rural China is still extremely poor relative to Canada, per capita income growth has been impressive by international standards. Since the inception of policy reforms, real per capita income in rural China has increased sharply during the period of 1978 and 1984, followed by a period of sustained growth. Several factors contribute to the remarkable performance during 1978 to 1984. In particular, the adoption of household responsibility system (HRS) and increases in state procurement prices were identified as the major sources of income growth prior to 1984, because it creates a profound *onetime* effect on earnings through increased labor effort and price incentives (Lin, 1992). Agricultural research and technological changes are also found to have significantly raised crop yields (Huang and Rozelle, 1996; Fan and Pardy, 1997). These studies are primarily concerned with productivity gains within agriculture during the early period of economic reform from 1978 to 1984. They do not explain sources of growth subsequent to the agricultural reform.

In this study, I examine the possible role of education in explaining the changes in factor allocation and its implication for income growth during for the period of nonagricultural development. Starting in the mid 1980s, the government announced a series of policies that is intended to loosen the restrictions on labor mobility out of agriculture. Despite restrictions on rural-urban migration is still tight back to the early 1990s, farm households are encouraged to establish nonfarm business and to seek off-farm employment with better pay. The idea of *leaving the farmland without leaving the countryside (li tu bu li xiang)* has long been regarded by the central government as the best way to absorb rural labor surplus. During the period of 1985 and 2002, the percentage of rural labor force employed in the Township and Rural Enterprises (TVEs) rises from 19 percent to over 27 percent, with the strongest growth of 22.2 percent in 1995 (China Statistical Yearbook, 2003). Figure 1 summarizes these changes. It generally suggests that there is a one-to-one movement between income growth, nonagricultural labor and nonagricultural income growth. There is a large literature on education and income in agriculture (see Jamison and van Der Gaag (1987), Li and Li (1994), Li and Zhang (1998), Cook (1999)). Consistent with the belief that return to education is low in absence of learning opportunities, these studies found negative or no effect of education in raising agricultural income. Another literature focuses on estimating the return of education in nonagricultural sector, mostly wage employment (see Meng (1995, 2001), Li and Urmanbetova (2002), de Brauw and Rozelle (2006) and Deng (2007)). These studies, primarily rely on Mincer equation, found positive return to education.

By and large, the aforementioned studies evaluate the productive value of education on earnings seperately for the agricultural and nonagricultural sectors. In most cases, the return to education is evaluated in a stable and dynamic environment. Theoretically, if choice to work in agriculture and nonagriculture are made at the optimum, the effect of education is reflected solely on its effect on total output. Seperately estimating wage functions for both sectors precisely captures the total contribution of education to earnings. However, this might not be true if rural households are constrained from making optimal decisions due to imperfections of the markets and the presence of policy controls. This study suggests that education might well impact earnings by adjusting the allocation of factor inputs between agriculture and nonagriculture. The concept of *allocation* is not new in the human capital literature. For example, education enhances the farmers' ability to deal with market disequilibria (see Schultz (1975) and Rosenzweig (1995)). Education may also improvefarm allocation decision as well as workers' production skills (Welch (1970)).

To facilitate interpretation, I set up a analytic framework, in which households maximize net profits from production that takes labor, capital and education as inputs. Under central planning, resources are exclusively allocated to farm production, resulting in resource misallocations. As restrictions relaxed, farm households respond by allocating inputs towards nonfarm production. The model assumes that household production takes capital, labor and education as input. The model shows the channel through which education might have an effect on earnings. In particular, the model yields two major predictions: (1) Controlling for initial endownments, the allocations of capital and labor are positively related to education; (2) Controlling for allocative decision (i.e. when all rural households make the same allocations between work in agriculture and nonagriculture), better educated farm households make greater profits.

The approach, taken in this study to evaluate the effect of education, differs previous studies in two ways. First and foremost, I am not only concerned with *how much* the return of education to output, but I am also concerned with *how* education might affect earnings. To a larger extent, this study seeks to understand the *mechanism(s)*. Previous studies are silent on this issue. Second, on obtaining the total effect of education on earnings, I consider a new methodology that uses both regression analysis and direct calculations. I am not only concerned with measuring the magnitude of the direct effect of education on household's net profits, but I am also concerned with the magnitude of *indirect effect* education has on net profits through augmenting capital and labor allocation. Multiplying these two products will give us full information about what the importance of education is in household net profits.

In section 4, I use CHIP (China Household Income Project) 2002 to explore *how* education impact households' net profits and to identify how much the allocative effect of education can account for difference in income. The results suggest an additional year of education is associated with 2.5 percent increase in net profits: Approximately 1.1 percent from improvement in efficiency in labor allocation and 0.35 percent from labor allocation. The rest 1 percent reflects education as an input factor in production.

The study here has potentially important implications, suggesting that education is an important element in facilitating China's reforms on sectoral allocation. Given that the key to the success of China's reforms rest on sectoral movement and in light of the recent decline in school quality in rural areas, public attention to educational infrastructure investment is imperative. As well, that highest education is the most relevant in terms of increasing net profits. The study also sheds light on how schooling might be financed.

The rest of the study is structured as follows: Section 2 outlines the policy reforms that set the background of this study; section 3 discusses the framework and illustrates how predictions of the study are generated; section 4 describes the data used for the empirical analysis; section 5 shows the empirical results and discusses their implications, and section 6 concludes.

2 Policy Reforms in China

This section outlines the institutional changes that shape the background of this study. Instead of offering an exhaustive description of how reforms were operated in China, I highlight three things: (1) why and how resources were misallocated under central planned system; (2) how reforms came into being in rural China; (3) and where it is heading.

2.1 The Mao's Legacy and Rural Institutions Prior to Reforms

Any story of China's reforms cannot be completed with a reference from Mao. Devasted by a century of turmoil and wars, the China that the Communists took over in 1949 was a desperately poor agrarian economy with hardly industrial assets. Nearly 90 percent of the population lived in rural areas, toiling on small plots of land using century old labor intensive farming technology. As the economy started to recover, the new government swirtly adopoted a Soviet-style, heavy industry oriented development strategy in 1952. To fund rapid industrialization, agricultural productivity had to be raised quickly in order to free up resources for industrial development(see Mao (1977, 5:196-97)).

Starting in 1953, at the urging of the central government, local cadres, eager to demonstrate their revolutionary zeal, rushed to create cooperatives. Ultimately, by January, 1958, the government amalgamated smaller cooperatives into 26,500 people communes, with each encompassing thousands of households. Believing that the collectivization drive had solved China's food problem permanently, the government diverted a large amount of rural labor force from agriculture to industry. The madness of transforming China into an industrialized economy reached the climax in 1959, when local cadres responded by making wild and baseless claims about grain yields and rural households would rush to operate backyard iron furnaces by melting their utensils[1]. Since the diverted rural labor to industry were usually more productive than those who stayed behind, agricultural output plumetted. A fall in labor productivity due to insufficient supply of grains, coupled with the lack of foreign assistance, lead to the famous Great Famine (1959 - 1961) where a reported 4 million people were killed.

After the Famine, the government reinforced the importance of grain production by introducing commune system and grain quotas. Under the commune system, grain produc-

[1] Rong Chang (1999) has a fascinating story in her book *Wild Swan*.

tion was carried in a unit of 50 households. Households have no responsibility to produce more than meeting the quotas. Therefore, incentives to innovate is weak. Rural industries remain subsidary to agirculture, emphasizing *five small* industries: iron, steel, cement, chemical fertilizer, hydroelectric power and farm implements. At the dawn of reforms in 1978, only 7 percent of the people are employed in the rural industries. Due to restrictions, return to capital and labor is high.

2.2 Growing out of Plan: Agricultural Reforms and Industrial Reforms

Starting in 1978, a set of policies were implemented that aims at increasing the productivity in agricultural productivity. The set of policies includes: The implementation of Household Responsibility System and the liberalization of markets. Contrasting to the Eastern European and Soviet experiences, reforms in China were very much carried out in way of small-scale experiments. It is like *Crossing the river by touching the stones.* One of the most famous examples is the Household Registration System (HRS). The implementation of household responsibility system is, by and large, incidental. In 1978 when the rest of the Chinese rural areas were operating under the collective farming system, in Fengyang county of Anhui Province, several households in a village began to contract with the local government for delivering fixed quota of grain in exchange for farming on a household basis. The practice was imitated by other counties in the province. By 1984, almost all the farm households across China had adopted this method. This institutional change induced strong family work effort, thus reducing the demand for workers on small Chinese farms. More importantly, the household responsibility system enabled individuals to have increased command over their productive resources. During the same period, the government also implemented reforms in production planning in which the state reduced the number of production planning targets. Of the remaining targets, few were mandatory and many were guided by complementary prices and incentive schemes (Sicular, 1988). Therefore, farmers regain some freedom in adjusting allocation of productive resources to maximize the profits by cutting costs and raising sales.

In consequence, price adjustments injected a large amount of funds into the rural economy, which created a demand for industrial products and supplied the flow of funds to capital investment, especially nonagricultural production. Liberalization of rural markets not only accommodated the sales of nonagricultural products, but also facilitated the purchase of inputs for nonagricultural activities. By the mid 1980s, the economic basis for accelerated growth in rural industries was already embedded in China's rural economy. Inputs and outputs markets had emerged; households were conscious of their alternative opportunities; and they had incentives to allocate resources that will ultimately generate higher returns[2].

It is well known that agricultural reform was the first reform success in China. But a bigger achievement lies elsewhere; in fact, most of the growth in 1990s came from nonagricultural sector, especially the industrial sector subsequent to agricultural reforms. By 1993, agriculture is only 15 percent of the total GDP, about the same level as that in former Soviet Union in 1980s. The second pillar of institutional change concerns the the development of nonagricultural firms, in particular, the rural firms called Township and Village enterprises (TVEs).

The TVEs are not state-owned firms nor private firms. They are local public firms controlled by community governments. To understand why TVEs have emerged and gained popularity, one has to understand the background. Starting in 1979, China started to devolve government authority from central to local government levels, the latter includes provinces, prefectures, counties, townships and villages. As a result, the local governments bore the responsibility for local interests. One would be curious why TVEs, instead of private enterprises came into prominence. In the absence of property rights and a credit market, the hyprid ownership of TVEs provides local government immunity to the possible predatory from state-owned firms. It also gives them opportunity to innovate through its close relationship with the state-owned companies. It is as also more possible for firms obtain credits from major banks given its close tie with the local government. Because of the typical structure of TVEs, they thrived as a result of policy reforms[3]

The development of local rural business or the so-called Township and Village Enterprises has been unexpected, even by Chinese reformers themselves. Between 1979 and 1993, the share of TVEs in the national industrial output expanded from 9 percent to 27 percent, while the share of rural private enterprises increased from 0 to 9 percent. Combining

[2]This view is supported by the empirical findings of Putterman (1993), who analyzed intersectoral factor allocation in five production teams of Dahe Township in Hebei province. The study suggests that, in 1985, the marginal productivity of capital and labor in the noncrop sector exceeded the levels in the cropping sector, indicating *overallocation* of resources in agriculture.

[3]Qian and Che (1994, 1998, 1999) provides a fascinating documentation on this account.

TVEs and private enterprises, rural industries as a whole produced 36 percent of national industrial output and employ about 123 million people, accounting for about one-half of the nonagricultural employment nationalwide. All together, these dramatic changes in policies and in farmers' responses marked the beginning of sustained expansion in nonagricultural activities.

2.3 Where the Reforms are Heading?

As reforms deepen, a set of drawbacks emerged. The most notable is still restrictions on labor migration between rural and urban areas. Chinese households are operated under the *hukou*[4] (household registration) system. This system identifies a person as a residence of an area. Previously, a person seeking nonagricultural employment in urban areas would have to apply through the relevant bureaucracies. The number of workers allowed to make such a move was tightly controlled. Rural households will lose their land title should they migrate. For those who successfully migrate, they are not entitled to employer provided health care and housing, education for their children and grain ration, etc.

Historically, with her large population, Chinese hukou limited mass migration from the land to cities to ensure some structural stability. By regulating labor in such a way, it ensured the supply of low cost labor to the plethora of state-owned business when needed. Nevertheless, with her accession to the WTO, China sees the pressure to embrace a reform that will ultimately liberalize the movement of all factor inputs.

3 An Analytic Framework

3.1 An Economic Model of Household Maximization

To better understand the mechanisms through which interventions lead to distortions in factor allocations and how education might influence farm households allocation decisions, I set up a farm household model with two activities: agricultural production and nonagricultural activities.

[4]The origin of hukou was initially invented by Guan Zhong, the Prime Minister of Qi state in 7th century, BC originally intended for convenience in taxation and conscription policies on different areas. In the book of Lord Shang, Shang Yang also described his policy banning immigration and emigration. Xiao He, the first Chancellor of the Han Dynasty, added the chapter of Hu as one of the nine basic laws of Han and established the Hukou system as the basis of tax revenue and conscription.

Let us consider a static profit maximization problem, in which a representative household i's return depends on both agricultural and nonagricultural productions:

$$y_j = f_j(k_j, l_j, e)$$

I have omitted land as an input factor to focus what is crucial the analysis in this study. In the empirical analysis, I will incorporate the role of land. As is standard in the literature, I assume that production function f is concave in all arguments and input factors are complementary to each other. Subscript $j \in (a, na)$, where a represents agriculture activities and na represents noagricultural activities. k and l represent capital investment, labor supply and inputs purchased by rural households. e denotes education. household chooses k_j, l_j, and e to maximize net profits:

$$\max_{k_j, l_j, e} V(k_j, l_j, e) = \sum_{j=1}^{2} P_j f_j(k_j, l_j, e) - \sum_{j=1}^{2}(w_j l_j + r_j k_j) \tag{1}$$

The first term of equation (2), $\sum_{j=1}^{2} P_j f_j(k_j, l_j, x, e)$, is the total revenue of rural household production. The second term $\sum_{j=1}^{2}(w_j l_j + r_j k_j)$ is referred to the cost of production. Several assumptions are made to facilitate interpretation as well as to capture the most relevant aspects of the Chinese economy.

First, I assume all factors of input are fixed in supply in the short term:

$$k_a + k_{na} = 1$$
$$l_a + l_{na} = 1 \tag{2}$$

I normalize the total capital and labor for the ease of display. It also provides directions for varibales construction in the empirical analysis: k_{na} and l_{na} are the shares of capital and labor, respectively. In the case of capital investment, this assumption will be valid as long as borrowing from outside is absent or at least very costly. Given that credit market is still undergoing transformation in rural China, it is reasonable to think of rural households as constrained by the availability of credits in the short run. In terms of labor, it is reasonable to think of households' labor supply is constrained by household size in the short run[5].

[5]One potential concern with fix labor supply is that hiring labor may become increasingly inexpensive. I argue here that it is not likely to crucially change the conclusion of the paper. As family labor is abandunt due to increase in agricultural productivity. As a robustness check, I will restrict the sample to those who does not employ outside labor in the empirical analysis.

Although farmers are not able to change the amount of factors of input in the short run, they can adjust the allocations of each of the input factors.

That resources are fixed in supply is, by no means, a modest simplication. In this paper, I do not systematically examine the accumulation of capital, in particular, although various researchers have emphazied the importance it plays in China's rapid development (see Chow (1993)). In practise, the way in which assets are distributed during the decollectivization period relies on a range of family backgrounds. From the theoretical point of view, incoporating these assumptions requires a different modelling strategy.

The household's maximization problem can be solved explicitly given certain functional form (i.e., Cobb-Douglas function). Solving equation (1) subject to equation (2) gives us a standard optimization solution under perfectly competitive market assumption:

$$l_{na}^{*} = l(p, w, r, e)$$

$$k_{na}^{*} = k(p, w, r, e)$$

While these optimal solutions can be used as a reference in studying farm household behavior in rural China, they have not taken into consideration that rural households in China still cannot adopt the optimal choices of labor and capital investment in the presence of restrictions. This is a particular case in terms of labor. Up to date, rural households in China are constrained from migration for two obvious reasons. First, land per farm in China is limited. Therefore, households who leave the countryside may risk losing their land title[6], implying that labor is overemployed in the agricultural sector. Second, as pointed out in section 2, Chinese residents are operated under a Registration system to which benefits of education and health care are linked. Therefore, the risk of losing one's benefit and not being able to obtain it elsewhere outside his/her residence forms another constraint, further implying that labor may be overemployed in the agricultural sector. Taken together, the following relationship holds:

$$l_{na}^{*} > l_{na} \tag{3}$$

where l_{na}^{*} is the optimal choice of labor in nonagricultural sector and l_{nf} is the labor allocation decisions under labor restrictions. Equation (3) implies that capital in nonagricultural

[6]Previous studies (see Zhao (1997, 1999)) have examined the role of land in rural labor migration to cities as rural households will lose their land title if they migrate.

sector is underinvested according to the assumptions of complementarity between input factors. Consequently, we have the following condition:

$$k_{na}^{*} > k_{na}^{p} \tag{4}$$

Again, k_{na}^{*} is the optimal choice of capital in nonagricultural sector without restrictions and k_{nap} is the choice of capital allocation under restrictions.

At this point, we have completed the full characterization of the Chinese rural economy. It involves maximizing the representative household's net profit, equation (1), subject to equations (2) - (4). The solutions to this problem can be implicitly expressed as a function of exogenous variables: p, w, r, and e. Formally, for household i we have:

$$\begin{aligned} k_{nap}^{i} &= k(p_i, w_i, r_i, e_i) \\ l_{nap}^{i} &= l(p_i, w_i, r_i, e_i) \end{aligned} \tag{5}$$

Ultimately, we are intersted in how education of household i is related to his/her net profits. To obtain an expression of this effect[7], we substitute equation (5) into equation (1). To do this, we would like to see how exactly education is related to net profits. The expression is given by $V_i(k(p_i, w_i, r_i, e_i), l(p_i, w_i, r_i, e_i), e)$. From here, we can see that education is not only related to net profits directly, but also through capital and labor. Total differentiating $V_i(k(p_i, w_i, r_i, e_i), l(p_i, w_i, r_i, e_i), e)$, we should be able to see education have an influece on net profits: One comes from education itself, the other through capital and labor. This can be formally expressed as follows:

$$\frac{\partial V_i}{\partial e_i} = \frac{\partial V_i}{\partial k_{nap}^{i}}\frac{\partial k_{nap}^{i}}{\partial e_i} + \frac{\partial V_i}{\partial l_{nap}^{i}}\frac{\partial l_{nap}^{i}}{\partial e_i} + \frac{\partial V_i}{\partial e_i} > 0 \tag{6}$$

Equation (6) provides the general framework for the estimation. In particular, we are interested in three terms in this equation. The last term $\frac{\partial V_i}{\partial e_i}$ captures the productive effect of education on household net profits. It is the focus of previous studies that seperately estimate returns to education in agiculture and nonagriculture. In this study, we are also concerned with $\frac{\partial V_i}{\partial k_{nap}^{i}}\frac{\partial k_{nap}^{i}}{\partial e_i}$ and $\frac{\partial V_i}{\partial l_{nap}^{i}}\frac{\partial l_{nap}^{i}}{\partial e_i}$. These two terms captures the main deviation of this study from others. It suggest that education may have an impact on net profits through augmenting labor and capital allocation, provided that $\frac{\partial k_{nap}^{i}}{\partial e_i} > 0$ and $\frac{\partial l_{nap}^{i}}{\partial e_i} > 0$.

Before moving to the discussion of methodology used for estimating the seperate effect

[7]Appendix discusses in more details on the solutions.

of education on household net profits, let us restate why $\frac{\partial k^i_{nap}}{\partial e_i} > 0$ and $\frac{\partial l^i_{nap}}{\partial e_i} > 0$. It is well known that if household decisions are made at the optimum, by Envelope Theorem, the terms $\frac{\partial k^i_{nap}}{\partial e_i}$ and $\frac{\partial l^i_{nap}}{\partial e_i}$ should vanish to 0. That is to say, any effect that e, education has on the endogenous variables k and l should be reflected on education's sole effect on net profits - a small tightening or relaxing of it should have no effect on the solution. However, as discussed in the setup of the model, the presence of restrictions on labor mobility and land titlement poses a constraint as such choice of labor and capital binds below the optimum, suggesting that $\frac{\partial k^i_{nap}}{\partial e_i} > 0$ and $\frac{\partial l^i_{nap}}{\partial e_i} > 0$. Given that the net profit function $V(k, l, e)$ is assumed to be concave in all arguments, $\partial V_i \partial k^i_{nap} > 0$ and $\partial V_i \partial l^i_{nap} > 0$. As a result, equation (6) is positive by assumption.

3.2 Methodology

This previous subsection suggests a framework used for estimating the effect of education. This subsection discusses the methodology. Specifically, I am interested in how to disset the effect of education on net profits that comes from its augmention on labor and capital allocation (allocative effect): $\frac{\partial k^i_{nap}}{\partial e_i}$ and $\frac{\partial l^i_{nap}}{\partial e_i}$, and the effect it has on net profit through total output (productive effect): $\frac{\partial V_i}{\partial e_i}$.

One way to tackle this is to employ a *Two Stage Least Square Estimates*[8], in which I estimate the effect of education on the allocation of non agricultural capital and labor seperately in the first stage by controlling for factor endowments. The equations estimated are:

$$\begin{aligned} capitalshare &= \alpha + \beta_1(factorendowment) + \beta_2(education) + \Phi X \\ laborshare &= \delta + \gamma_1(factorendowment) + \gamma_2(education) + \Phi X \end{aligned} \tag{7}$$

where capital share and labor share are proxies used for allocation of resources. Factor endowments includes: household fix capital stock, the size of family work force and land. They control for household endowments. ΦX[9] represents a vector of controls: household size, the average number of durables, whether the household is located in an area has a road,

[8]It is important to note that, while I will continue to refer to my estimation strategy as a two stage least square estimation, that does not connote anything about instrumentation. What is done here is simply a mechanical adjustment to generate the effect of education on factor allocation.

[9]The set of control should be identical for both estimations in equation (7), given that they are both run at the same individual level. The similar rationale is applie to estimating the net profit function.

geographic conditions (plain/hilly/mountainous), whether the community of the household lives has elementary schools, and so forth - that may affact the allocation of capital and labor. β_2 and γ_2 captures the effect of education on capital and labor, respectively. Equation (7) will run for all individuals i. The estimated coefficients on the effect of education on factor allocation is given by: $\hat{\beta}_2$ and $\hat{\gamma}_2$. They correspond to the terms $\frac{\partial k^i_{nap}}{\partial e_i}$ and $\frac{\partial l^i_{nap}}{\partial e_i}$, respectively.

Our ultimate interest is to estimate the net profit function and to establish a relationship between net profit for household i and his/her eduation e_i. Given that our ultimate interest lies in dissecting the effect of education on household net profits, I estimate the following equation:

$$\begin{aligned} netprofit &= \rho + \nu_1(factorendowment) + \nu_2(capitalshare) + \nu_3(laborshare) \\ &\quad + \nu_4(education) + \Phi X \end{aligned} \tag{8}$$

To see how we may be able to obtain the estimates of the education that comes from adjusting factor inputs and total output seperately, we substitute equation (7) in (8) for capital share and labor share, respectively. This gives us the following expression:

$$\begin{aligned} netprofit &= \rho + \nu_1(factorendowment) + \nu_2(\alpha + \beta_1(factorendowment) + \beta_3 education) \\ &\quad + \nu_3(\delta + \gamma_1(factorendowment) + \gamma_2(education)) \\ &\quad + \nu_4(education) + \Phi X \end{aligned} \tag{9}$$

From equation (9), with a slight rearrangement, it is easy to identify the coefficients of interest. The coefficient of factor endowments is given by $\nu_1 + \nu_2\beta_1 + \nu_3\gamma_3$. The effect of education that comes from augmenting capital is given by $\nu_2\beta_2$ and that comes from augmenting labor is given by $\nu_3\gamma_3$. The direct impact of education is estimated by ν_4. This suggests that the combined effect of education on net profit can be calculated as:

$$\frac{\partial V}{\partial e} = \nu_2\beta_2 + \nu_3\gamma_3 + \nu_4 \tag{10}$$

Before moving on to the data and results, it is worth briefly discussing how the methodology used here is different from that of the exisiting literature. There are two basic difference. First, the approach taken here will not only allow me to capture the total effect of education on net profits, but it also enables me to seperately evaluates the effects coming from augmenting factor inputs and output, as reflected on net profits. Previous studies generally evaluate returns to education seperately for agricultural and nonagricultural sectors.

In this case, ν_4 is the coefficient of their interest. If education is related to net profits through augmenting factor inputs, previous studies tend to underestate this effect. Second, the framework above clearly has implication regarding how education might be related to households' net profit. As a result, my study does not only present a new approach of estimation, but it also improves our understanding on an important question: How the better educated might be better off.

4 Data

The analysis here is run using both individual-level and household-level microdata in rural China. The dataset is called China Household Income Project (CHIP). The complete project on rural household consists of three cross-sectional survey in 1988, 1995 and 2002. I make primary use of the third wave in 2002. The survey in 2002 covers 22 provinces[10], 9200 households and 37,969 individuals in total. The rural survey is derived from a larger sample of the National Rural Household Survey conducted by National Bureau of Statistics (NBS). The survey is implemented using a three-stage stratified and systematic sampling method. In the first stage, counties are selected from each provinces; villages are drawn from counties; and finally households.

The CHIP 2002 provides detailed information on the sector and types of the employment. Working individuals are asked to provide information whether they are primarily engaged in agricultural production and if so, how they spend the time among different agricultural tasks. Similarly, for those who are employed in nonagricultural sector (self-employed and wage employment), they are asked the primary employment sectors. There are 17 categories: husbandry, forestry, fishery, cropping, minining, industry, constructions, communication, wholesales, etc. Consistent with the definition of *agriculture* in China, I group people who are primarily employed and work in forestry, fishery, cropping as agricultural labor. Therefore, nonagricultural labor is calculated by subtracting the family workforce by agricultural labor. Household net profits are calculated as the income from both agricultural and nonagricultural activities net of the production costs.

There mainly two types of productive capital: agricultural capital and nonagricultural

[10]The provinces covered in the survey is Beijing, Hebei, Shanxi, Liaoning, Jilin, Jiangsu, Anhui, Jiangxi, Shangdong, Henan, Hubei, Hunan, Guangdong, Sichuan, Guizhou, Yunnan, Shangxi, Gansu.

capital. Agricultural capital includes daft animals, large and medium-size farming tools and equipments, while nonagricultural capital includes industrial machinery, transportation machinery, construction machinery and storage space. The survey also records the number of durables each household has. Land is reported as cultivated land.

The CHIP reports education in two ways. It asks all household members the years of education as well as the level of completion. It also reports the school performance of the working individuals, which allows for control on school quality. Table 1 reports the summary statistics. Panel A reports real per capita net profits and other factor inputs. One notable features is that net profits and production capital stock have large standard deviations, with net profits ranging from -283.25 to 35225.33 and fixed productive capital 0 to 180. Share of nonagricultural fix productive capital reveals the same pattern. This suggests that these variables are generally much nosier than the rest. Without linearization, raw data regression may produce estimates that are misleading (i.e., the regression may be overwhelmed by the noisy variables). Panel B thus compares the summary statistics of the loglinearized variables with raw data. Panel C reports the schooling and experiences of working household members.

5 Empirical Results

This section discusses the empirical results, using the methodology discussed in section 3.2. There are several issues that are worth discussing before I move on to the empirical results. First is concerned with the measurement of education. I follow Yang (1997) to use the highest education in the household as a proxy for education. This approach is consistent with that family members have incentives to share information with each other. As a result, the highest educated one will play the most important role. As a robustness check, I consider other measures of education, such as average and household head education.

The second is concerned with omitted variables. Unfortunately, I do not have a panel data that follows the same individuals over time. In this case, my results on interpreting the relationship between education and net profits may be driven by some omitted factor. For example, an individual from a wealthier family may have a better chance of going to school and completing school. This kind of relationship may not be possible to observe in a cross section data. In the absence of such an individual-level panel where I could follow individual over time, this could be a difficult issue to solve.

In the following section, I focus on two tests. The first test concerns the effect of education on labor and capital allocation. The second calculates the combined effect of education on household net profits. The third subsection deals with omitted variable problems by focusing on county level analysis.

5.1 Estimating the Allocative Effect of Education

This section estimates equation (7) for capital and labor. On obtaining the estimates of the effect of education, the dependent variables are the logarithm of the share of nonagricultural labor in family workforce, and the logarithm of the share of nonagricultural capital in total fixed productive capital. I also compare the results with using different proxies for allocation: the logarithm of nonagricultural labor, and the logarithm of nonagricultural capital. Dependent variables includes a set of factor endowments: fixed production capital stock, total family workforce, and cultivated land per capita, all in logarithm. I used years of schooling for education for two reasons. First, using educational level tends to *overstate* the effect of education at the lower education level and *understate* it at the higher education level. For example, an individual drops-outs may understate their education, while those who stay at school will report the opposite. Using years of education can partially alliviate this problem. Second, a continuous measurement of education makes interpretation easier (i.e. the marginal effect of education).

Table 2 summarizes the results on labor allocation. Column (1) - (3) uses the absolute number of labor in nonagriculture as dependent variable while column (4) - (6) uses share of nonagricultural labor. The variables of interest are the education coefficients. All regressions includes a provincial dummies to capture any effect that we miss due to the limitation of the data. I show regression with different measures of education. Among all measures of education, only regression that uses highest education in the household is significant. The effect of highest education on the allocation of labor ranges from .0413 to .0516 (all significant at 1 percent level), implying that increasing education by 1 year is associated with 4.13 - 5.16 percent increase in laborforce moving from agricultural to nonagricultural sector. A potential problem is that the result might be driven by outliers. As a robustness check, I run regressions dropping one province at a time. I find that the effect of highest education is of similar magnitude. Reckoning section 3.2, table 1 provides estimate of γ_2, which is the coefficient on highest education.

Table 2 also shows that all variables have their expected signs: The negative sign on land is consistent with previous studies that land does pose a constraint on movement of labor out of agriculture, while 1 percent increasing total workforce is associated with around 50 percent increase in labor moving from agriculture to nonagriculture. The negative sign on the workforce in the nonagricultural labor share regression is mainly due to the use of total workforce as a denominator. In general, both regressions should reconcile (I run a seperate regression for nonagricultural labor in order to show how total laborforce is related to changes in nonagricultural labor).

In both regressions for capital and labor, experiences do not seem to influence intersectoral allocation decision. The signs on both experiences and its quadratic term are negative and insignificant both in magnitude and statistically. This suggests that older households with the same schooling experience is less likely to work in nonagricultural sector - a result consistent with the observation that younger household members prefer leaving the farm regardless of the experience.

Table 3 shows the estimates for capital by running the same regressions as labor. The effect of education on capital allocation ranges from .0097 to .011, implying that increasing education by 1 years is associated with 0.97 percent to 1.1 percent increase in capital moving from agriculture to nonagriculture. This is the measure of β_2 in section 3.2. To some extend of surprise, any increase in capital stock is almost devoted to nonagricultural use given that the coefficient of total fixed capital stock is around 1.

Results in table 2 - 3 generally suggest that education does utilize the allocation of factor inputs. The results are also consistent with prior belief that highest farm education is the most important education variable in explaining efficiency and that there is centralized decision making on the farms where the households utilize all available human resources. I now turn to estimating the total effect of education.

5.2 Estimating the Total Effect of Education

Table 4 reports the results for the net profit function (8). Column (1) of table 4 shows the baseline estimates without control for allocation of labor and capital. Column (2) takes into account of allocation decisions. Column (3) presents the full set of controls with a focus on comparing the effect of highest education and average education.

The results suggest that land, labor and capital all contribute to household's net profits, although increasing family laborforce seems to reduce profits without controlling for labor and capital share in nonagricultural sector and its effect is quite insignificant even after controls for these factor allocations. Our interest is to examine how factor allocation is related to household's net profits. These coefficients correspond to ν_2 and ν_3 in equation (8). The results suggest that 10 percent increase in the share of labor in nonagricultural sector is associated with 2.7 percent increase in net profits. Similarly, a 10 percent increase in the share of capital in nonagricultural sector is associated with 0.3 percent increase in net profits.

In addition to facilitating allocation of capital and labor to nonagricultural activities, education also influence net profits directly to capture other aspects of their effect on earnings. In all regressions shown in table 4, the coefficients of highest education ranges from .0109 to .0120 and are significant at 1% level. This suggests that 1 year increase in education is associated with 1.1 percent increase in net profits. This measure corresponds to coefficient ν_4 in equation (8). Average education of household members has significant influence on net profits as well, but remain second order to highest education, saying that 1 years increase in overall education increases net profits by 0.6 percent. Consider a household of 5 people in general, this means a total five years increase of education to achieve a 0.6 percent increase in net profits.

Table 2, 3 and 4 provides estimates that enable us to directly calculate the effect of education on households' net profits. In order to do this, we make use of equation (10): $\frac{\partial V}{\partial e} = \nu_2\beta_2 + \nu_3\beta_3 + \nu_4$, where ν_2 is the coefficient of capitalshare in column (2) of table 4; β_2 is measure the impact of education on capitalshare in column (4) of table 3; ν_3 is the coefficient of laborshare in column (2) of table 4; β_3 is effect of eduation on laborshare. ν_4 measures the direct effect of education in net profits.

Table 5 replicates columns from table 2 - 4. The variables of interest are in bold format. Column (1) replicates column (2) of table 4. Column (2) is taken from column (4) of table 2 and column (3) resembles column (4) of table 3. The calculation yields the following results: Effect coming from labor allocation is $(.0413) \times (.2686) = 1.1\%$; effect from capital is given by $(.0097) \times (.0364) = 0.035\%$. The direct effect of education is given by $.0109 = 1.09\%$. The total effect of education on net profits can be obtained by summing up the three effects, yielding $1.1\% + .035\% + 1.09\% = 2.23\%$. That says, an additional year of education increases households' net profits by 2.23 percent, out of which the effect of education on labor allocation is the strongest. This is consistent with the one-to-one movement between income growth and nonagricultural labor observed in Figure 1.

6 Conclusion

This study uses cross-sectional data from rural China to investigate the possible sources and determinants of variation in income in rural China. It is hypothesized that education plays a critical role in facilitating resources allocations and previous studies tend to overlook this effect. The findings here suggest that education does play a critical role in raising efficiency in rural households in respond to changing market conditions. Under policy interventions, better educated household are not only more productive, but also able to make better allocative decisions in terms of working and investing in nonfarm activities. As such, they are able to rip bigger profits.

It is worth noting the possible policy implications that may come out of the study. The central planned-system created massive misallocation of resources within the rural sector and across rural-urban regions. While past reforms has greatly improved allocative efficiency within rural economy, China is still facing long-term, arduous structural adjustments across the sectors. Mobility of resources will be the key aspect of this process; consequently rural schooling will have a high value during the transition. In view of the fact that the conditions of many rural schools have deteriorated during recent institutional changes, public attention and investment in infrastructure is imperative. To a large extent, this study of rural China also mirror the experiences of other developing countries, in which rural people must face the selection of income activities and the prospect of leaving agriculture. Education plays a critical role in these allocative decisions for raising incomes in the current period as well as for the future.

Second, a little bit further, this study provides evidence on the composition of demand for education in rural households. In particular, that only highest education within the households matters may have potentially important implication regarding how schooling should be financed: focusing on a few with available resources rather than providing universal schooling may improve efficiency, which in turn translates into higher profits. With certainty, this remains a speculation. Future research that seeks to determine optimal schooling would be desirable.

Appendix

This section discusses a general solution to the economic model of household profit maximization in section 3. A representative rural household maximizes his/her net profit by choice of agricultural capital k_a and nonagricultural capital k_{na}, agricultural and nonagricultural labor, l_a and l_{na}, respectively. Prices of outputs and costs of inputs are assumed to be exogenous. Education choice e is predetermined :

$$\max_{k_a,l_a,k_{na},l_{na}} [p_a f_a(k_a,l_a,e) - (w_a l_a + r_a k_a)] + [p_{na} f_{na}(k_{na},l_{na},e) - (w_{na} l_{na} + r_{na} k_{na})$$

subject to the resource constraint:

$$k_a + k_{na} = 1$$

$$l_a + l_{na} = 1$$

By standard Lagrangean method, we can rewrite the problem as if it is an unconstrained maximization problem by substituting k_a with $1 - k_{na}$. The same method applies to labor. Here is the revised problem:

$$\max_{k_{na},l_{na}} p_a f_a(1-k_{na}, 1-l_{na}, e) - [w_a(1-l_{na}) + r_a(1-k_a)] + [p_{na} f_{na}(k_{na},l_{na},e) - (w_{na} l_{na} + r_{na} k_{na})$$

Under normal circumstances, meaning in a world without further restrictions, solving the above maximization problem shall give us the optimal choice of k^*_{na} and l^*_{na}. As in section 3.1, we express them in terms of exogenous variables, p, w, r, and e. But rural households in China still cannot adopt the optimal choices above for various reasons, most notably restrictions on labor mobility. We thus imposes another two constraints. The left hand side states that choices should be made positive (i.e., no rational beings will throw resources away). The right hand side captures the idea stated above.

$$0 < l_{na} < l^*_{na}$$

$$0 < k_{na} < k^*_{na}$$

Therefore, the problem is an inequality constraint maximization problem. Usual Lagrangean methods still applies. However, instead of getting the standard first order conditions. We obtained two sets of conditions called the Complementary Slackness Conditions. Our ultimate goal is not to obtain the exact solutions of the whole problem, but rather to infer the comparative statics (i.e. how one variable is related to the other). The Lagrangean is given as follows, where the multiplier of the constraints are called the shadow prices. They have interesting interpretation in economics: they measure the changes in one variable given the trivial changes in the other. As a result, λ and μ will be zero if everything is made at the optimun (i.e., nothing can be made better/worse). If choices are made below the optimum, meaning that something can be made better. In this case, the shadow prices will be strictly positive ($\mu > 0$ and $\lambda > 0$) (i.e., a reward for getting better). The Lagrangean is given as follows:

$$L = \underbrace{p_a f_a(1-k_{na}, 1-l_{na}, e) - [w_a(1-l_{na}) + r_a(1-k_a)] + [p_{na} f_{na}(k_{na}, l_{na}, e) - (w_{na} l_{na} + r_{na} k_{na})}_{V, net profits}$$
$$+\lambda(l^*_{na} - l_{na}) + \mu(k^*_{na} - k_{na})$$

The Complementary Slackness Conditions are given by:

1. Capital

$$(k^*_{na} - k_{na}) \times \frac{\partial L}{\partial k_{na}} = (k^*_{na} - k_{na}) \times [\underbrace{(p_{na} f_{nak} - p_a f_{ak} + r_a - r_{na})}_{\frac{\partial V}{\partial k_{na}}, marginal profit of capital} - \lambda] = 0$$

2. Labor

$$(l^*_{na} - l_{na}) \times \frac{\partial L}{\partial l_{na}} = (l^*_{na} - l_{na}) \times [\underbrace{(p_{na} f_{nal} - p_a f_{al} + w_a - w_{na})}_{\frac{\partial V}{\partial l_{na}}, marginal profit of labor} - \mu] = 0$$

Since the first term in the parenthesis are positive, $k^*_{na} - k_{na} > 0$ and $l^*_{na} - l_{na} > 0$. This means that the terms that they multiply must equal to zero.

$$\underbrace{(p_{na} f_{nak} - p_a f_{ak} + r_a - r_{na})}_{\frac{\partial V}{\partial k_{na}}, marginal profit of capital} - \lambda = 0$$
$$\underbrace{(p_{na} f_{nal} - p_a f_{al} + w_a - w_{na})}_{\frac{\partial V}{\partial l_{na}}, marginal profit of labor} - \mu = 0$$

Given $\lambda > 0$ and $\mu > 0$, we know the marginal profits of labor and capital, the terms inside the brackets will be strictly positive.

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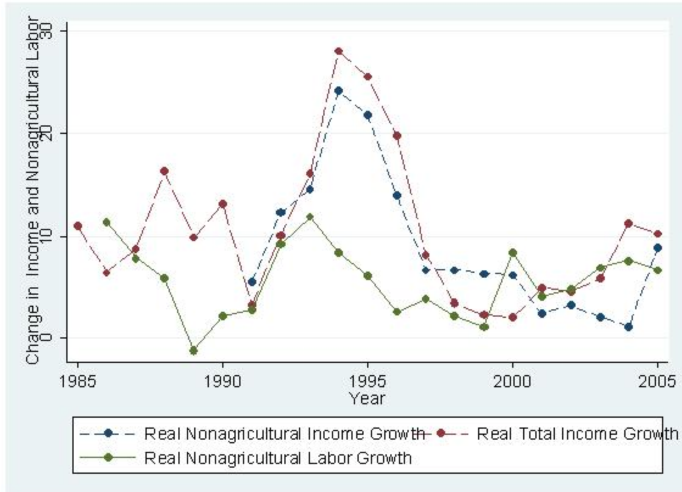

Figure 1: Growth in Net Income, Nonagricultural Income and Nonagricultural Labor

Source: China Statistical Yearbook, 1996, 2003, 2006 and China Statistical Yearbook of Rural Survey, 2006

Table 1: Summary Statistics

	Mean	Stardard Deviation	Min	Max
Panel A: Net Profits and Production Inputs				
Net Real Profits	2707.772	2267.41	−283.25	35225.33
Cultivated Land	4.6475	4.8689	0	180
Productive Capital	1180.996	3586.24	0	198365
Household Size	4.3894	1.2355	0	11
Family Workforce	2.5819	1.2062	0	8
Nonagr. Labor	1.1736	.9541	0	5
Nonagr. Labor Share	48.5667	34.7866	0	100
Nonagr. Capital	685.2171	3393.429	0	198115
Nonagr. Capital Share	42.1569	36.5100	0	100
Panel B: Net Profits and Production Inputs (Log Transformation)				
Net Real Profits	3.3304	.2969	1.301	4.5469
Cultivated Land	.5970	.3305	-1.3010	2.2553
Productive Capital	2.7676	.5556	1	5.2974
Household Size	.6245	.1269	0	1.0414
Family Workforce	.3909	.1862	0	.9031
Nonagr. Labor	.1474	.1884	0	.6990
Nonagr. Labor Share	1.7489	.1990	1.1549	2
Nonagr. Capital	2.5171	.6016	.8539	5.2969
Nonagr. Capital Share	1.6543	.3426	−.2788	2
Panel C: Schooling and Experiences of Working Household Members				
Highest Education	9.1541	2.2018	0	18
Average Education	6.7900	1.7954	0	14.3333
Household Head Education	7.2449	2.5129	0	16
Average Experience	34.7878	20.696	0	182

Panel A reports the raw data summary statistics; panel B is the logarithm transformation of Panel A. Panel C contains basic schooling information. Experience is calculated by subtracting working individual's age with schooling years and 7, the age of enrollment.

Table 2: Estimating the Demand of Nonagricultural Labor

Explanatory Variables	Dependent Variables					
	log(nalabor)			log(share.nalabor)		
	(1)	(2)	(3)	(4)	(5)	(6)
log(land)	−.06786***	−.0614***	−.0627***	−.0691	−.0635***	−.0627***
	(.0117)	(.0116)	(.0115)	(.0117)	(.0116)	(.0115)
log(laborforce)	.5029***	.4939***	.4827***	−.4970***	−.5061***	−.5173
	(.0216)	(.0205)	(.0206)	(.0216)	(.0204)	(.0206)
log(capitalstock)	−.0046	−.0041	−.0034	−.0041	−.0036	−.0039
	(.0062)	(.0061)	(.0061)	(.0062)	(.0061)	(.524)
highest education	.0413***		.0516***	.0413***		.0516***
	(.0124)		(.0150)	(.0124)		(.0015)
average education		.0139	−.0053		(.0140)	(−.0053)
		(.0108)	(.0118)		(.0108)	(.0118)
hhead education		.0026**	−.0003		.0026**	−.0003
		(.0024)	(.0029)		(.0024)	(.0029)
Average experience	−.0002	−.0002	−.0002	−.0002	−.0002	−.0003
	(.0003)	(.0004)	(.011)	(.0004)	(.0003)	(.0003)
$Averageexperience^2$	$4.85^e - 6$	$4.92^e - 6$	$4.24^e - 6$	$4.92^e - 6$	$4.24^e - 6$	$4.85^e - 6$
	$(2.30^e - 6)$	$(2.31^e - 6)$	$(2.31^e - 6)$	$(2.50^e - 6)$	$(2.31^e - 6)$	$(2.30^e - 6)$
R^2	.31	.29	.29	.35	.34	.36
Obs.	17569	17569	17569	17569	17569	17569

All regressions include provincial dummies. Standard errors are in parenthesis and corrected for intra-village correlation. level. Controls for the regressions are geographic conditions (hilly/plain/mountainous), whether and when the village has roads, whether the village has junior high school, the number of minority people.

*** siginificant at 1%

**significant at 5%

*significant at 10%

Table 3: Estimating the Demand of Nonagricultural Capital

Explanatory Variables	Dependent Variables					
	log(nacapital)			log(share.nacapital)		
	(1)	(2)	(3)	(4)	(5)	(6)
log(land)	$-.2077^{***}$	$-.2104^{***}$	$-.2123^{***}$	$-.2077$	$-.2104^{***}$	$-.2123^{***}$
	(.0256)	(.02600)	(.0260)	(.02561)	(.02600)	(.02603)
log(laborforce)	$-.0988^{**}$	$-.0807^{**}$	$-.1046^{***}$	$-.0988^{***}$	$-.0807^{***}$	$-.1046^{***}$
	(.0396)	(.0390)	(.0391)	(.0396)	(.0390)	(.0391)
log(capitalstock)	$.9752^{***}$	$.9688^{***}$	$.9686^{***}$	$-.0988$	$-.0312^{*}$	$-.0314^{**}$
	(.0168)	(.0160)	(.0160)	(.0168)	(.0160)	(.0160)
highest education	$.0097^{***}$		$.0105^{***}$	$.0097^{***}$		$.0105^{***}$
	(.0024)		(.0030)	(.0024)		(.0030)
average education		$-.0139$	$-.0649$		$-.0242$	$-.0649 * **$
		(.0108)	(.0118)		(.0108)	(.0118)
hhead education		$.0048^{**}$	$-.0014$		$.0027^{**}$	$-.0003$
		(.0024)	(.0029)		(.0024)	(.0029)
Average experience	.0003	.0002	$-.0001$	.0003	.0002	$-.0001$
	(.0003)	(.0002)	(.0009)	(.0009)	(.0009)	(.0009)
$Averageexperience^2$	-8.48^e-6	-7.96^e-6	-7.01^e-6	-8.48^e-6	-7.96^e-6	-7.01^e-6
	(7.09^e-6)	(7.13^e-6)	(7.05^e-6)	(7.09^e-6)	(7.13^e-6)	(7.05^e-6)
R^2	.73	.73	.73	.15	.16	.16
Obs.	16786	16786	16786	16786	16786	16786

All regressions include provincial dummies. Standard errors are in parenthesis and corrected for intra-village correlation. Controls for the regressions are geographic conditions (hilly/plain/mountainous), whether and when the village has roads, whether the village has junior high school, the distance to the nearest junior high schools the number of minority people.

*** siginificant at 1%

**significant at 5%

*significant at 10%

Table 4: Estimating the Net Profits Function

	log(netprofits)		
	(1)	(2)	(3)
log(land)	.0526***	.0703***	.0754***
	(.0148)	(0.181)	(.0179)
log(laborforce)	$-.1332^{***}$	.0315	.03111
	(.0249)	(.0340)	(.0337)
log(capitalstock)	.0440***	.0588***	.0641***
	(.0079)	(.0106)	(.0107)
log(share.nalabor)		.2686***	.2631***
		(.0330)	(.0320)
log(share.nacapital)		.0364**	.0371**
		(.0153)	(.0153)
higheset education	.0120***	.0109***	.0114***
	(.0017)	(.0022)	(.0021)
average education			.0065**
			(.0214)
average experience	$-.0017$	$-.0018$	$-.0017$
	(.0005)	(.0005)	(.0006)
$averageexperience^2$	$3.08e-6$	$3.22e-6$	$2.91e-6$
	$(3.54e-6)$	$(4.66e-6)$	$(4.82e-6)$
R^2	.37	.45	.46
Obs.	22165	13055	13055

Table 5: Calculation of the Total Effect of Education on Net Profits

	log(share.nalabor)	log(share.nacapital)	log(netprofits)
log(land)	−.0691	−.2077	.0526
log(laborforce)	−.4970	−.0988	−.1332
log(capitalstock)	−.0041	−.0988	.0588
log(share.nalabor)			**.2686**
log(share.nacapital)			**.0364**
highest education	**.0413**	**.0097**	**.0109**