Benefits of Women's Education within Marriage Evidence from South Africa[1]

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Abstract

This paper examines returns to wife's schooling in husband's earnings using panel data from a province in South Africa. Although it has been recognized in previous studies that woman's human capital has significant influence on children being as a mother, the effect of woman's education on husband's earnings has not been properly identified. In particular, the roles of women's human capital in the household and labor market are interesting in the post-apartheid South Africa where institutional constraints in apartheid labor markets are abolished. Empirical results in fixed-effect and difference-in-difference estimation show that i) wife's education also contributes to the husband's wage growth, ii) the number of years in marriage augments the wife's education effect on the husband's wage growth, and iii) marriage premium do not exist in this study. The results have implications on marriage market and income distribution.

Key Word: Schooling, Returns to schooling, Wage, Earning, Marriage Market, Assortative mating

JEL Classification: D13,I21,J31

1 Introduction

Recent studies have well-documented that schooling is positively associated with both labor market and non-labor market outcomes. It is also recognized that other individual characteristics than formal education and specific training also constitute the effective stock of human capital, which will augment the individual productivity. Individual characteristics, such as ability, motivation, knowledge are actually affected by other members' educational attainment in the same household. Marriage is distinguished from most other non-market relations. The couples have great incentives to share acquired abilities within the household. The cost of sharing information between couples would also appear to be lower than those in other kinship (Benham 1972). From this viewpoint, therefore, it is not difficult to imagine that wife's higher schooling can improve her husband's earning capability by properly managing household, sharing information and suggesting on careers.

On the other hand, it is also important to note a positive correlation between the couple's abilities which may also lead to an observation that a husband's earning is positively related to his wife's schooling. This makes us spuriously infer the pure productivity effect which I have discussed above. Therefore, estimation should be designed to deal with the correlation.

This paper attempts to ask the following questions. (1) Does wife's schooling positively affect her husband's earnings through household production? (2) If empirical results suggest such cross-productivity effects, then is it successfully identified against assortative mating in marriage market? (3) Is there any complementary effect between couples' human capital ? (4) Does marriage premium exist in this study? (5) If wife's schooling effect contributes to her husband's labor market productivity, can we observe any changes from apartheid to post-apartheid?

Although the data and empirical strategies I used can not fully answer all of the questions, I examine the roles of women's education in their husbands' earnings, correcting for the correlation between wife's schooling and husband's unobserved individual abilities, which may arise from assortative sorting in marriage market. For this purpose, I use KwaZulu-Natal Income Dynamics Study (KIDS) from South Africa, which allows me to examine dynamic changes of male earnings from 1993 to 1998 and to control for unobserved time-invariant heterogeneity at individual level. If the cross-productivity effect exists even after controlling for unobserved time-invariant factors, then returns to wife's schooling within the household have some im-

plications to developing countries such as South Africa, where women have not been given the same opportunities as men to participate in labor markets.

The empirical setting of this paper comes from South Africa, which has experienced racial discrimination for more than 30 years. In apartheid South Africa, non-white women had to bear a double burden: they were not only oppressed because of their race in apartheid regime but also simultaneously carried the burden of patriarchy that had existed in their own culture. To provide a sense of the gender difference, Figure 1 depicts the distribution of years of schooling and regular monthly wage income of South African labor market in 1998. As Verhoef (1996) mentioned that the utilization of female labor does not correspond with the level of female education, we confirm a similar situation from our data.

Figure 1 to be inserted

In many industries, even though the average years of schooling are higher among women than men, women only earn lower incomes than men do. However, once taking into account their contributions in household, we may obtain a different picture. This is the focus of this paper.

Given that women are better at generating positive externalities within the family, these findings have implications on schooling investments in girls with a new interpretation. As Behrman et al.(1999) discuss the relation between demands for schooled wife and economic growth during India's green revolution, limited opportunities in labor market for women is not a necessary condition to justify the investments in female schooling. Here woman's human capital not only affects their children, her education also can contribute to her marriage spouse's activities. The within-household effects might offset some of the absence of labor-market returns to schooling for women, in particular, with a relatively low levels of female nonagricultural employment in post-apartheid South Africa. However, there has not been many studies on this cross-productivity effect and human capital externality from wife to husband.

Empirical findings are summarized as follows. First, wife's schooling significantly increases husband's log wage in both 1993 and 1998. However, this result can be spurious due to a positive correlation between wife's schooling and husband's unobserved earning endowment. Second, using the sample of married males between 1993 and 1998, fixed-effect model identified pos-

itive effects of wife's schooling and marriage experience on husband's wage growth. Third, using the sample of single male as of 1993, difference-in-difference model confirmed that a wife's schooling contributes to her husband's wage growth more than marriage does.

Before going into the main analysis, a reservation should be made. The period of 1993 to 1998 covers the first democratic election in 1994, which is a fundamental turning point in the country's democratic transformation. Although I cannot identify the impact of this transition in this paper, it would be interesting to test for the effect that a wife's human capital has on her marital partner's labor market productivity from apartheid to post-apartheid within the household. Moreover, according to the specificity of South African women's role in household and the labor market under apartheid's residency restrictions, I am also curious about whether there is any dramatic change of wives' human capital effect to their husbands after the 1994 democratical turning point. For example, one possibility could be, without the restrictions of migration, non-white women could live with their outside-working husbands more easily. It implies their cross-productivity or human capital externality could have a larger effect on their husbands' income via daily co-residence after apartheid. At the same time, the possibility of finding a job in the urban labor market has increased with easier migration, but the time allocation of wives in home production would have decreased simultaneously. However, since unemployment rate became even higher in the post-apartheid labor market in addition to gender discrimination, we could hardly expect a more possibility of women's obtaining a job outside their home. Or we can also imagine that, although apartheid has been ended, non-white families still have the difficulties to move from the rural area due to their financial constraint. It could be therefore possible that empirical findings of this paper might have generated from these rather drastic circumstantial changes in the country.

The paper is organized as follows. The following section provides a brief summary on the previous studies which are related to this topic. In Section 3, I construct a simple theoretical framework. My hypothesis is whether wife's human capital increases husbands' earnings through household productions, and marital partner's human capital inputs are complementary in their home production. Section 4 discusses identification and specification for empirical analysis. Section 5 describes the data, the sample and the variables for analysis. Empirical findings are summarized in Section 6. Concluding remarks are made in the final section.

2 Benefit of women's education

Labor economists have long noted that married men earn substantially more per-hour worked than single men, and the majority of the cross-section wage studies has reported the marriage premium in male wage income. Hill (1979) finds that the currently-married and ever-married white men earn on average hourly wages with $1.75 to $2.00 greater than never-married men from the Panel Study of Income Dynamics. Korenman and Neumark (1991) use the National Longitudinal Survey of Youth to find that married white men (with spouse in presence) earn about 11 percent more per hour, and that divorced or separated men earn about 9 percent more than never-married men. In this paper, they also find from a company personnel data that the probability of being promoted for a married men is 10.5 percentage points higher than for single men, controlling for all other characteristics. Using other data sets from the US (NLSY, NLS, CPS), Daniel (1994) reports a wage premium of 6.3% for white men and 4.5% for black men, with corrections of individual heterogeneity and marriage selectivity. Gray (1997) observes that married men earn 11 percent more, and divorced or separated men earn 10 percent more than comparable never-married men. Examples in this line of empirical findings are many in the US (e.g., Chun and Lee, 2001; Loh, 1996). Bardasi and Taylor (2004) also find the evidence of marriage premium of 9-18% from the British Household Panel Survey, and interestingly, that even cohabiting men also receive a premium about 7-9%.

Where does marriage premium come from? There are two major hypotheses that have been discussed in the previous studies: marriage sorting that occurred in marriage market, and increased productivity during marriage. Many of the previous studies concerned the assortative mating in marriage market both in theory and empirical studies. For example, Marriage Theory (Becker, 1973) suggests that men with different physical capital, education or intelligence (aside from their effects on wage rates) will tend to get married with women of similar traits. Nakosteen and Zimmer(1987) argue that men with a higher earnings capability is evaluated highly in marriage market; married men are more productive not because they become more productive after their marriage but because they are more productive before their marriage. Ignoring the positive correlation between couples' schooling or unobservables not only leads to bias in marriage premium estimates, which makes us erroneously infer a direction of causality. In this paper, the empirical estimation strategy is designed to solve the endogeneity

problem associated with spouse's schooling as well as the self-selectivity bias that arises from endogenous marriage decisions.

I argue that if marriage premium comes from an improvement in husband's productivity in labor market, this improvement could be directly affected by wife's human capital. In a sense, the employer receives additional unpaid benefits from wife's human capital by hiring a married man (Jacobsen and Rayack 1996). There are some papers on marriage premium mention that wife can contribute to her husband's human capital accumulation through their cohabiting life (Bardasi and Taylor,2004; Daniel,1994). Benham (1974) estimates a log earning equation for husband with explanatory factors including wife's schooling with the U.S. Census, CHAS and SEO 60's data. He suggested that a more educated wife could contribute to her husband's productivity, i) providing a close substitute for his formal education by extending information and advice, ii) helping him acquire specific skills and iii) helping him acquire general skills related to information acquisition and assimilation and coping with changes. His empirical results showed that the coefficient of wife's education is significantly positive in all three datasets and that the husband's earnings increase by 3.0 to 4.1 percent with an additional year of his wife's schooling. However, the estimation results seemed to be overstated since they do not control the already mentioned selectivity problem in marriage market. This point was verified by Welch (1972) who uses the NBER-Thorndike sample data with enough information on IQ, background, and religion. The coefficient of wife's schooling decreased to only one-half of the Benham's original estimates.

Neauman and Ziderman (1993) provide the recent estimation results of women's human capital contribution in husband's earnings, using the Israel Labor Mobility Survey. They suggest that such cross-productivity effects in some occupational groups may be strong, but could be weak or absent in other groups. The wife's human capital stock as well as the husband's can increase the husband's earnings in formal sectors, which is consistent with Benham's result in the US.

Although their cross-section studies find that husband's earnings are positively correlated with wife's schooling, these correlations can be easily inferred from the positive correlations between couple's abilities with assortative mating in marriage market and with the endogeneity of wife's schooling correlated with her ability. The emphasis of this paper is placed on the question of how much wife's schooling facilitates husband's productivity through their household production or human capital externality, controlling for positive sorting in marriage market.

Marriage experience is also related to the effect of wife's human capital on husband's earning. Following Benham (1974) and Neauman and Ziderman (1993), I include marriage years as an explanatory variable as well as its interaction terms with couples' schooling in the estimation. Suppose that marriage is a process of learning with an eventual convergence to a higher productivity, then years of marriage augments husband's earnings. As the years of marriage increases, the cross-productivity effect increases except some cases of divorce or separation. The empirical results in this paper show that returns to marriage experience are higher if wife is educated. In other words, returns to wife's schooling increase as marriage experience accumulates.

3 Empirical Framework

3.1 Specification

Statistical inference on our hypothesis is based on reduced-form log wage equations. I want to identify returns to husband's and wife's schooling in husband's labor-market earnings. In particular, I attempt to identify the existence of home production or the spillover of household human capital, incorporating assortative mating in marriage market. The home production function F is introduced in the Mincerian wage equation. With the household production function F, log wage equation is assumed as,

$$\ln w_{it} = \beta_1 s_i + \beta_2 m_{it} + F(s_i, s_{i'}, m_{it}) + \beta_3 age_{it} + \beta_4 {age_{it}}^2 + \gamma x_{it} + \mu_i + \epsilon_{it} \qquad (1)$$

where s_i and $s_{i'}$ are individual's and his spouse's years of schooling respectively, age_{it} is individual i's age at t period, and x_{it} denotes other determinants such as race, language, and community factors. Here I introduce marriage experience m_{it} into the household production function in order to test the complementary effect between the couple's schooling and their marriage experience. μ_i is time-invariant unobserved earnings endowment such

as ability which is not orthogonal to his schooling, i.e., $E(S_i\mu_i) \neq 0$. ϵ_{it} is time-variant error term such as health and economic shock, we assume that $E(S_i\epsilon_{it}) = 0$.

The nonlinear approximation of household production F is:

$$F(s_i, s_{i'}, m_t) = \beta_5 s_{i'} + \beta_6 m_t s_{i'} + \beta_7 m_t s_i s_{i'} \tag{2}$$

Here, following Benham (1974) and Neauman and Ziderman (1993), I include marriage years interacted with wife's schooling and with the interaction of both couples' schooling in the specification. As I discussed above, if marriage years are considered to capture a learning process, the duration of marriage may not only affect husband's earnings but also the effect can be augmented by wife's schooling. Although individual's schooling is not orthogonal to μ_i, I anticipate that $\beta_1 > 0$ in Eq.(1). Furthermore, according to Benham (1974), β_5 is likely to be positive. Because of the endogeneity bias in the estimated effects of β's, we can not directly distinguish the effect of home production from the assortative mating in marriage market.

3.2 Identification and Estimation

In this section, I discuss identification strategy. The problem arises from the correlation between unobserved fixed-effects and explanatory variables, such as years of schooling. This is important when schooling choice is endogenous, i.e., correlated with unobserved ability, and the choice of marriage partner and her characteristics such as schooling are correlated with unobserved endowment. I take two approaches below.

Before going into the identification strategy, let me clarify why the unobservable heterogeneity causes identification problem in Eq.(2). For simplicity, suppose

$$\begin{aligned} \ln w_{it} &= \beta_1 s_i + \beta_2 s_{i'} + \beta_3 age_{it} + \beta_4 age_{it}^2 + \gamma x_{it} + \mu_i + \epsilon_{it} \\ E(\mu_i s_i) &\neq 0, E(\mu_i s_{i'}) \neq 0 \end{aligned}$$

This is the equation which Benham (1974) has adopted to estimate returns to wife's education. However, he did not assume μ_i. However, it is μ_i that leads to all potential endogeneity problems. There are two kinds of endogeneity that may arise.

First, the husband's fixed effect μ_i, which represents unobserved ability, is likely to be correlated with s_i, his observed education. This is the well-known individual ability bias. Second, according to the assortative mating, agents tend to select his marital partner with similar characteristics, including educational level. So the couples' schooling might be correlated with each others. Therefore partner's education $s_{i'}$ should be correlated with his own ability μ_i. Ignoring this unobserved earning endowment will lead to upward bias in estimates of returns to both husband's and wife's schooling.

3.2.1 Fixed-effect model for married sample

Consider Eq.(1) in two periods:

$$\begin{aligned} \ln w_{it} &= \beta_1 s_i + F_{it} + \beta_2 age_{it} + \beta_3 (age_{it})^2 + \gamma x_{it} + \mu_i + \epsilon_{it} \\ \ln w_{it+1} &= \beta_1 s_i + F_{it+1} + \beta_2 age_{it+1} + \beta_3 (age_{it+1})^2 + \gamma x_{it+1} + \mu_i + \epsilon_{it+1} \end{aligned}$$

First differencing them over time, we obtain:

$$\Delta \ln w_i = F_{it} - F_{it+1} + \beta_2 \Delta(age_i^2) + \gamma \Delta x_i + \Delta \epsilon_i \qquad (3)$$

Here, individual's fixed effect μ_i, which is constant over time and specific to the individual, can be differenced out with the panel data. Therefore, we solve the first type of endogeneity, which arises from the correlation between unobservable individual heterogeneity and explanatory variables. With the knowledge of F_{it} in Eq.(2), the linearized difference wage equation is

$$\begin{aligned}\Delta \ln w_i &= \theta_1 \Delta(m_{it} s_i) + \theta_2 \Delta(m_{it}^2 s_i) + \theta_3 \Delta(m_{it} s_{i'}) + \theta_4 \Delta(m_{it}^2 s_{i'}) \\ &\quad + \theta_5 \Delta(m_{it} s_i s_{i'}) + \theta_6 \Delta({m_{it}}^2 s_i s_{i'}) + \theta_7 \Delta x_i + \theta_8 \Delta(age_i^2) + + \Delta\epsilon_i \quad (4)\end{aligned}$$

If either θ_3,or θ_5 is positive, the results may support my hypothesis. According to the previous studies[1], the interaction terms between wife's schooling and marriage years (and the squared terms) are designed to capture nonstationary effects of wife's schooling on husband's earnings, which is augmented by marriage experience. The above specification also captures the complementarity between husband's and wife's schooling, which may change in marriage years.

In fact, by first differencing, not only endogeneity has been eliminated, but we can also avoid the reverse causality problem. Consider about the cross-sectional equation, we can interpret as wife's education contribute to husband's wage income, but on the other hand, it also could be reasonable to think in an opposite way that higher income could attract a well educated wife. In equation (3), wife's schooling, which is included in the F function, can be treated as exogenous to the change of wage income since the marital status keep same from t to t+1 period, thereby we do not have reverse causality problem any more.

3.2.2 Difference-in-difference(DD) model for single sample

In order to estimate the marriage premium that has been studied in the previous literatures, I take a difference-in-difference approach with the sample of single males in the initial period. Similar log wage equation is assumed,

$$\ln w_{it} = \beta_1 s_i + \beta_2 s_i p_t + \beta_3 s_{i'} p_t + \beta_4 age_{it} + \beta_5 age_{it}^2 + \gamma x_{it} + \mu_i + \epsilon_{it} \quad (5)$$

[1] Benham(1972) showed some results of wife's education as compared with husband's education on husband's income (β_4^t/β_3^t) by age of wife, "... for wives of ages 22-26, husband's income increases 37 percent as much with an increase in wife's education as with a similar increase in husband's own education, this ratio increases to 80 percent for wives ages 32-36 and then declines at older ages..."

where p_t is marriage status in period t, which takes the value of one if i get married and zero otherwise and $s_{i'}$ is the bride's years of schooling. Therefore, we have 2 sub-samples: those who newly married and those who remained single. Eq.(5) is designed to capture two differences between different subsamples - married and single and different years - 1993 and 1998. We made an assumption here that marriage decision is not correlated with earning shocks.

The equation used in estimation is

$$\begin{aligned} \ln w_{i,t+1} - \ln w_{i,t} &= \gamma_0 p_{it+1} + \gamma_1 s_i p_{it+1} + \gamma_2 s_i^2 p_{it+1} \\ &\quad + \gamma_3 s_{i'} p_{it+1} + \gamma_4 s_{i'}^2 p_{it+1} + \gamma_5 \Delta(age_i^2) + \Delta\epsilon_i \quad (6) \end{aligned}$$

There potentially remain some problems about the assumptions. These coefficients can be consistently estimated only $\Delta\epsilon_i$ is uncorrelated with the other covariates. In other words, there is no unobserved individual effect in earnings growth correlated with marriage status or spouse choosing. As I have discussed in the previous section, the estimation can not avoid the bias if marriage status is correlated with past earnings shocks, i.e.$E(m_{it} s_i \Delta\epsilon_i) \neq 0$, $E(p_{it+1}\Delta\epsilon_i) \neq 0$. There are two possibilities: First, it is reasonable to suppose that marriage decision and marriage continuity are correlated with all the events that occur during the two periods. If a positive (negative) exogenous economic shock changed people's marriage decision or spouse selection, the estimates of marital status and the interaction terms with marriage period or wife's schooling might be upward (downward) biased. On the other side if a positive earning shock in the past increases the likelihood of marriage in the subsequent periods, we have downward bias in the estimates of returns to wife's schooling. Hence, a positive estimate that we obtain in the empirical analysis remains robust to this potential problem, and still would support our hypothesis.

4 Data, Variables and Sample

I use KwaZulu-Natal Income Dynamics Study (KIDS) from South Africa for empirical analysis. KIDS includes various information on household demography, household environment, education, food and non-food expenditures, remittances, employment and income, agricultural activities with a great focus on individual ownership of assets and control over their use.

The good features of this data are: (1) Surveys were conducted twice to yield panel data in which the same households were visited at two points in time: 1993 and 1998. Therefore, it is possible to observe dynamical changes from 1993 to1998 in the KawZulu-Natal labor market.[2] With the panel data, I can estimate returns to marriage experience and labor-market experience. (2) The surveys cover households both in rural and urban labor market. (3) In particular, since marriage information is contained in the survey such as spouse's age and education, marriage history including status, divorce, and marriage assets in 1993 and 1998, I can identify how wife's schooling and marriage experience influence husband's wage income and employment status as well.

As a first step, it is important to consider earnings types that we are interested in, since the data show incomes from a wide range of sources such as regular employment, causal or temporary employment, agricultural production and self-employment. So I exclude incomes from non-employment sources such as pension, fund, and inheritance. I also exclude income from agricultural production because in most cases this income category should be considered as the output of joint production that require labor inputs from household members. I focus on the following categories: wage or salary received from regular employment, i.e., monthly take-home pay after deductions plus bonus and profit shared; wage or salary received from casual or temporary employment; subsidized food or goods received from casual or temporary employment including those paid in cash and the proportion of self-employment incomes based on individual's involvement. As the cross-productivity effect on individual's productivity is the focus of analysis, I deduct the overtime wage income using the information on actual working hours per day and hours of paid overtime per week.

The second feature of the data also brings us some problems: first, as we exclude the income from agricultural production, there is only around 30% male individual work in urban labor market. Furthermore, first differencing estimation requires at least 2 years of observations with complete informa-

[2]To merge the 1993 and 1998 information by individuals, we cleaned some duplicate observations of identical individuals across original and split households in 1998 that we detected in the preliminary data analysis.

tion on labor market activities, the sample size decreases a lot. Second, selectivity bias may exist if individual's choice of agriculture production or regular employment is nonrandom. In that sense, we might only chosen the higher education and higher ability people, who are more likely to get regular employment, into our sample. To check this issue, I compare the mean of schooling level between people who have regular wage income and who have not. There is around 1.5 to 2 years of schooling difference between them which implies a slight selection bias.

The highest educational attainment is used to compute years of schooling completed as an independent variable for both husbands and wives. Investigating the data, I understand that there is no significant difference between male and female's education attainment, but there is significant difference in their employment status and wage incomes, as discussed in the Introduction. Another issue is about the measurement error on years of schooling, which could generate or even expand the bias. I choose the years of schooling which was reported in 1993 instead of differencing data to reduce the measurement error with some adjustments[3] in first differencing specification.

Individuals' marriage experience is calculated with the year of couple began to co-resident. I used the oldest child age instead for some couples, whose marriage date are not available from the data.

The samples consist of more than 700 males who are qualified as those who continued their marriage with the same spouse from 1993 to 1998, excluding multiple-spouse cases[4]. The reason I drop the multiple-spouse cases is the difficulty to separate the cross-productivity from different wives to the same husband. Meanwhile, it is also possible that I may drop the most productive group from the sample.

Table 1 to be inserted

The descriptive statistics of employment data in 1993 and 1998 are shown by gender in Table 1. First, we can easily assess that employment rate has obviously decreased from 1993 to 1998. Comparing wage incomes between the two rounds, it is interesting to notice that both the regular and temporary nominal wage income have increased from 1993 to 1998, which may

[3] There are 920 observations report their education attainment in 1993 are higher than in 1998. For these individuals, I take the average of 2 years' schooling to decrease the measurement error.

[4] There are more than 30 male individuals report they have more than one married partners either in 1993 or in 1998.

appear to be contradicting to high unemployment rate in 1998. However after adjusting by the inflation rate, the average monthly real income in 1998 actually has decreased almost 30% for male workers. Higher unemployment rate and lower real wage income tell us the labor market is getting tighter and labor demand can not respond to the increasing labor supply in the labor market.

Second, comparing the male and female sample, it is obvious that both in 1993 and 1998, there is no significant difference in years of schooling between men and women in the current generation. However, there is a gap in their regular wage income. Moreover, in 1998 educational attainment among women was higher than that for men, but the wage income for women were 20-percent lower than that for men which implies a more difficult situation might have existed for women in their participation in labor markets. All of these indicate that gender discrimination is an important issue in post-apartheid South African labor market. From this viewpoint, it is reasonable to assert that women probably choose to work at home instead of working outside, which augments the time allocation in household production and create a positive effect on husband's labor market income.

Table 2 to be inserted

For comparison purpose, Table 2 presents summary statistics on education and employment for both married and single male samples by different age groups. Median ages of married groups are slightly larger than the single ones. Although the wage income did not include the income from agriculture, it is still striking to find that in 1993, more than half of married men had regular or temporary jobs, but only 20 percent of single men had jobs other than agriculture; in 1998, the employment rate was around 40 percent for married groups which is more than twice larger than that for single groups[5]. Furthermore, not only the large difference in employment rate, but we also find similar gaps in the regular wage income. Except the 30s groups in 1998, wage income from regular employment is much more higher in the married groups than in the single ones. In particular, the youngest group of 1993 earn almost 40% more than the singles from regular employment.

[5] In order to check for the self-selectivity bias, I estimated heckman two-step and pooled OLS with control of selectivity-bias (Wooldridge, 2002). However since neigher of these 2 methods can control for individual's unobservable fixed-effect, the results I get are not precise.

But the difference of average years of schooling between the married and single sample were not obvious. Table 2 implies that married men are more likely to get a job and earn more than singles. This is consistent with the previous studies, which show that married people are supposed to be more productive. However, as I discussed in the previous section, all of these observations might have been derived from a correlation between marriage status and individual ability. That is, highly able men are more likely to get job, and also more likely to be paid more, ultimately indicating that they have advantage in getting married. Therefore it is necessary to use the empirical methods discussed in the previous section to eliminate the effects of the assortative mating in marriage market.

5 Estimation Results

This section summarizes empirical results. Table 3 shows cross-section estimates of log wage equation by OLS in 1993 and 1998's married sample[6]. Log of monthly earnings from regular, temporary and self-employment regressed on age,age squared, years of schooling, marriage experience and their nonlinear terms. In all specifications, community dummies are included to capture the community-level common unobservables.

Table 3 to be inserted

Columns 1 and 5 confirm the benchmark effects of schooling, age and age squared. As we expect, returns to husband's own schooling are positive and significant in both 2 years. Estimation results from the first specification gives a usual concave shape of individual's age effect. Then I include wife's schooling is from the second specification. We found the returns to wife's schooling in either 1993 or 1998 are positive and statistically significant in husband's wage income, which is consistent with the previous literature (e.g., Benham, 1972). In particular, wife's schooling significantly increases

[6]The information of marriage experience in 1993 is borrowed from 1998 data round which causes the observation in 1993 is limited by continuing married couples with same spouses from 1993 to 1998.

her husband's wage even more than husband's own schooling does. It is also interesting to find that the inclusion of wife's schooling reduces the husband's schooling effect, compared to Column 1 and 2. The husband's schooling coefficient decreased from 0.0478 to 0.0169 in 1993 and 0.0969 to 0.0719 in 1998. In the third column, I add marriage experience into the wage estimation, while marriage years does not play an important role. In the last specification, I check the robustness with the squared term of own schooling. Wife's schooling effect remains positive and significant. However due to the endogeneity of schooling, these cross-section estimates are probably biased if more able workers are more likely to get married with higher educated women.

Table 4 to be inserted

Table 4 shows the first-difference results of Eq. (3) for married male workers only. The sample consists of married men with complete employment information and with identical spouses from 1993 to 1998. In this differenced version of the human capital earnings function, time-invariant unobservables specific to individuals are differenced out, so the endogeneity in years of schooling and potential self-selectivity problems in employment and marriage status do not exist. To control for characteristics specific to community, I include community fixed effects in the growth equation. Occupation, employer type and economic sector dummies are also added to control heterogeneity of occupation-industry specific factors during this period. The dependent variable includes wage income from regular employment, temporary or casual employment, and per-person net-profits from household self-employment.

Column 1 includes individual age and own schooling to estimate the coefficients θ_1 and θ_8 in Eq. (4). Age have negative effect on wage growth, which is consistent with the conventional concave wage-age profile. Own schooling does not increase wage growth. In other words, returns to marriage experience do not change with years of male workers' own schooling. In Column 2, wife's schooling is included. Interestingly, returns to wife's schooling are positive, although it is not statistically significant. There is a predicted 1.23% increase in husband wage with 1 more year of his wife's schooling. Going back to Eq. (4), the coefficient also implies that wife's education effect increases with marriage experience. In this sense, marriage with

an educated wife raises husband's wage income, and its effect is reinforced as marriage years increase.

The specification in Column 3 is designed to check whether the complementarity between couple's schooling changes as marriage experience increase. Here, wife's schooling has a significantly and positive effect on husband's wage growth, while the complementarity decreases wage income. In Column 4, I check the robustness by including all the quadratic terms according to equation (4). The main finding does not change, again, the positive effect of wife's schooling significantly increases with marriage experience. However husband's own schooling have insignificant effects on his wage growth. This specification reports a 2.96% increase in earnings with an additional year of wife's educational attainment which is almost three times larger than male worker's own schooling returns. The results confirm that returns to wife's schooling become larger as the couples accumulate their experience during their marriage life. However the complementary effect between couples' human capital decreases wage income as marriage experience increases. This evidence could be linked with some previous discussion about married women's time input in home production and outside labor market. (Hersch & Stratton 1994, Jacobsen & Rayack 1996) Given no gender inequality in labor market, if those who have time input or human capital in home production are substitutable, men whose wives with higher education may earn less due to his own sacrifice in home production. Thus the estimation results from Eq. (4) supported our hypothesis that wife's schooling has positive effects on husband's wage growth.

Table 5 to be inserted

Table 5 reports difference-in-difference model with the sample of single men in 1993, some of who got married between 1993 and 1998. In Column 1, I regressed the differenced log monthly earnings between 1993 and 1998 on the indicator of new marriage in 1993-1998 as well as male workers' own schooling and age. Marriage effect is negative and insignificant. Column 2 includes marriage status interacted with bride's schooling and additionally with own schooling respectively. Interestingly, I find that bride's schooling significantly increases her husband's earnings ($\gamma_3 > 0$ in equation 6), while neither the marriage itself nor husband's own schooling increases his income growth, i.e., $\gamma_0, \gamma_1 < 0$. Controlling for marriage status, newly married male

workers have additional 11% increase in earnings per year of their wives' schooling. I add marriage status interacted with husband's schooling in Column 3. Compared with single workers, married people benefit from their wife's schooling but suffer a income loss from marriage and own schooling. In Column 4, I check the robustness of these findings by adding all the interaction terms with squared years of schooling. The returns to bride's schooling remain robust. Although wife's schooling effect is positive and concave in the earning profile, wife with more than 16 years of education still have positive effects on her husband's wage growth. Given the high correlation in education between spouses, I include own schooling to avoid bias in the estimate of wife's schooling effect, and find that the basic findings did not change. As I discussed, the endogeneity which comes from the correlation between marriage decision or spouse selection and exogenous economic shock during 1993 and 1998 might still exist in our estimation[7].

From the above results, I conclude that our hypothesis has been confirmed, with an interpretation that wife's human capital contributes to husband's income and the effect is augmented with marriage experience. This is robust to potential bias which may arise from unobservable individual ability and assortative mating in marriage market. However, it is also important to notice that wife's human capital plays a crucial role, not marriage itself, in augmenting husband's earnings. In contrast to the previous studies, marriage premium did not exist in our analysis. So, marriage can make men more productive but it does so effectively only if he is with a woman with greater human capital.

6 Conclusions

This paper empirically examined the benefits of women's schooling within marriage using panel data from South Africa. Due to labor-market discrimination and high unemployment rate in the post Apartheid, wages for women are much lower than those for men. In addition, female workers face worse

[7] With the assumption of fixed-effect's linearity and time-invariance, difference in difference process provide us a more precise estimates of the returns to wife's schooling then cross-section does. However, we should notice that the estimation can not avoid the correlation between marriage decision and stochastic economical shocks, i.e.$E(ms\Delta\epsilon_{it}) \neq 0$. Therefore the estimates of marital status may be upward or downward biased depending on the positive or negative economical shocks occurred during 1993 to 1998.

employment condition compared to male workers. However female educational attainment on average is comparable to that for men, which implies that female human capital in the labor market is under utilized. In this situation, it is reasonable to ask how female human capital contributes to activities outside labor market and whether their marital partners benefit from their human capital through home production. The motivation of this paper is to estimate returns to wife's schooling in husband's wage earnings, as a consequence of marriage partnership or co-residence. In the context of post-apartheid South Africa, the abolishment of apartheid-related restrictions which changed social as well as family life dramatically also might have led to the alternation in returns to wife's schooling in home production and labor market in the country.

The main hypothesis of this paper is that wives' human capital influences husbands' earnings through household production or human-capital spillover. I estimated Mincerian wage equations to assess this hypothesis using the sample of male workers. In order to wipe out the endogeneity of schooling that arises from unobserved abilities and marriage-market sorting as well as marriage decision, fixed-effect model was used to identify returns to schooling that varies with years of marriage. Second, difference-in-difference model was used with the sample of single and newly married men so as to identify the marriage premium, which has been confirmed in previous studies.

Some interesting findings are obtained. First, wife's human capital has cross-productivity effect on husband's earnings, which supports the hypothesis. Once controlling the wife's schooling effects on husband's wages, marriage premium disappears. This is in contrast to the previous studies. Whether or not and how much a man is productive depends on whom he gets married with, not just on whether he is married or not. This finding is robust to a potential correlation between marriage decision and earning shocks in the past.

Second, in first differenced form, it is found that returns to wife's schooling becomes greater as years of marriage increases. The cross-productivity effect depends on both wife's education and their marital continuity. Marriage experience augments returns to wife's schooling in husband's earnings determination.

Third, the complementarity between couple's human capital with marriage experience has not been observed in the fixed-effect model, which gives some implication of sorting effect in marriage market and household income distribution.

My interpretation of the women's behavior in labor market and house-

hold production is consistent with lower returns to schooling for women in post-apartheid labor market. When women's remuneration in labor market is lower than that for men, even if schooling is higher for women, it might be optimal for them to concentrate on home production to increase the efficiency in home production. This not only improves child human capital but also their husband's health condition, which enhances their job search and performance.

However, there still remains the question of whether the women's schooling effects are in their information sets prior to their marriage decisions. If they do not know this effect ex ante, we can interpret the cross-productivity effects as unanticipated intra-household externalities. If they know this benefit, they must incorporate these dynamics in their marriage decisions. Whether marriage market can achieve the first best depends on the above scenarios. The related question on how to identify the marriage market efficiency; how to distinguish home production from intra-household externalities; whether returns to wife's schooling depend on factors such as wife's bargaining power within the household, social position and economic development in general are quite interesting, but beyond the scope of this paper.

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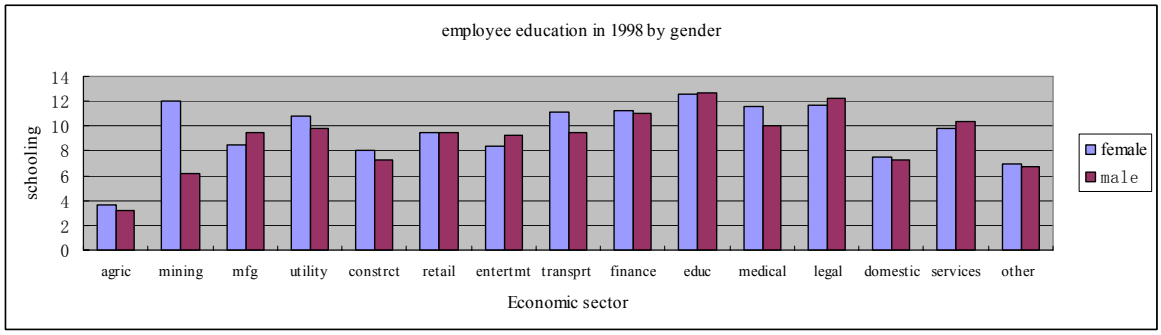
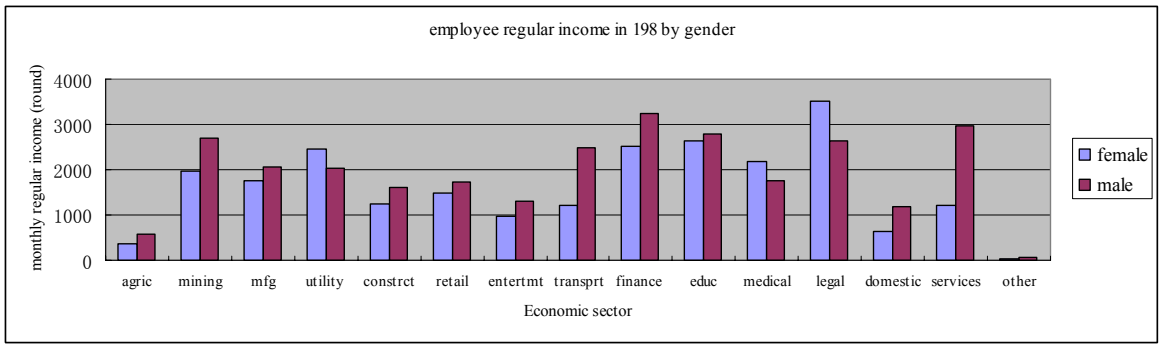
Figure 1





Economic sectors are selected if female ratio is equal or greater than 10%

Table 1

Employee sample by gender (data summary)

	Male 1993	Female 1993	Male 1998	Female 1998
age	**35.404**	**34.833**	**37.505**	**36.914**
	(9.671)	**(9.520)**	**(9.588)**	**(9.397)**
schooling	**8.724**	**7.968**	**8.257**	**8.455**
	(4.277)	**(4.151)**	**(4.009)**	**(3.804)**
spouse schooling	**8.329**	**8.586/**	**7.546**	**7.216**
	(4.245)	**(4.629)**	**(3.845)**	**(4.344)**
father's schooling	**5.935**	**4.642**	**4.587**	**5.239**
	(4.492)	**(3.816)**	**(4.401)**	**(4.199)**
mother's schooling	**3.815**	**4.192**	**3.848**	**4.416**
	(3.550)	**(3.641)**	**(3.602)**	**(3.894)**
Income from	**27.145**	**33.890**	**128.658**	**141.725**
temporary employment	**(124.990)**	**(135.006)**	**(419.307)**	**(350.616)**
Income from	**1500.002**	**812.275**	**1563.696**	**1207.874**
regular employment	**(1843.839)**	**(851.045)**	**(1709.713)**	**(1414.98)**
log monthly income	**6.663**	**5.790**	**6.954**	**6.436**
	(1.267)	**(1.457)**	**(1.048)**	**(1.267)**
employee obs.	**711**	**679**	**417**	**411**
whole obs.	**2369**	**2726**	**2575**	**3085**

Standard deviations are in parentheses. Age is equal to or larger than 16 and smaller than 55. Total monthly income includes income from regular, temporary and self employment.

Table 2

married sample vs. single sample in 1993 by age (data summary)

age	20 to 30		31 to 40		41 to 50	
	married	single	married	Single	married	single
age	27.523	24.905	35.757	34.777	45.600	45.330
	(2.332)	(2.867)	(2.768)	(2.959)	(2.899)	(3.237)
schooling	8.492	8.364	8.563	6.961	7.255	6.712
	(4.072)	(3.702)	(4.581)	(4.278)	(4.675)	(4.719)
wife's schooling	8.057		8.208		7.804	
	(4.073)		(4.447)		(4.168)	
regular income	1322.776	792.785	1913.324	1691,736	1754.891	1750.095
	(1078,723)	(763.032)	(2501.454)	(2000.509)	(1809.592)	(1277.209)
Log total income	6.785	6.189	6.936	6.757	6.962	7.072
	(1.053)	(1.169)	(1.163)	(1.297)	(1.226)	(0.985)
employment rate	62.81%	21.68%	57.85%	21.58%	52.99%	16.67%

married sample vs. single sample by age in 1998(data summary)

age	20 to 30		31 to 40		41 to 50	
	married	single	married	Single	married	Single
age	27.319	25.195	35.963	34.601	45.348	44.752
	(2.624)	(2.780)	(2.836)	(2.671)	(2.932)	(2.733)
Schooling	8.702	9.515	8.250	7.949	7.074	6.263
	(3.648)	(3.171)	(3.869)	(3.876)	(4.363)	(3.769)
wife's schooling	8.412		7.969		6.968	
	(3.636)		(3.778)		(4.301)	
regular income	1643.042	1136.016	1496.317	1822.527	1923.443	1221.026
	(852.813)	(1111.068)	(1198.645)	(2591.026)	(1978.24)	(1163.930)
Log total income	7.177	6.834	6.974	7.188	7.027	6.947
	(0.876)	(0.897)	(0.921)	(0.958)	(1.116)	(0.830)
employment rate	44.74%	11.34%	42.56%	19.41%	45.21%	18.10%

Standard deviations are in parentheses. Total income includes income from regular, temporary and self-employment.

Table 3: **Cross-section log total monthly income estimation by OLS**

dependent variable: log monthly income (from regular, temporary and self-employment)

	1993				1998			
age	**0.0844**	**0.0822**	**0.0799**	**0.0814**	**0.1308**	**0.0810**	**0.0826**	**0.0822**
	(2.13)	**(2.11)**	**(1.98)**	**(2.05)**	**(5.39)**	**(1.85)**	**(1.68)**	**(1.67)**
age squared	**-0.0011**	**-0.0010**	**-0.0010**	**-0.0010**	**-0.0014**	**-0.0009**	**-0.0008**	**-0.0008**
	(2.24)	**(2.15)**	**(2.11)**	**(2.18)**	**(4.45)**	**(1.72)**	**(1.55)**	**(1.53)**
own schooling	**0.0478**	**0.0169**	**0.0167**	**-0.0386**	**0.0969**	**0.0719**	**0.0745**	**0.0870**
	(2.51)	**(0.82)**	**(0.81)**	**(-0.82)**	**(6.22)**	**(3.04)**	**(3.10)**	**(1.47)**
own schooling squared				**0.0445**				**-0.0008**
				(1.33)				**(0.27)**
wife schooling		**0.0601**	**0.607**	**0.0591**		**0.0489**	**0.0469**	**0.0471**
		(2.37)	**(2.35)**	**(2.26)**		**(1.95)**	**(1.81)**	**(1.81)**
marriage experience			**0.0020**	**0.0026**			**-0.0028**	**-0.0028**
			(0.20)	**(0.26)**			**(0.27)**	**(0.27)**
Constant	**5.2673**	**4.9457**	**4.9790**	**4.3500**	**3.8313**	**4.8149**	**4.7175**	**4.6864**
	(6.36)	**(6.20)**	**(6.21)**	**(5.35)**	**(7.07)**	**(4.77)**	**(4.34)**	**(4.24)**
observation	**338**	**338**	**338**	**338**	**467**	**288**	**281**	**281**
R squared	**0.5129**	**0.5263**	**0.5264**	**0.5300**	**0.4605**	**0.5262**	**0.5193**	**0.5195**

Absolute T values are in parentheses. Standard errors used here are robust estimates with household-level clusters. Community-fixed effects are included in all specifications. Marriage information in 1993 is borrowed from 1998 which causes the observation in 1993 is limited by continuing married couples during 1993 to 1998.

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Table 4: Fixed-effect model

(first-differencing with married sample: all individuals have complete marriage information in 1993 and 1998s with same spouses, age is less than 55)

Dependent Variable: change in logarithm monthly total income				
own schooling	-0.0097	-0.01368	0.0027	0.0135
	(1.60)	(2.00)	(0.21)	(1.01)
own schooling*marriage experience				-0.0004
				(0.77)
wife's schooling		0.0123	0.0241	0.0296
		(1.44)	(2.10)	(2.43)
wife's schooling*marriage experience				-0.0003
				(0.97)
own schooling*wife's schooling			-0.0026	-0.0047
			(1.69)	(2.93)
own sch.*wife's sch.*marriage exp.				0.0001
				(1.58)
own age	-0.0007	-0.0004	-0.0003	-0.0002
	(2.10)	(1.18)	(0.85)	(0.61)
constant	3.8865	3.6662	3.6866	3.9635
	(2.21)	(2.13)	(2.20)	(2.19)
observation	174	174	174	174
R square	0.6250	0.6368	0.6526	0.6650

Absolute T values are in parentheses. Standard errors used here are robust estimates with household-level clusters. Community-fixed effects, household head, household size, occupation type, employer type, economic sector and language are controlled in all specifications.

Table 5: **Difference-in-difference model (observations was originally in single sample of 1993)**

Dependent variable: change in logarithm monthly total income				
own schooling	**-0.0043**	**-0.0058**	**0.0083**	**0.0295**
	(0.09)	**(0.11)**	**(0.15)**	**(0.10)**
own schooling squared				**-0.0009**
				(0.04)
marriage dummy	**-0.1311**	**-1.0662**	**-0.8888**	**-0.9987**
	(0.58)	**(3.08)**	**(2.47)**	**(2.27)**
marriage dummy*own schooling			**-0.1604**	**0.0630**
			(5.89)	**(0.34)**
marriage dummy*own sch. Squared				**-0.0186**
				(1.18)
marriage dummy*wife's schooling		**0.1100**	**0.2017**	**0.3372**
		(2.01)	**(5.17)**	**(2.56)**
marriage dummy*wife's sch.Squared				**-0.0122**
				(0.89)
age	**-0.0015**	**-0.0007**	**-0.0006**	**-0.0006**
	(0.41)	**(0.22)**	**(0.17)**	**(0.16)**
constant	**0.8309**	**0.5889**	**0.3501**	**0.1113**
	(0.45)	**(0.37)**	**(0.22)**	**(0.08)**
observations	**70**	**70**	**70**	**70**
R squared	**0.6214**	**0.6503**	**0.6762**	**0.6824**

Absolute T values are in parentheses. Standard errors used here are robust estimates with community-level clusters. Community-fixed effects and language dummies are included in all specifications.