AUSTRALIAN JOURNAL OF LABOUR ECONOMICS
Volume 18 • Number 1 • 2015 • pp 53 - 74

Externalities and the Social Return to Education in Indonesia

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Abstract

It is widely known that education provides economic benefits to individuals. However, education also has the potential to generate significant externalities. These external effects of education, in Indonesia, are the focus of the current paper. They are investigated using a local labour market (the province) approach. Significant externalities, as high as, or even much higher than, the private return to schooling, are documented, using both OLS and IV estimations. Sensitivity tests involving separate analyses for skill groups along the lines of Moretti (2004a) and Muravyev (2008), indicate that this finding is robust. The results thus strongly support the view that investing in education is more important for aggregate economic outcomes than it is for the individuals who do so. It appears that there is a clear role for the government fostering further expansion of education opportunities in Indonesia.

Keywords: Externality, Earnings, Experience, Returns to schooling, Instrumental variables

JEL Classification: I210, I220, J240, J310

1. Introduction

Studies of the return to education in Indonesia have shown that this is much lower than in comparator countries.[1] For example, Duflo (2001) reported that the return to

[1] The Indonesian economy shifted from a controlled economy to a market driven economy in 1966 (Ananta and Arifin, 2008). Referring to the general pattern of the return to schooling in economic transition countries, the low return to schooling in Indonesia in the late 2000s invites a question. At this period, where the economic reform process had already reached the market driven economy stage, the return to schooling is expected to be higher than the estimates described in this section.

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Acknowledgement: Purnastuti, Miller and Salim acknowledge financial assistance from the Australian Government through the Australian Development Research Awards Scheme (ADRAS). Helpful comments from two anonymous referees are gratefully acknowledged. However, authors remain responsible for any error. Miller passed away while the paper was under revision. We dedicate this paper in honour of Professor Paul Miller.

education ranged from 6.8 to 10.6 per cent, based on data from the 1995 inter-census survey of Indonesia. Similarly, Comola and Mello (2010), using data from the 2004 Indonesian labour market survey, found that the return to education estimated by ordinary least squares ranged from 9.49 per cent to 10.32 per cent. It was similar to these figures when sample selectivity correction methods of estimation were employed. Both Duflo (2001) and Comola and Mello (2010) have a focus on a single average return to years of education. Other studies have examined variations in the return to education according to the level of schooling. Thus, Deolalikar (1993), based on data from the 1987 round of the National Socioeconomic Survey and the Village Potential module of the 1986 Economic Census, reported that the returns to schooling ranged from around 10 per cent for workers with some primary schooling, to close to 20 per cent for workers with secondary or higher education. In comparison, Psacharopoulos (1981, 1985 and 1994) reported that the returns to schooling for Asian countries are 31 to 39 per cent, 15 to 18.9 per cent and 18 to 19.9 per cent for primary, secondary, and tertiary education, respectively. Hence, not only is the return to schooling relatively low in Indonesia, but it also exhibits a pattern across levels of education that is different from that in most other comparator countries.

Moreover, there is evidence that the returns to schooling in Indonesia have fallen in recent years. Thus, Purnastuti, Miller and Salim (2013a) reported that the payoff to schooling in Indonesia in 2007/2008 was several percentage points lower than in 1987. They argue that this may be linked to the large-scale expansion of the education sector in that country.

Investment in education by the government is in part due to the benefits to the economy of a highly educated workforce. The main measure of these benefits is the private return discussed above. Indeed, for Indonesia, this appears to be the only measure of the benefits of education. From this perspective, the picture of relatively low rates of return, rates of return that are relatively modest at the primary and secondary level, and of falling rates of return, might call into question the recent, and planned, rapid expansion of the education sector in Indonesia.

However, the private monetary gains associated with additional years of schooling are only one part of the potential benefits of education. Another potentially important component of the benefits to society as a whole is the external effects of education. These external effects are the focus of the current paper.

The rest of the paper proceeds as follows. Section 2 outlines the conceptual framework and related empirical evidence for this study. This framework is based on the idea that education can have external effects in local labour markets. Section 3 outlines the data sets used. Empirical results are presented and discussed in section 4. Both ordinary least squares and instrumental variables methods of estimation are used. Some sensitivity analyses are presented in section 5, and these are followed by a conclusion in section 6.

2. Conceptual Framework and Empirical Evidence

It is widely accepted that an individual's educational attainment affects not only the individual's productivity but also that of others in society. Workers, for example, may benefit from being close to a dense, skilled, labour market where, through different

channels, they can learn from others, and hence enhance their productivity and earnings, without cost. Education externalities need not be limited to market externalities of this type. A wide range of other potential externalities have been discussed in the literature (see, for example, McMahon, 2007), such as more informed voting and better parenting practices. However, most empirical research has focussed on local labour market monetary externalities using the Mincerian equation.[2] Acemoglu (1997) and Acemoglu and Angrist (2000) develop theories about monetary externalities of education, whereas Jacobs (1970) discuss nonmonetary externalities of education.

Recently Fu (2007) proposes that human capital externalities penetrate through four channels. Workers can learn from their occupational and industrial peers, who are in the same local labour market, through the depth (quality) of the human capital stock in the local labour market; Marshallian labour market externalities, or specialisation and peer competition effects; Jacobs labour market externalities or the diversity of the local labour market in terms of occupations and industries; and the thickness (density) of the local labour market, or labour market pooling effects. The depth of human capital stock captures the vertical difference of knowledge i.e. workers with better human capital in their fields can learn more and faster than those with lower human capital levels in their fields. Marshallian labour market externalities emphasize technological spillovers. According to this phenomenon workers can learn from the local concentration of same-occupation and same-industry peers. While Jacobs labour market externalities consider the benefit from urban diversity which results from the variety and diversity of geographical proximate industries that promote innovation and growth. The thickness of a labour market considers how workers benefit from the thickness or density of a local labour market. The higher the thickness of a local labour market the higher the possibility that worker can socialize more frequently and build social networks more easily to exchange information.

Acemoglu and Angrist (2000) and Rudd (2000) study human capital externalities in the US at the state level, whereas Rauch (1993) and Morreti (1998, 2004a) investigate human capital externalities in that country at the metropolitan area (cities) level. A study for Canada by Rakova and Vaillancourt (2005) also has a focus on metropolitan area-level data. Similarly, two studies of less developed countries are based on disaggregated data, namely Kenya (district level), and China (city level).

Acemoglu and Angrist's (2000) research was based on a panel of US states, and accounted for state-fixed effects as well as for the endogeneity of the average and individual schooling variables. The focus was on white men aged 40-49, using data from the 1960-1980 US Censuses. Acemoglu and Angrist (2000) measured aggregate human capital by the average years of schooling at the state level. The main findings of this research suggest that a small external return, of about one per cent (mostly ranging from one to three per cent), is possible, though the effect was statistically insignificant in the IV estimations.

[2] Moretti (2004a) argues that there are two separate reasons why an increase in the share of educated workers may increase total wages over and above the private return to schooling. First, if educated workers and uneducated workers are imperfect substitutes, an increase in the share of educated workers will raise the productivity of uneducated workers. Second, the human capital externality raises the productivity of uneducated workers through the learning effects noted above. This matter is investigated in section 5.

Turning to developing countries, Kimenyi *et al*. (2006) applied the augmented Mincer equation to analyse returns to education and the social externality of education at the district level in Kenya. The data used were derived from the Welfare Monitoring Survey of 1994 undertaken by the Central Bureau of Statistics in Kenya. The results of this study provided evidence of significant human capital externalities in urban areas.

Liu (2007) investigated the external returns to education associated with a measure of city average education in China. This study was based on the 1988 and 1995 waves of the Chinese Household Income Project. Several approaches to estimate the impact of human capital externalities were employed, such as OLS estimation using city average education for city-level education, OLS estimation using the fraction of college-educated workers for city-level education, IV estimation, and estimation of the external returns by education group. The OLS estimates indicate that a one-year increase in city average education could raise the earnings of individuals by 4.9 per cent to 6.7 per cent. The IV estimates of the external returns range from 11 per cent to 13 per cent. As such the social returns to education, which consist of the private and external returns, were as high as 16 per cent in the mid-1990s in urban China.

Turning to the case of Indonesia, McMahon, Jung and Boediono (1992), and Behrman and Deolalikar (1993) analysed the rate of return to education. McMahon, Jung and Boediono (1992) compared the social return between general and vocational schools in major regions of Indonesia and found that rate of return varies from five to 22 per cent on average for all regions but narrows to nine to 14 per cent in case of the most densely populated area of Central Java. Considering the gender difference on the rate of return to schooling, Behrman and Deolalikar (1993) found that private rates of return to schooling investments in females are higher than are those to males. Sohn (2013) analysed both the monetary and nonmonetary returns to education in Indonesia using Mincerian specification and quintile regression approach. He found that monetary rate of return is lower for self-employment than for paid employment for person- and- sector specific reasons. He also found positive, substantial and robust non-monetary effects of returns to education above and beyond absolute and relative level of monetary returns to education.

Thus, the literature indicates that the importance of human capital externalities depends on the level of disaggregation. Significant results are obtained when the aggregate human capital is measured at the city or district level. In studies where the level of analysis is extended to a wider geographical area, such as the state level, the human capital externalities are generally not significant. The literature also has two other features. First, the measures of human capital that are commonly utilised are the average of the years of schooling, and the proportion of workers with college or higher degrees. However, the studies indicate that where human capital externalities are important they are important regardless of the aggregate human capital measure employed. Second, most of the studies suggest that when estimating human capital externalities there should be consideration of a potential endogenity problem.

3. Empirical Conceptualisation and Data

The augmented Mincerian earnings equation in the current application to the Indonesian labour market can be written as:

$$\ln(E_i) = \beta_0 + \beta_1 S_i + Z_i\beta_2 + X_i\beta_3 + \varepsilon_i \quad (1)$$

Where $\ln(E_i)$ is natural logarithm of monthly earnings of individual *i*. These monthly earnings include the value of all benefits secured by an individual in their job. The variables for individual characteristics employed in the estimations are years of schooling (S_i), job experience and its square, job tenure and its square, marital status, urban area of residence, and gender (X_i). These are standard control variables in an estimation of this type.

The external effect of human capital (Z) can be internalised within a small group, such as a firm, or a bigger group, such as a city, province, or state. Consequently, two approximations for the aggregate-level human capital measure are used. The first aggregate-level human capital measure is based on the province of residence. The second aggregate-level human capital measure is based on the industrial sector of employment within the province. Within each of these aggregate-level human capital measures two types of variables are constructed, based on the average years of schooling of workers and on the percentage of workers with higher education qualifications. Thus, the aggregate-level human capital measures for each province are: (i) the average years of schooling among all the workers in the province (*AveSchool*); (ii) the province-specific average years of schooling in the industrial sector in which the worker is employed (*AveSchool-Ind*); (iii) the percentage of college or higher-degree holders among all the workers in the province (*PerHE*); and (iv) the province-specific percentage of college or higher-degree holders in the industrial sector in which the worker is employed (*PerHE-Ind*).[3]

Estimating external returns to schooling using the OLS approach invites the question of whether the estimation results will suffer from omitted variables bias. As noted by Acemoglu and Angrist (2000) and Moretti (2004a), among others, the unobserved characteristics of individuals and provinces could be correlated with the average years of schooling or the percentage of higher education graduates, and this could raise individuals' earnings, biasing the coefficient on the aggregate human capital measure. An IV approach is used to address this potential source of bias. Two instruments are considered, namely the ratio of higher education institution per 1,000 people (HE1000), and the percentage of household use clean water (CW).

While both the *HE1000* and electricity variables are available for use as instruments for the province-level variables, suitable variables are not available for their industry-level counterparts. However, we are instrumenting *AveSchool-Ind* and *PerHE-Ind* using internal instruments following Lewbel (2012).[4] This approach is based on the use of the product of heteroscedastic residuals from a first-stage

[3] The externalities estimated using these variables are those which Choi (2011) describes as static externalities, as distinct from the learning externalities examined in his calibrated (using US data) growth model.

[4] We are grateful to Christopher F. Baum and Mark E. Schaffer for access to their Ivreg2h Stata module that implements Lewbel's (2012) heteroskedasticty-based procedure.

equation explaining variation in the endogenous regressor and each of the exogenous regressors as generated or internal instruments. In general, the greater the degree of heteroscedasticity in the first-stage regression the better (that is, the higher the correlation of the generated instruments with the endogenous variable) the instruments.

The data used are taken from four sources. Individual-level data are taken from the Indonesian Family Life Survey 4 (IFLS4). IFLS4 is a nationally representative sample comprising 13,536 households and 50,580 individuals, spread across provinces on the islands of Java, Sumatra, Bali, West Nusa Tenggara, Kalimantan, and Sulawesi. Together these provinces encompass approximately 83 per cent of the Indonesian population and much of its heterogeneity. IFLS4 was fielded in late 2007 and early 2008. It was a collaborative effort by RAND, the Center for Population and Policy Studies of the University of Gadjah Mada, and Survey Meter. Average provincial-level data are taken from the BPS - Statistics Indonesia and the Ministry of Manpower and Transmigration (MoMT). The variables to instrument the average years of schooling and the percentage of workers with higher education variables are based on data from the BPS - Statistics Indonesia and the Ministry of National Education (MoNE).

Table 1 shows the summary statistics for the variables. The mean total monthly earnings in log form are 5.908 across the workers. The mean years of schooling is relatively low, specifically 10.67 years, and so exceeds the nine years of compulsory study by slightly less than two years. The workers in the sample have mean work experience of approximately 17.87 years. The mean length of job tenure is 7.89 years.

Table 1 - Summary Statistics of Variables

Variables	*Mean*	*Standard Deviation*	*Variables*	*Mean*	*Standard Deviation*
Monthly earnings (IDR)	1,339,521	1,961,290	Average years of schooling	8.744	0.770
Years of schooling	10.669	3.751	Average years of schooling based on industrial sector	9.370	1.493
Experience	17.869	10.604	Percentage of workers with higher education	7.731	3.139
Tenure	7.890	8.142	Percentage of workers with higher education based on industrial sector	12.348	12.406
Married	0.868	0.339	The number of higher education institution per 1000 people	0.0158	0.010
Urban	0.674	0.469	Percentage of household use clean water	53.649	12.099
Female	0.334	0.472			

Source: Authors' calculation based on IFLS4, BPS's, MoMT's and MoNE's databases.

Table 2 presents some characteristics of the provincial-level data. It shows a substantial variation in the number of people - between 1.1 and 40.6 million – across the provinces. There are four provinces in the sample with a population of over 10 million. Three of these provinces are located in Java Island, namely Jawa Barat, Jawa Tengah,

and Jawa Timur. Jawa Barat is the most populated province among these (population of 40.6 million), followed by Jawa Timur, Jawa Tengah, and Sumatera Utara, which have populations of 37 million, 32.5 million, and 12.9 million, respectively. The province with the smallest population is Kepulauan Bangka Belitung, with 1.1 million inhabitants.

In terms of the average years of schooling for workers in each province, Daerah Istimewa Yogyakarta (DIY) has the highest average years of schooling, with 12.22 years of schooling. However, this figure is just equal to an individual who completed senior high school (grade 12). The province with the lowest average years of schooling for its workers is Riau, 9.42 years of schooling, and this is just equal to an individual who completed basic education (grade 9).

Table 2 - Characteristics of Provincial-Level Data

Province	*2007/2008 population (thousands)*	*Per cent of workers with higher education*	*The number of higher education institution per 1,000 people*	*Per cent HH use clean water*
Sumatera Utara	12,938.35	6.38	0.018	47.82
Sumatera Barat	4,730.45	8.46	0.023	46.29
			0.0026	40.11
Lampung	7,289.8			
Kepulauan Riau	1,423.00	10.71	0.0026	69.33
Riau	5,130.10	7.75	0.0096	34.90
DKI	9,105.40	16.20	0.037	80.36
Jawa Barat	40,623.70	7.31	0.011	41.97
Jawa Tengah	32,503.35	5.68	0.0084	50.71
DIY	3,451.50	10.43	0.039	66.93
Jawa Timur	36,995.20	5.49	0.011	57.63
Banten	9,512.90	7.89	0.012	45.05
Bali	3,497.90	8.64	0.012	63.76
NTB	4,328.15	5.04	0.012	46.72
Kalimantan Selatan	3,421.65	5.50	0.012	53.89
Sulawesi Selatan	3,421.65	7.80	0.021	48.26

Source: Authors' calculation based on IFLS4, BPS's, MoMT's and MoNE's databases.

The percentage of the workers with higher education is low. Only three provinces in the sample have a percentage of their workers with higher education of more than 10 per cent, namely Daerah Khusus Ibukota (DKI), Kepulauan Riau, and DIY, with 16.20, 10.71 and 10.43 per cent, respectively. Nusa Tenggara Barat (NTB) is the province with the lowest percentage of workers with higher education, with only 5.04 per cent. The largest ratio of the number of higher education institution per 1,000 people is for the province of DKI, with a ratio of 0.037. The province with the lowest ratio is Kepualuan Riau, with a ratio of 0.0026.

4. Statistical Analyses

The discussion in this section commences with the analysis based on the OLS approach. Following this the IV analyses are considered.

(i) OLS Analyses

Table 3 shows the results from the estimation of the augmented Mincerian model. The findings in the two left-hand columns are for when the average years of schooling and the average years of schooling based on the industrial sector within each province are utilised as the aggregate-level human capital measures. The findings in the final two columns are based on the percentage of workers with higher education as the aggregate-level human capital measures. In each instance the first model presented contains only the aggregate-level variable that is based solely on the province of residence, while the second model contains this variable together with the corresponding variable based on the worker's industry of employment within the province. This sequential approach to estimation will inform on whether there are collinearities between the two measures of external effects. It also provides a tractable approach for the IV estimations that follow. Two sets of standard errors are listed for each variable. The first standard error is the conventional robust one. The second reflects the clustering of the measures of the external effects at the provincial level. The presentation of both types of standard errors follows Hyytinen, Ilmakunnas and Toivanen (2013). It is noted that variables which are statistically significant have this status in this instance regardless of the standard error used. In subsequent presentations, only clustered standard errors are listed.

The results reported in table 3 can be considered satisfactory, as close to 30 per cent of the variance in earnings is explained. The findings associated with the non-education variables conform to conventional wisdom, and will not be discussed here (see, Purnastuti, Miller and Salim (2013a) for relevant analysis). Rather the discussion will focus on the individual and aggregate-level education variables.

The estimates of the private returns to education are comparable for the two sets of results. Each additional year of schooling is expected to increase individual earnings by between four and five per cent.[5]

The estimates of the human capital externalities are all positive and statistically significant at the five per cent level of significance or better. In the model of column (i), where only the provincial average years of schooling is included in the estimating equation, the estimated effect indicates that an increase by one in the average years of schooling in the province is expected to be associated with an increase in the individual worker's wage of 5.8 per cent.[6] This finding is in line with those reported by Liu (2007) in China, where an increase in the average years of schooling by one

[5] The estimates of the private return to schooling using levels of education show that the payoff to schooling increases as higher levels of education are considered. As noted in section 1, this pattern, which is the same as reported by Deolalikar (1993), contrasts with the pattern typically found in developing countries (Psacharopoulos, 1981, 1985 and 1994).

[6] Similar estimates of the external effects are obtained when variables for the level of education for the individual are used in the estimations. This contrasts with Rudd's (2000) finding. Rudd (2000) reported that there was no evidence of human capital spillovers when a years' of schooling variable was used in the estimation, while such spillovers were evident when dummy variables for educational attainment were utilised in the model.

year led to an increase in individual earnings by 4.90 to 6.67 per cent. The external effect associated with an expansion of the education sector in Indonesia is almost one percentage point higher than the internalised effect associated with the individual's years of schooling variable.

Table 3 - OLS Estimates of Augmented Mincerian Earnings Equation

	(i)	*(ii)*	*(iii)*	*(iv)*
	Externality measure			
Variable	*Average years of schooling*		*Percentage of workers with higher education*	
Constant	4.7118 ***	4.4942 ***	5.1434 ***	5.1545 ***
	(0.137)	(0.148)	(0.068)	(0.068)
Years of schooling	0.0492 ***	0.0439 ***	0.0491 ***	0.0460 ***
	(0.003)	(0.003)	(0.003)	(0.003)
Experience	0.0076 **	0.0074 **	0.0078 **	0.0077 **
	(0.003)	(0.003)	(0.003)	(0.003)
Experience^2/100	-0.0129 *	-0.0128 *	-0.0135 *	-0.0134 *
	(0.007)	(0.007)	(0.007)	(0.007)
Tenure	0.0162 ***	0.0161 ***	0.0160 ***	0.0158 ***
	(0.003)	(0.003)	(0.003)	(0.003)
Tenure^2/100	-0.0283 ***	-0.0284 ***	-0.0281 ***	-0.0281 ***
	(0.008)	(0.008)	(0.009	(0.009)
Marital status	-0.0073	-0.0018	-0.0076	-0.0053
	(0.019)	(0.020)	(0.019)	(0.020)
Urban	0.0950 ***	0.0760 ***	0.0942 ***	0.0904 ***
	(0.022)	(0.023)	(0.021)	(0.021)
Female	-0.1909 ***	-0.2008 ***	-0.1917 ***	-0.1961 ***
	(0.018)	(0.019)	(0.019)	(0.020)
AveSchool	0.0580 ***	0.0524 ***		
	(0.014)	(0.012)		
AveSchool-Ind		0.0361 ***		
		(0.009)		
PerHE			0.0098 **	0.0096 **
			(0.005)	(0.004)
PerHE-Ind				0.0024 ***
				(0.001)
Adj-R^2	0.2847	0.2965	0.2791	0.2829
Observations	4528	4528	4528	4528

Notes: Heteroscedasticity-consistent standard errors in parentheses; *, ** and *** denote statistical significance at the 10 per cent, five per cent and one per cent levels, respectively.

The model of column (ii) is distinguished by the addition of the depth of the same industrial sector human capital stock. The inclusion of this variable is associated with a small reduction in the coefficient on the overall human capital stock variable, from 0.0580 to 0.0524. The *AveSchool-Ind* variable has a coefficient of 0.0361, indicating that an increase by one in the average years of schooling in each worker's industrial sector is associated with an increase in the worker's monthly earnings by around 3.6 per cent. It therefore appears that the effects of human capital depth within the worker's industrial sector of employment are slightly smaller than the effects of the

overall human capital depth, though both sources of externality are important. This is in agreement with Fu's (2007) finding using Boston metropolitan data.

The social return[7] to schooling consists of both the private and external returns to schooling. Thus, social return to schooling in this article is measured as (Years of schooling + Average Schooling)/Private Return to school. Then, based on the results in column (i) of table 3, it can be seen that the social return exceeds the private return by a factor of (0.0492 + 0.0580)/0.0492, or by about 2.2. This figure is higher than the finding of Rauch (1993), based on US data. Rauch (1993) found that the social return exceeded the private return by a factor of 1.7.

To check the robustness of the OLS estimates considered above, the models of columns (i) and (ii) were re-estimated using the alternative measure for the provincial level education, namely the percentage of workers with higher education. The results are reported in columns (iii) and (iv) of table 3. It is apparent that the results for the variables other than the aggregate-level variables are unaffected by this change to the specification.

Including an aggregate-level human capital measure based on the percentage of workers with higher education leads to lower estimated coefficients compared to those obtained using the average years of schooling. Using this new variable, the estimated coefficient is around 0.01 in each specification, implying that an increase in the percentage of workers with higher education by one percentage point can be expected to increase an individual's monthly earnings by about one per cent. These results are very similar to the OLS estimates of 1.02 per cent to 1.42 per cent reported by Morreti (2004a) based on US data, the 1.10 per cent to 1.45 per cent reported by Liu (2007) based on Chinese data, and the recent estimates of 0.6 per cent to 1.8 per cent for Germany by Heuermann (2011). Comparison with the estimates presented in the first two columns of table 3 suggest the externalities associated with education in Indonesia seem to derive more from expansion of the pre-tertiary levels of schooling rather than from the higher education sector.[8]

The estimates based on the variables constructed using the percentage of workers with higher education based on the industrial sector within each province are consistent with the above conclusion. These results show that an increase in the percentage of workers with higher education in each industrial sector by one percentage point is associated with an increase in an individual's monthly earnings by approximately 0.2 per cent. Similar to the results in columns (i) and (ii), the external returns to schooling associated with the aggregate-level human capital in the same industrial sector within the province are lower than those from the overall-level of human capital within the province. The social returns to education associated with the

[7] Private and social returns to education may differ in the presence of externalities.

[8] Note that the *PerHE* and *PerHE-Ind* variables are measured as a per cent whereas *AveSchool, AveSchool-Ind* and years of schooling are in years. Comparisons of estimated impacts might be more useful if undertaken using an elasticity measure. In the semi-logarithmic specification of the earnings equation, the elasticity is found by multiplying the regression coefficient by the mean of the variable of interest. However, as the means are comparable (for example, the mean of *AveSchool* is 8.74 and the mean of *PerHE* is 7.73), the regression coefficients provide a good basis for comparisons from this perspective. For this reason also, the discussion of the social return using the *PerHE* variables is based simply on the summation of the estimated coefficients.

percentage of workers with higher education (columns (iii) and (iv)) exceed the private returns by a factor of at least 1.2. This is lower than that recorded on the basis of the specifications listed in columns (i) and (ii).

Summing up, these OLS estimates reveal four points of interest. First, the estimates of the private returns to schooling are stable across all specifications. Second, all estimates of the external returns to schooling are positive and statistically significant, both for the overall level and for the industrial sector level variables. Third, the externalities associated with education in Indonesia appear to be associated mainly with expansion of schooling at the pre-tertiary level. Fourth, the social return to schooling could be more than double the conventionally estimated private return. If this is the case the policy implications in relation to the potential for further expansion of the education sector would be altered considerably. Before pursuing these policy implications, however, the IV estimates will be discussed.

(ii) IV Approach

In this sub-section an IV approach is adopted to address the issue of potential bias that may arise because of unobserved factors being correlated with the provincial level human capital. Tables 4 reports the results. The column (i) and (ii) of this table are based on the use of the *AveSchool* variables as the measure of aggregate-level human capital. Of these columns of results, the first is for where the Number of higher education institution per 1000 people is employed as an instrument (*HE1000*), and the second covers the results from the IV estimations using the percentage of household use clean water as an instrument (*CW*). The results contained in the final two columns are based on the *PerHE* variable as the aggregate-level human capital measure, with the *HE1000* and *CW* as instruments.

Ideally the bias that may arise because of unobserved factors being correlated with the human capital measure based on the industrial sector within each province should also be evaluated. Unfortunately, as noted above, there is no suitable instrument for this disaggregated measure of the human capital stock within each province. The model was, however, estimated with internal instruments along the lines of Lewbel (2012). While the error structure in the first-stage regression was heteroscedastic, suggesting the approach may have merit, the industrial sector human capital measure was statistically insignificant in the earnings equation, indicating the internal instruments are weak. For this reason, the IV estimations reported here are based only on one aggregate-level human capital measure per equation, as per columns (i) and (iii) of table 3.

Table 4 - Instrumental Variables Estimates of the Augmented Mincerian Model[9]

	(i)		*(ii)*		*(iii)*		*(iv)*	
	Externality Measure							
	Years of schooling				*Per cent of workers with higher education*			
	Type of Instrument							
	Number of higher education institution per 1,000 people		*Per cent household use clean water*		*Number of higher education institution per 1,000 people*		*Per cent household use clean water*	
Variable	*1st stage*		*1st stage*		*1st stage*		*1st stage*	
Constant	8.2423 ***	4.1957 ***	7.5336 ***	4.3383 ***	4.6747 ***	5.1727 ***	3.4880 ***	5.0532 ***
	(0.0578)	(0.2685)	(0.0729)	(0.22154)	(0.2243)	(0.0430)	(0.2996)	(0.0662)
Years of schooling	0.0011	0.0408 **	0.0031 ***	0.0409 ***	0 .0204 *	0.0405 ***	0.0276 **	0.0401 ***
	(0.0031)	(0.0016)	(0.0031)	(0.0016)	(0.0121)	(0.0016)	(0.0126)	(0.0016)
Experience	0.0103 **	(0.0053) ***	0.0118 ***	0.0054 ***	0.0331 **	0.0059 ***	0.0384 ***	0.0052 **
	(0.0041)	(0.0021)	(0.0041)	(0.0021)	(0.0161)	(0.0021)	(0.0168)	(0.0022)
Experience^2/100	-0.0211 **	-0.0088 ***	-0.0236 ***	-0.0092 **	-0.0662 *	-0.0101 **	-0.0772 ***	-0.0086 *
	(0.0090)	(0.0046)	(0.0089)	(0.0046)	(0.0348)	(0.0046)	(0.0363)	(0.0047)
Tenure	-0.0011	0.0173 **	-0.0037 **	0.0173 ***	0.0090	0.01670 ***	-0.0024	0.0170 ***
	(0.0040)	(0.0020)	(0.0039)	(0.0020)	(0.0155)	(0.0020)	(0.0161)	(0.2079)
Tenure2/100	-0.0068	-0.0301 ***	0.0010 ***	-0.0301 ***	-0.0521	-0.0298 ***	-0.0162	-0.0293 ***
	(0.01300)	(0.0066)	(0.0128)	(0.0066)	(0.0504)	(0.0066)	(0.0527)	(0.0068)
Marital status	0.0486	-0.0032	0.0417 **	-0.0027	0.3017 **	-0.0036	0.23487	-0.0077
	(0.0357)	(0.0182)	(0.0352)	(0.0181)	(0.1384)	(0.0182)	(0.1446)	(0.0187)
Urban	0.1480 ***	0.0876 ***	0.1482 *	0.0914 ***	0.9427 ***	0.0861 ***	1.2034 ***	0.0580 ***
	(0.0255)	(0.0145)	(0.0248)	(0.0139)	(0.0981)	(0.0147)	(0.1019	(0.0190)
Female	-0.0274	-0.1880 ***	-0.0236 *	-0.1883 ***	-0.0804	-0.1898 ***	-0.0412	-0.1892 ***
	(0.0237)	(0.0120)	(0.0233)	(0.0120)	(0.0918)	(0.0120)	(0.0959)	(0.0124)
AveSchool		0.1311 ***		0.1143 ***				
		(0.0315)		(0.0259)				
PerHE						0.0222 ***		0.0419 ***
						(0.0053)		(0.0098)
HE1000	17.8576 *				05.6164 ***			
	(1.1057)				(4.2888)			
CW			0.0181 ***				0.0493 ***	
			(0.0009)				(0.0037)	
F-test of exogeneity		5.3290 **		4.6249 **		5.6940 **		11.5154 ***
Observations	4528	4528	4528	4528	4528	4528	4528	4528

Notes: Standard errors in parentheses. *, ** and *** denote statistical significance at the 10 per cent, five per cent and one per cent levels, respectively.

The identifying instrument is statistically significant, and has the expected sign in each estimation. The F-test of the endogeneity of the aggregate-level human capital measure rejects the null hypothesis of exogeneity in all the models. Attempts to instrument using both the external instruments and generated instruments, in line with Lewbel's (2012) approach, was not associated with any quantitative improvement in the results. Hence only the findings based on the external instruments, and in particular the estimations using the HE1,000 variable as the instrument, are discussed.

There are no material changes to the results presented in table 4 for the variables other than the aggregate-level human capital measures. Each of the aggregate-level human capital measures is associated with the same positive impact on individual's wages that characterised the OLS estimates. However, there are important changes in magnitude. Applying the IV approach leads to much higher (by a factor of four) estimated external returns to schooling compared to those obtained using the OLS approach. Thus, according to the column (i) results, an increase by one in the average years of schooling in the province is associated with an increase in the individual's monthly earnings by about 13 per cent. These results are lower than the study using 1990 Canadian data conducted by Rakova and Vaillancourt (2005). They found that an increase by a year in their average education variable had an effect on labour productivity of 23 per cent.

When the *AveSchool* variable is replaced by *PerHE* the IV findings are consistent with those obtained using OLS, in that the use of this alternative measure of aggregate-level human capital is associated with a much lower estimate of the human capital externality. In particular, the estimated coefficient on the *PerHE* variable is 0.0222 in the column (iii) results. However, even this lower estimate of the external return to schooling exceeds the estimated private return to schooling.

Summing up the patterns of these IV estimates results, there are two points that need to be highlighted. First, the findings from the IV analyses are sensitive to the choice of instrument, including whether external or internal instruments are employed. This is consistent with research on the IV estimation of the private return to schooling, such as Levin and Plug (1999). Second, the estimated external returns to schooling associated with both the average years of schooling and the percentage of workers with higher education obtained using the IV approach are larger than that obtained using OLS. Hence, it appears that education externalities are an important issue for public policy makers to consider in Indonesia.

[9] (Table 4) To evaluate whether the instruments used in this analysis are appropriate the quality and relevance criteria of the instruments are introduced. The test for the quality of the instruments by examining the F-test of the joint significant of the respective instrument sets in their first stage equation has been undertaken. The second criterion is relevance. The relevance of the instrument is to answer the most essential question, whether instrumenting the schooling variable is necessary or not? To answer this question, the Hausman test can be applied (Hausman, 1978).

5. Sensitivity Analyses

In this section the results of two extensions of the above set of analyses are presented.[10] First, results from estimations undertaken for samples disaggregated by level of education are presented. This approach provides a test of the substitution hypothesis of Moretti (2004b) and Muravyev (2008). Second, the variable for each worker's years of schooling, which captures the private return to education, is instrumented at the same time that the aggregate-level measure is instrumented. Acemoglu and Angrist (2000) argue that this is an important consideration. Parents' educational attainments are used as instruments for the individual-level schooling variable.

(i) Human Capital Spillovers vs. Substitutability

Moretti (2004b, 2004a) argued that the correlation between aggregate-level human capital and earnings is not always associated with human capital externalities. Rather, it could arise from imperfect substitution between low-skilled and high-skilled workers.[11] Specifically, in a conventional demand and supply model with imperfect substitution between high-skilled and low-skilled workers, an increase in the number of high-skilled workers will tend to decrease the earnings of the high-skilled workers and, at the same time, the earnings of low-skilled workers will tend to increase. In other words, although there are no human capital externalities, low-skilled workers receive benefit from an increase in the number of high-skilled workers under imperfect substitution between these types of workers. However, at the same time, human capital externalities may increase the earnings of both low- and high-skilled workers. Putting these two effects together, an increase in the ratio of workers with higher education should have a positive effect on the earnings of low-skilled workers. The effect for high-skilled workers will be positive only where the spillover effect is sufficient to offset the supply effect. Hence, externalities can be said to be present when an increase in the average-level of education translates into an increase in the earnings of high-skilled workers.

To examine which of these explanations is more credible for Indonesia we follow Moretti (2004b, 2004a) and Muravyev (2008), and estimate the education spillover effect separately for low-skilled and high-skilled workers.[12] Table 5 shows the results for the OLS estimations, separately for workers who obtained higher education (columns (iii) and (iv)) and for all other (less-skilled) workers (columns (i) and (ii)). These equations were also estimated using an IV approach, and with the industry-level variables as well (results are available from the authors upon request).

The results reported in table 5 show that the coefficient of the AveSchool variable for workers without higher education is 0.058, whereas the coefficient of this variable for workers with higher education is 0.074. Each of these coefficients is statistically significant. These results thus show that the average years of schooling in each province has a two percentage points larger effect on the earnings of high-

[10] As an additional test of robustness the models were estimated separately by gender. Broadly similar results were obtained for males and females.
[11] See, for example, the theoretical exposition in Heuermann (2011).
[12] Low-skilled workers are defined as workers with education lower than higher education. High-skilled workers are defined as workers with higher education.

skilled workers than they have on the earnings of low-skilled workers. Hence, these findings appear to confirm the presence of human capital externalities, since both of the aggregate-level human capital variables are associated with increases in the earnings of high-skilled workers. This result is similar to Moretti (2004a), though in Moretti's analyses for the US an increase in the proportion of high-skilled workers had a larger positive effect on the wages of low-skilled workers than it had on the wages of the high-skilled workers. The relativity in the current paper between the effects for high-skilled and low-skilled workers is, however, consistent with Heuermann's (2011) recent findings for Germany.

The coefficient of the *PerHE* variable for workers without higher education is 0.0088, whereas the coefficient of this variable for workers with higher education is 0.0170. These estimates for the *PerHE* variable indicate that a one percentage point increase in the percentage of workers with higher education in each province is associated with increases in the earnings of low-skilled workers of 0.88 per cent, and increases in the earnings of high-skilled workers of 1.70 per cent. These results support the finding discussed earlier in this sub-section.

In conclusion, these estimates on the samples disaggregated by skill level give further assurance in relation to the existence of human capital externalities.

Table 5 - Test for Imperfect Substitutability of Workers with and without Higher Education (OLS Estimation)

	(i)	*(ii)*	*(iii)*	*(iv)*
	Skill level			
Variable	*Low Levels of Education*		*Higher Education*	
Constant	4.8505 ***	5.2830 ***	3.6941 ***	4.2123 ***
	(0.1720)	(0.073)	(0.318)	(0.211)
Years of schooling	0.0379 ***	0.0381 ***	0.1002 ***	0.1004 ***
	(0.004)	(0.004)	(0.014)	(0.014)
Experience	0.0046	0.0051	0.0201 ***	0.0202 ***
	(0.003)	(0.003)	(0.007)	(0.007)
Experience^2/100	-0.0091	-0.0099	-0.0428 **	-0.0432 **
	(0.007)	(0.007)	(0.018)	(0.018)
Tenure	0.0156 ***	0.0155 ***	0.0157 ***	0.0142 ***
	(0.003)	(0.003)	(0.003)	(0.004)
Tenure^2/100	-0.0272 ***	-0.0274 ***	-0.0270 ***	-0.0215 *
	(0.009)	(0.010)	(0.010)	(0.011)
Marital Status	-0.0019	-0.0031	-0.0336	-0.0310
	(0.016)	(0.016)	(0.053)	(0.055)
Urban	0.0955 ***	0.0953 ***	0.1424 ***	0.1358 ***
	(0.024)	(0.023)	(0.025)	(0.022)
Female	-0.2168 ***	-0.2172 ***	-0.1297 ***	-0.1293 ***
	(0.024)	(0.026)	(0.016)	(0.015)
AveSchool	0.0577 ***	0.0740 ***		
	(0.018)	(0.026)		
PerHE		0.0088 *		0.0170 ***
		(0.005)		(0.005)
Adjusted R^2	0.2112	0.2043	0.2115	0.2101
Observations	3680	3680	848	848

Notes: Clustered (at level of province) standard errors in parentheses. *, ** and *** denote statistical significance at the 10 per cent, five per cent and one per cent levels, respectively.

(i) Endogeneity of Individual and Average Schooling

Following Acemoglu and Angrist (2000), we further address the endogeneity of both the individual and average schooling variables. The levels of education of parents and the number of higher education institution per 1,000 people are used as instruments. The variation in the parental education variables across individuals in a given age group appears to provide a superior basis for the IV framework than variables that have minimal variation across groups (see, Purnastuti, Miller and Salim, 2013b).

The results from the first-stage estimation reveal that father's years of schooling and mother's years of schooling both have highly significant positive influences on the individuals' years of schooling. At the aggregate level, it is apparent that father's and mother's years of schooling do not impact the average schooling variable, measured using either *AveSchool* or *PerHE*. The number of higher education institution per 1,000 people continues to have a marked impact on the provincial-level human capital measures. An F-test, robust to the clustering in the data, of the null hypothesis that both variables are exogenous was rejected, suggesting that an IV approach to accommodate endogeneity is appropriate.

The results reported in table 6 are distinguished by an increase in the private return to schooling of about three percentage points compared to the estimations where the worker's individual years of schooling was treated as exogenous. Nevertheless, the estimated external returns are as least as large as the private returns, and typically much larger for the model using AveSchool. For example, in the column (i) specification, the private return to schooling is 7.47, and the externality effect is close to 10.84 per cent. These results support the conclusion of the analyses in the previous sub-sections, to the effect that the education externalities in Indonesia are sizeable, and as such warrant consideration in public decision making over expenditure levels on education.

Thus our results suggest that the most obvious outcome of the private returns to schooling is higher earnings. However, an additional year of schooling raises the level of economic activity more than its private return. The results of the study of imperfect substitutability between low-skilled and high-skilled workers strengthen reveals that human capital spillovers exist in Indonesia. Provinces with higher amount high-skilled workers have higher human capital externalities. This finding supports the Marshallian propositions of labour market externalities. This can be explained by the channel that the concentration of skilled workers creates competition, which in turn provides a strong motivation for other to learn which is ultimately conducive to the creation and diffusion of knowledge.

Table 6 - Estimates of External Return to Schooling when Individual and Average Schooling are treated as Endogenous Variables

	(i)	*(ii)*
	Externality Measure	
	Years of schooling	*Percentage of workers with higher education*
	Type of Instrument	
Variable	*Parental education and number of HE institution per 1,000 people*	*Parental education and number of HE institution per 1,000 people*
Constant	4.0075 ***	4.8007 ***
	(0.2667)	(0.0593)
Years of schooling	0 .0747 ***	0.0759 ***
	(0.0045)	(0.0044)
Experience	0.0111 ***	0.0118 ***
	(0.0023)	(0.0022)
Experience^2/100	-0.0099 **	-0.0109 **
	(0.0047)	(0.0046)
Tenure	0.0128 ***	0.0123 ***
	(0.0021)	(0.0021)
Tenure^2/100	-0.0251 ***	-0.0247 ***
	(0.0067)	(0.0067)
Marital status	-0.0302	-0.0316 *
	(0.0186)	(0 .0187)
Urban	0.0334 **	0.0296 *
	(0.0159)	(0.0164)
Female	-0.1908 ***	-0.1924 ***
	(0.01215)	(0.0122)
AveSchool	0.1084 ***	
	(0.0320)	
PerHE		0.0182 ***
		(0.0054)
Observations	4528	4528
F-test of exogeneity	26.5235 ***	27.6468 ***

Notes: Clustered (at level of province) standard errors in parentheses. *, ** and *** denote statistical significance at the 10 per cent, five per cent and one per cent levels, respectively.

6. Conclusion

Using IFLS4 data, this paper has analysed whether a relationship exists between the aggregate-level of human capital and individual earnings in Indonesian provinces, and also whether this relationship reflects the presence of human capital externalities. The estimations are based on Mincerian earnings regression augmented with measures of the aggregate-level human capital in each province and in the industrial sector within each province. Specifically, four alternative measures of aggregate-level human capital are used, namely the average years of schooling, the percentage of workers with higher education, the average years of schooling based on the industrial sector within each province, and the percentage of workers with higher education based on the industrial sector within each province. A potential endogeneity problem is addressed, and the possibility of imperfect substitutability between low-skilled and high-skilled workers is also examined.

The main set of analyses suggests that human capital externalities are economically important in Indonesia. The OLS estimate of these is typically as large as the private return to schooling, which means that the social return is about double the private return to schooling. The IV estimates are associated with even higher values of the externalities, of over two times the magnitude of the private return to education. These sizeable externalities are also a feature of the labour market outcomes of both males and females.

The results of the study of imperfect substitutability between low-skilled and high-skilled workers strengthen our conclusion that human capital spillovers exist in Indonesia. Hence, the results of this study strongly support the view that investing in education is even more important for aggregate economic outcomes than it is for the individuals who do so. This study also provides evidence of the existence of human capital externalities as high as, or even much higher than, the private return to schooling. Thus, there would appear to be a clear role for the public sector fostering education and human capital development in order to seize the benefit of these externalities.

Appendix

Table A1 - IV with External Instruments plus Lewbel's Generated Instruments (AveSchool as Aggregate Human Capital)

	Standard IV		*IV with Generated Instruments*		*IV with Generated Instruments and External Instruments*	
Variable	*Number of higher education institution per 1,000 people*	*Per cent household use clean water*	*Number of higher education institution per 1,000 people*	*Per cent household use clean water*	*Number of higher education institution per 1,000 people*	*Per cent household use clean water*
Constant	4.8109 ***	4.7990 ***	4.8154 ***	4.8154 ***	4.8140 ***	4.8023 ***
	(0.0737)	(0.0733)	(0.2970)	(0.2970)	(0.0733)	(0.0730)
Years of schooling	0.0409 ***	0.0409 ***	0.0410 ***	0.0410 ***	0.0410 ***	0.0409 ***
	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0016)
Experienc	0.0060 ***	0.0060 ***	0.0061 ***	0.0061 ***	0.0061 ***	0.0060 ***
	0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)
Experience^2/100	-0.0001 **	-0.0001 ***	-0.0104 **	-0.0104 **	-0.0104 **	-0.0104 **
	(0.0045)	(0.0045)	(0.0046)	(0.0046)	(0.0045)	(0.0045)
Tenure	0.0171 ***	0.0171 ***	0.0171 ***	0.0171 ***	0.0171 ***	0.0171 ***
	(0.0020)	(0.0020)	(0.0020)	(0.0020)	(0.0020)	(0.0020
Tenure^2/100	-0.0302 ***	-0.0302 ***	-0.0302 ***	-0.0302 ***	-0.0302 ***	-0.0302 ***
	(0.0065)	(0.0065)	(0.0065)	(0.0065)	(0.0065)	(0.0065)
Marital status	-.0008	-.0009 ***	-.0008	-.0008	-.0008	-.0008
	(0.0180)	(0.0180)	(0.0180)	(0.0180)	(0.0180)	(0.0180)
Urban	0.1042 ***	0.1039 ***	0.1043 ***	0.1043 ***	0.1043 ***	0.1040 ***
	(0.0126)	(0.0126)	(0.0149)	(0.0149)	(0.0126)	(0.0126)
Female	0.1893 ***	-0.1893 ***	-0.1893 ***	-0.1893 ***	-0.1893 ***	-0.1893 ***
	(0.0119)	(0.0119)	(0.0119)	(0.0119)	(0.0119)	(0.0119)
AveSchool	0.0585 ***	0.0599 ***	0.0580 *	0.0580 *	0.0582 ***	0.0595 ***
	(0.0080)	(0.0080)	(0.0349)	(0.0349)	(0.0080)	(0.0079)
F test (weak identification est.)	5,147.711	1.1e+04	25.710	25.710	2,247.346	2,395.848
Observations	4,528	4,528	4,528	4,528	4,528	4,528

Notes: Clustered (at level of province) standard errors in parentheses. *, ** and *** denote statistical significance at the 10 per cent, five per cent and one per cent levels, respectively.

Table A2 - IV with External Instruments plus Lewbel's Generated Instruments (PerHE as Aggregate Human Capital)

	Standard IV		*IV with Generated Instruments*		*IV with Generated Instruments and External Instruments*	
Variable	*Number of higher education institution per 1,000 people*	*Per cent household use clean water*	*Number of higher education institution per 1,000 people*	*Per cent household use clean water*	*Number of higher education institution per 1,000 people*	*Per cent household use clean water*
Constant	5.2670 ***	5.2628 ***	5.2079 ***	5.2079 ***	5.2587 ***	5.2579 ***
	(0.0313)	(0.0312)	(0.0363)	(0.0363)	(0.0310)	(0.0310)
Years of schooling	0.0409 ***	0.0409 ***	0.0407 ***	0.0407 ***	0.0409 ***	0.0409 ***
	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0016)
Experience	0.0064 ***	0.0064 ***	01.0061 ***	01.0061 ***	0.0064 ***	0.0064 ***
	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)
Experience^2/100	-0.0112 ***	-0.0112 **	-0.0105 **	-0.0105 **	-0.0111 **	-0.0111 **
	(0.0045)	(0.0045)	(0.0046)	(0.0046)	(0.0045)	(0.0045)
Tenure	0.0170 ***	0.0170 ***	0.0170 ***	0.0170 ***	0.0170 ***	0.0170 ***
	(0.0020)	(0.0020)	(0.0020)	(0.0020)	(0.0020)	(0.0020)
Tenure^2/100	-0.0302 ***	-0.0302 ***	-0.0299 ***	-0.0299 ***	-0.0301 ***	-0.0301 ***
	(0.0066)	(0.0066)	(0.0066) ***	(0.0066)	(0.0066)	(0.0066)
Marital status	-0.0002	-0.0004	-0.0023	-0.0023	-0.0005	-0.0006
	(0.0181)	(0.0180)	(0.0181)	(0.0181)	(0.0180)	(0.0180)
Urban	0.1082 ***	0.1073 ***	0.0943 ***	0.0943 ***	0.1063	0 .1061 ***
	(0.0129)	(0.0129)	(0.0136)	(0.0136)	(0.0129)	(0.0129)
Female	-0.1902 **	-0.1902 ***	-0.1899 ***	-0.1899 ***	-0.1902 ***	-0.1901 ***
	(0.0120)	(0.0120)	(0.0120)	(0.0120)	(0.0120)	(0.0120)
PerHE	0.0066 ***	0.0073 ***	0.0164 ***	0.0164 ***	0.0080 ***	0.0081 ***
	(0.0022)	(0.0022)	(0.0037)	(0.0037)	(0.0021	(0.0021)
F test (weak identification test)	5,147.711	5,577.561	176.793	176.793	1,427.088	3,454.474
Observations	4,528	4,528	4,528	4,528	4,528	4,528

Notes: Clustered (at level of province) standard errors in parentheses. *, ** and *** denote statistical significance at the 10 per cent, five per cent and one per cent levels, respectively.

Table A3 - First Stage Regression of The Estimates of External Return to Schooling when Individual and Average Schooling are treated as Endogenous Variables

	(i)		*(ii)*	
	Externality Measure			
	Years of schooling		*Per cent workers with higher education*	
	Type of Instrument			
	Parental education and number of HE institution per 1,000 people		*Parental education and number of HE institution per 1,000 people*	
Variable	*Partial*	*Aggregate/ Provincial*	*Partial*	*Aggregate/ Provincial*
Constant	7.4974 ***	8.1745 ***	7.4974 ***	4.6354 ***
	(0.21487)	(0.0554)	(0.2149)	(0.2150)
Experience	-0.1063 ***	0.0114 ***	-0.1064 ***	0.0340 **
	(0.0160)	(0.0041)	(0.0160)	(0.0161)
Experience^2/100	-0.0011 ***	-0.0011 ***	-0.1142 ***	-0.0727 *
	(0.0347)	(0.0347)	(0.0347)	(0.0348)
Tenure	0.1187 ***	0.1187 ***	0.1187 ***	0.0105
	(0.0154)	(0.0154)	(0.0154)	(0.0154)
Tenure^2/100	-0.0847 *	-0.0847 *	-0.0847 *	-0.0516
	(0.0504)	(0.0504)	(0.0504)	(0.0504)
Marital status	0.6727 ***	0.6727 ***	0.6727 ***	0.3113 **
	(0.1381)	(0.1381)	(0.1381)	(0.1382)
Urban	1.3175 ***	1.3175 ***	1.3175 ***	0.9396 ***
	(0.0968)	(0.0968)	(0.0968)	(0.0968)
Female	-0.0856	-0.0856	-0.0856	-0.0883
	(0.0918)	(0.0918)	(0.0918)	(0.0919)
Father's education	0.2894 ***	0.2894 ***	0.2894 ***	0.0079
	(0.0172)	(0.0172)	(0.0172)	(0.0172)
Mother's education	0.1742 ***	0.1742 ***	0.1742 ***	0.0298
	(0.0198)	(0.0198)	(0.0198)	(0.0198)
HE1000	0.3392	17.6602 ***	0.3392	105.0362 ***
	(4.2945)	(1.1071)	(4.2945)	(4.2967)
Observations	4528			4528
F test (weak identification TEST)	83.797	83.797	194.549	194.549
F-test of exogeneity	26.5235 ***	26.5235 ***	27.6468 ***	27.6468 ***

Notes: Clustered (at level of province) standard errors in parentheses. *, ** and *** denote statistical significance at the 10 per cent, five per cent and one per cent levels, respectively.

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