INVESTMENT IN HUMAN CAPITAL AND INDUSTRIAL DEVELOPMENT IN VIETNAM'S PROVINCES

by TAM BANG VU* & ERIC IKSOON IM**

This paper examines the effect of human capital accumulated from higher education on regional development in Vietnam. It also examines a possible two-way causality between these two variables. Two types of schools are compared and contrasted: vocational and university. Regional development is measured by industrial output per capita and industrialization level for each province. A combination of the System Generalized Method of Moments (SGMM) and Fixed Effect Three Stage Least Squares (FE3SLS) procedures is performed in order to control lagged dependent variables and improve the efficiency of the estimators. The results show that vocational education helps regional development in Vietnam more than university education. On the reverse causality, we find that the effect of regional development on university enrollments is higher than on vocational-school enrollments.

Keywords: regional development, vocational schools, universities.

1. Introduction

Most people agree that human capital accumulated from education is very crucial for economic development. Higher education has shown its effects on increases in GDP per capita or productivity. However, educators and economists alike are divided on what kind of education is important to the regional development in a transitional economy like Vietnam. In the meantime, most societies have valued university education much higher than vocational education. This tendency is even more pronounced in Asia where households strive to send their children to universities, causing vocational schools to take a back seat in the nation's educational system. Influenced by the preferable mode of education, most economists have focused their attention on general or university education, ignoring the effects of vocational education on economic development.

Using OLS on two single-equation estimations for cross sectional data of 81 to 93 countries, Bils and Klenow (2000) find that education only has a very weak effect on GDP per capita, but this GDP increase in turn has a positive effect on school enrollments. Hojo (2003) uses the country-specific residual from the regression by Caselli et al. (1996) as a proxy for productivity. Employing the GMM procedure introduced by Arellano and Bond (1991) on a single equation for cross sectional data of 90 countries, he finds that education has a positive effect on productivity. Since a higher productivity is related to a higher GDP per capita as shown in Islam (1995), Hojo's results imply that education can indirectly affect GDP per capita through productivity improvement at national level.

Concerning the case of Asia, Demuger (2001) and Chen and Feng 2000) have shown that education affects GDP per capita positively. Hua (2006) uses macroeconomic yearly data for 29 regions in China to investigate the direct effects of education on productivity. His data on education are measured by numbers of graduates from each level divided by population. His overall

* Corresponding Author, Associate Professor, Doctor of Philosophy in Economics, University of Hawaii-Hilo

** Professor, Doctor of Philosophy in Economics, University of Hawaii-Hilo

result is that the effects of secondary and primary education on productivity are either negative or insignificant, whereas that of college education is positive and significant. Hua also finds that the combined effect of all three levels of education is only weakly significant.

Since all aforementioned papers use single equation estimations, their coefficient estimates will be biased if a two-way causality between education and GDP per capita exists.

Kumar (2003) develops a model that addresses this problem. Employing the two stage least squares (2SLS) approach for a system of equations, he uses cross sectional data with 68 to 91 observations. In contrast to Bils and Klenow (2000) and in accordance with Hojo (2003), he finds that education clearly increases productivity growth, but this growth in turn has a negative effect on enrollments instead of a positive one as in Bils and Klenow. However, the 2SLS estimations are only asymptotically consistent, so large sample sizes are called for instead of Kumar's 68 to 91 observation data sets at national level.

Vũ and Hammes (2007) addressed Kumar's problem by using larger panel data set and a more advanced econometric method of three stage least squares (3SLS). They find that the two way causality are both positive.

Regarding the case of Vietnam, Henaff (2005) emphasizes that it is very difficult to measure the role of education on regional development in Vietnam. Although education gives access to the higher incomes, it is only necessary for increases in the per capita income from work because costs of education are a too high condition instead of a sufficient one. No theoretical model or data analysis is provided to support the author's argument.

Moock et al. (1998) and Doan (2011) perform data analyses for Vietnam, focusing on the returns to schooling using microeconomic data for households. Using single equation estimations, both papers find that returns to schooling in Vietnam are very low. The first paper shows that individuals in Vietnam increase their earnings by only five percent for each additional year in a university. Doan's results are even worse: the total return to the four-year university education is seventeen percent, implying roughly four percent for each additional year in a university. The only author that focuses on regional development and education in Southeast Asia is Turpin (2010) who writes that Australian higher education makes some contribution to industrial development in this region but offers only three options: helping with tuition fees, increasing regional mobility of professors, and building cross-border campuses.

None of the papers on Vietnam or Southeast Asia compare and contrast the effect of vocational versus university education on regional development in Vietnam's provinces. Since part of the government policy on education has to be drafted based on regional development analysis, this is an urgent issue for education reform in Vietnam. Vũ (2011) performs a parallel estimation using provincial data from China. She finds that vocational education helps regional development more than university education in China. So what could be the results for Vietnam?

Right from the start of the Vietnamese modern government, the burning question of what might be the best method of education for Vietnam has been discussed. Vũ (1945 and 1946) summarizes education methods around the world and recommends that Vietnam's education should follow a practical approach. Two hypotheses can be drawn from his books: First, vocational education is a more favorable mode of education than university education that tends to be more general and theoretical than practical. Second, among universities, the ones with a more practical approach are more favorable than the ones with a more theoretical approach. More than sixty years have passed since these two books were published, no quantitative research has been carried out to verify his argument. This paper attempts to test the first of these two hypotheses.

2. Materials and Methodology

a. Materials:

We use an augmented production function as discussed in Romer (2006) as a supply equation and add an education-demand equation to account for the two-way causality between higher education and regional development:

$$DEV_{it} = \alpha_1 EDU_{it} + \sum_{j=1}^{n} \alpha_j C_{jt} + u_i + v_t + \varepsilon_{it}$$

$$EDU_{it} = \beta_1 DEV_{it} + \sum_{k=1}^{m} \beta_k A_{kt} + w_i + z_t + \psi_{it} \quad (1)$$

where *DEV* is regional development (For the purpose of this research, regional development is alternatively measured by industrial output per capita and industrialization level, which is the ratio of industrial output to the sum of all outputs for each province); *EDU* is higher education that is either vocational or university education in this paper; *C* is a vector of control variables that might affect regional development; and *A* is a vector of auxiliary variables that might affect higher education.

The subscripts i is for each province and t is for each year, resulting in the provincial fixed effect, time fixed effect, and the idiosyncratic disturbance, respectively.

Data for sixty four provinces are obtained from Vietnam Statistical Yearbooks for the period from 1996 to 2009. Data on outputs of the above sectors are divided by population to obtain data about industrial output per person. Data for service sector are not comprehensive and so are eliminated, so the sum of all outputs is calculated by summing up agricultural, fishery, forestry, and industrial outputs. Data for all outputs are at 1994 constant prices.

Data on these two levels of education—secondary technical schools (henceforth called vocational), and university—are also from Vietnam Statistical Yearbooks. Data for other variables are available from 1996 to 2009, but data about education are not comprehensive before 2002, and province's divisions have been changed a great deal before 2003, so we only use data for the period from 2003 to 2009. Additionally, data about Điện Biên are not comprehensive and so are eliminated from the research. Data on enrollments for each level of education are divided by population at provincial level to form a proxy for human capital accumulated from education.

Figure 1 shows the graph of provincial outputs for industrial and agricultural sectors, sketched against enrollments in universities and vocational schools. One can see that industrial output has grown quite well whereas agricultural output remains almost flat over time. This is clear evidence of good regional development with high growth in both industrial outputs per person and industrialization level. Although both types of higher education enjoy some growth, university enrollment grows much faster than vocational education, especially during the last two years. This suggests that the regional development might have caused university enrollments to grow faster than vocational-school enrollments.

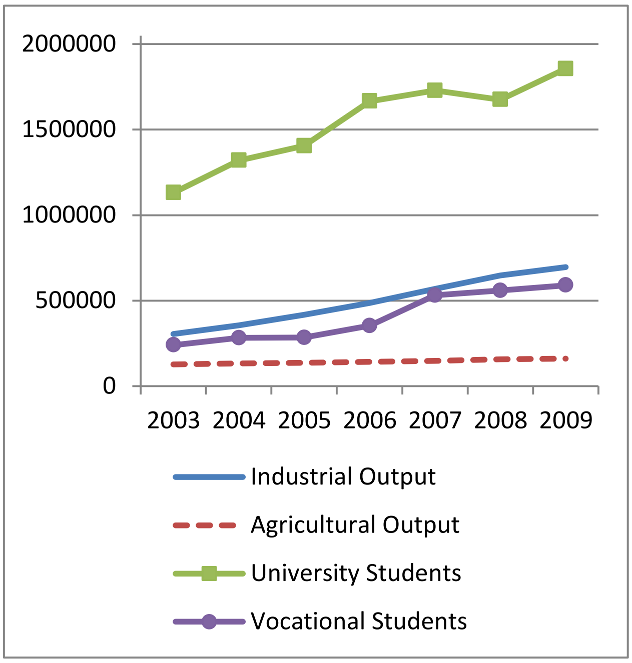

Figure 1: Regional Outputs versus University and Vocational-School Enrollments

Note: Time Period: 2003-2009 - Vertical axis units are in 1994 constant VND price for outputs or numbers of students for higher education enrollments.

The data set on the number of medical staffs is used a proxy for health care, the number of telephones as proxy for telecommunication and length of road in kilometer as a proxy for infrastructure. The data set on retail sales is used as a proxy for private expenditures and is in current prices, so we convert it to 1994 constant price using the consumer price index (CPI). Data on fixed investment and public expenditures on education are only available at national level, so we calculate accumulated national investment then divide both data sets by national population to use as a proxy for physical capital per person and average public expenditures on education per person.

b. Methodology:

We follow a test-down approach to avoid omitted variables, starting with all available variables that might affect regional development or higher education and gradually eliminating any variable with high colinearity or with a p-value greater than 0.50. We also use the Akaike Information Criterion (AIC) procedure to determine numbers of lagged values used in the Granger causality tests for the possible two-way causality. In either case of industrial output per capita or industrialization, we find that the two-way causality is indeed in existence. Hence using the 3SLS approach is rather appropriate. To test the multicolinearity among explanatory variables, we use the Variance Inflation Factors (VIF) procedure by Kennedy (2006) who recommends an acceptable level for any individual variable with VIF less than 10.00 and the average VIF of 5.00 for a combined test of all explanatory variables.

In cross sectional data analysis, it is very difficult to find an instrumental variable (IV) for each equation as discussed in Bils and Klenow (2000). In panel data analysis, it becomes easy because lagged dependent variables can be used as IVs. We use the SGMM approach by Blundel and Bond (1998) and Bond (2002) to control the lagged dependent variables in the reduced forms.

The Blundell-Bond procedure is a refined application of the Arellano and Bond (1991) and the Arellano and Bover (1995) procedures. Arellano and Bond (1991) developed the *difference* GMM estimator for dynamic panels. The method accounts for lagged dependent variables that are predetermined but not exogenous: they are independent of current disturbances but may be influenced by past ones. Differencing the lagged dependent variables or taking deviations from the mean will eliminate the fixed effects. Nonetheless, the difference GMM produces biased coefficient estimates and unreliable tests when an endogenous variable is close to a random walk. In this case, past values provide little information about future changes, so the untransformed lags are weak instruments for transformed variables.

To solve this problem, Blundell and Bond (1998) develop a modified procedure introduced in Arellano and Bover (1995). In this approach, they add the difference of the instrumental variable (IVs) to make them exogenous to the fixed effects. In order to build this while retaining the original Arellano-Bonds for the transformed equation, they design a *system* GMM estimator while left-multiplying the original data by a transformation matrix, $Z_{+}^{*} = \begin{bmatrix} Z^{*} \\ I \end{bmatrix}$, where Z^* is the differenced matrix. Hence for individual i, the new data set is

$$X_{i+}^{*} = \begin{bmatrix} X_i^{*} \\ X_i \end{bmatrix}, \quad Y_{i+}^{*} = \begin{bmatrix} Y_i^{*} \\ Y_i \end{bmatrix}. \quad (2)$$

When an endogenous variable is close to a random walk, past changes are more predictive of current levels than past levels are of current changes, so the new instruments add extra controls to the original ones for models with lagged dependent variables. Hence, the Blundell-Bond (1998) approach effectively controls autocorrelation and heteroskedasticity, provides consistent coefficient estimates, and performs more reliable Arellano-Bond tests for autocorrelations and Sargent tests for over-identifying restrictions than the original Arellano-Bond (1991). The application of this method is discussed in details in Roodman (2006).

We also carry out the modified Hausman endogeneity test to pinpoint the endogenous variables that need instrumental variables in the procedure for each regression, and so the reduced form for System (1) is:

$$EDU_{it} = \gamma_0 + \gamma_1 EDU_{i,t-1} + \sum_{j=1}^{n} \chi_j C_{jt} + \phi_{it}$$
$$IND_{it} = \kappa_0 + \kappa_1 IND_{i,t-1} + \sum_{k=1}^{m} \eta_k A_{kt} + \theta_{it} \quad (3)$$

Estimating the reduced form using SGMM approach, we obtain the predicted values of *EDU* and *IND* to use as instrumental variables (IVs) for the structural form shown in System (1). We then perform the fixed effect three stage least squares (FE3SLS) estimations, which account for the feedback effects of the two equations in System (1), and so improve the efficiency of the estimators beyond the 2SLS estimations used in Kumar (2003). Finally, any variable that has a p-value greater than 0.50 is eliminated, and a RESET Ramsey test is performed for each system to make sure there is no omitted variable. This yields the final structural form for the model involving industrial output per person:

$$OUTPUT_{it} = \alpha_1 EDUHAT_{it} + \alpha_2 TEL_{it} + \alpha_3 INFRA_{it} + \alpha_4 INIT_i + \alpha_5 EXPN_{it} + u_i + v_t + \varepsilon_{it}$$
$$EDU_{it} = \beta_1 OUTHAT_{it} + \beta_2 EXPN_{it} + \beta_3 TEL_{it} + \beta_4 PEXPN_{it} + w_i + z_t + \psi_{it} \quad , (4)$$

where *OUTPUT* is industrial output per capita, *EDUHAT* and *OUTHAT* are the predicted values of *EDU* and *OUTPUT* obtained from system (3) estimations, respectively; *TEL* is telecommunication; *INFRA* is infrastructure; *INIT* is initial level of development measured by initial level of industrial output per person or initial level of industrialization; *EXPN* is private expenditures; and *PEXPN* is public expenditures on education.

The final structural form for the model involving industrialization level is:

$$INDUS_{it} = \alpha_1 EDUHAT_{it} + \alpha_2 TEL_{it} + \alpha_3 INFRA_{it} + \alpha_4 INIT_i + u_i + v_t + \varepsilon_{it}$$
$$EDU_{it} = \beta_1 INDHAT_{it} + \beta_2 EXPN_{it} + \beta_3 TEL_{it} + \beta_4 PEXPN_{it} + w_i + z_t + \psi_{it} \quad , (5)$$

where *INDUS* is industrialization; and *INDHAT* is the predicted value of *INDUS*. The remaining variables are the same as in System (4).

3. Results and Discussions

Tables 1 and 2 report the estimation results for System (4) involving industrial output per capita and using vocational education and university education data, respectively. The signs of all variables are as expected, and the effects are positive both ways. However, the effect of the human capital accumulated from vocational education on industrial output per capita is much larger than that of the university education. Specifically, the effect of university education is only equal to about seventy percent of the vocational education. Interestingly, the reverse causality runs opposite way: the regional development encourages more people to attend universities than vocational schools. When industrial output per capita increases, it causes university enrollments to increase fifty percent more than the vocational-school enrollments. One more interesting detail is that the effect of the average public expenditure on vocational education is roughly fifty percent higher than its effect on university education.

Tables 3 and 4 report the estimation results for System (5) involving regional industrialization level for vocational education and university education, respectively. Again, the signs of all variables are as expected, and the effects are positive both ways. Here the difference is even more pronounced: while the effect of university education on regional industrialization level is still roughly seventy percent of vocational education, the effect of the industrialization level on university enrollments is twice as large as its effect on vocational enrollments. The impact of average public expenditure on vocational education is also very forceful: it is twice as large as the impact on university education in this case.

The results of the VIF tests for multicolinearity among the explanatory variables are reported in Tables (5.a) for System (4) and (5.b) for System (5), respectively. They show that all VIF statistics for individual variables are far less than 10.00 and average VIF statistics for combined tests of all explanatory variables are also far below the acceptable level of 5.00. Hence, all t-tests, F-tests, and Chi-squared statistics are valid.

One might wonder why university education produces less effect on regional development than vocational education does. After all, it is generally supposed that the higher the education level is, the more productive a person becomes. The problem is that a theoretical and general education approach works only for a small number of students. The rest will forget most theories they learn in schools and end up with no specialized skills to make substantial contribution to the regional development process. Vocational education provides specific skills that are necessary and sufficient for average students to land in jobs suitable to their degrees and make good contribution to the society.

4. Implications

Regarding economic theory, a couple of implications are drawn. First, current development theory holds: a virtuous circle of regional development and education in a cumulative process exists, where education enhancing regional development, which in turn increases education as personal income rises due to higher output per capita. Second, the common belief that industrial development is stimulated more by university than vocational education may not hold. Since the latter provides direct working skills, it may increase industrial output per capita and the industrialization level more than the former. Third, the strong reverse results for university education reflect Vietnamese culture pretty well: the more money people have due to higher level of industrial development, the more they want their children to pursue university education instead of vocational education.

Concerning government policy, several implications are also in order. First, one can see that public expenditures on vocational education are more efficient than on university education: the same amount of money spent increases vocational enrollments roughly 50% to 100% more than university enrollments. Hence, the government might want to establish or support private sector in establishing more vocational school facilities. Second, since vocational education spurs industrial development more than university education, government might want to provide favorable grants to students who wish to go to vocational schools. Third, efforts have to be made in terms of extending information to the public and educators so that people gradually realize that vocational education is not only important to regional development but also helps increases per capita income when output per capita and productivity rise.

Finally, although this paper focuses on vocational versus university education, the results imply that among universities, schools with a more practical or specialized approach to education will help regional development more than the ones with a more theoretical or general approach. Therefore, education reform might want to aim at more practices, internships, and field work than pure theory. While a small number of students might perform exceptionally well in theoretical-oriented schools and will become great scientists, a majority of the students might need the specialized and practical skills in practical-oriented schools to survive. Otherwise, average students with university degrees might end up being sale-men or sale-women instead of getting jobs equivalent to what they spend four hard-working years learning in their respective universities. Investing in human capital is very costly, so education reformers might want to be exceptionally prudent in dictating a major model of education for a majority of the people. This is even more important in a transitional economy than in a developed country, as resources are more limited in the former than in the latter.

5. Conclusion

In this paper, we focus on the effects of human capital accumulated from vocational versus university education on industrial development at provincial level and examine a possible two-way causality between the two variables. The results show that vocational education helps regional development in Vietnam more than university education. On the reverse causality, we find that the effect of regional development on university enrollments is more profound than on vocational-school enrollments.

Future research can decompose the aggregate data into specific region such as the Hồng Delta, Northwest, and South Central, etc. to investigate the effect on each region. When data on numbers of graduates become available, researchers can repeat the above exercises to measure the impact of investment in human capital more accurately than the use of school enrollments. Researchers can also carry out research on the effect of specialized universities versus general universities, which is the second hypothesis drawn from Vũ (1945 and 1946). At this moment, it is hard to quantify how practical a university is so that a rank from the most practical university to the least practical one can be built and quantitative examination can be carried out. This is a challenging task that is beyond scope of this paper■

References

1. Arellano, M., & S. Bond (1991), "Some Test of Specification for Panel Data: Monte Carlo Evidence and an Application for Employment Equations," *The Review of Economic Studies,* 58 (2): 277-297.

2. Bils, M., & P.J. Klenow (2000), "Does Schooling Cause Growth?" *American Economic Review*, 90: 1160-1183.

3. Blundell, R., & S. Bond (1998), "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models," *Journal of Econometrics,* 87: 11–143.

4. Bond, S. (2002), "Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice," CEMMAP working paper; CWP09/, 02.

5. Caselli, F., G. Esquivel, & F. Lefort (1996), "Reopening the Convergence Debate: A New Look at Cross-Country Empirics," *Journal of Economic Growth* 1, 363-389

6. Chen, B. & Y. Feng (2000), "Determinant of Economic Growth in China: Private Enterprise, Education, and Openness," *China Economic Review,* 11 (1): 1-15.

7. Doan, T. (2011), "Labour Market Returns to Higher Education in Vietnam," *eEconomics*, No. 2011-4, 1-23.

8. Demuger, S. (2001), "Infrastructure and Economic Growth: An Explanation for Regional Disparities in China," *Journal of Comparative Economics,* 29: 95-117.

9. Hua, P. (2006), "How Education Influences Productivity Growth? Evidence from the Chinese Provinces," working paper, CERDI-INDIRECT, CNRS-University d' Auvergne.

10. Henaff, N. (2005), "Education and Poverty in Vietnam", *Social Science,* January 2005, 9-26.

11. Hojo, M. (2003), "An Indirect Effect of Education on Growth," *Economics Letters*, 80, 31-34.

12. Islam, N. (1995), "Growth Empirics: A Panel Data Approach," *Quarterly Journal of Economics* 110, 1127-1170.

13. Kennedy, P. (2006), *A Guide to Econometrics,* 6th edition, MIT Press, Cambridge, MA

14. Kumar, K.B. (2003), "Education and Technology Adoption in a Small Open Economy: Theory and Evidence," *Macroeconomic Dynamic,* Vol. 7, No. 4, 586-617.

15. Moock, P., H. Patrinos & M. Venkataraman (1998), "Education and Earnings in a Transition Economy: The Case of Vietnam," World Bank's *Vietnam Education Financing Sector Study*, 1-26

16. Romer, D. (2006), *Advanced Macroeconomics,* McGraw-Hill, Boston.

17. Turpin, T. (2010), "Higher Education and Regional Development: Tension, Challenges, and Options" 8th IDP International Education Conference, University of Western Sydney, 1-9

18. Vũ Đình Hòe (1945), *Những phương pháp giáo dục ở các nước và vấn đề cải cách giáo dục* (Some foreign education methods and the education reform), Thanh nghị Tùng thư, Hà Nội, Việt Nam

19. Vũ Đình Hòe (1946), *Một nền giáo dục bình dân* (On a popular education), Thanh nghị Tùng thư, Hà Nội, Việt Nam

20. Vũ Băng Tâm (2011), "Education and Regional Development in China," The International Conference on Quantitative and Qualitative Economic Research, Singapore, conference proceedings,

21. Vũ Băng Tâm & D. Hammes (2007), "Education and Productivity: A Three Stage Least Squares Estimation," The 10th International Conference for Business and Development, Kyoto, Japan, conference proceedings, 1023-1048.

Table 1: Estimation results for System (4) - Model for vocational education

Panel (1a). Dependent variable: Industrial output per capita				
Variable	Coefficients	Standard error	t-statistics	p-value
Vocational education	.1065**	.0429	.248	.013
Telecommunication	14.748**	2.5262	5.84	.000
Infrastructure	4.43**	.6232	7.11	.000
Private Expenditures	.0932**	.0408	2.34	.020
Initial Level of Industrial Output per person	-.0222**	.00333	-6.66	.000
Root Mean Square Error 1.6870 Adjusted R-squared .8457 p-value for the significance of the model: 0.000 Number of observations: 349 Variance of the residuals: .0201 p-value for the AR(1): .4257 and p-value for the AR(2): .5187 p-value for RESET Ramsey test on omitted variables: .784				

Panel (1b). Dependent variable: Vocational education				
Variable	Coefficients	Standard error	t-statistics	p-value
Industrial output per person	.4209**	.0615	6.83	.000
Private Expenditure	.0494	.0586	0.84	0.400
Telecommunication	8.225**	3.592	2.29	0.022
Public expenditure on education	3.541**	1.0763	3.29	0.001
Root Mean Square Error 2.2417 Adjusted R-squared .8170 p-value for the significance of the model: 0.000 Number of observations: 349 Variance of the residuals: .0312; p-value for White test: .6243 p-value for the AR(1): .5013 and p-value for the AR(2): .6869 p-value for RESET Ramsey test on omitted variables: .539 p-value for RESET Ramsey test on omitted variables: .784				

Note: * and ** denotes 10% and 5% significant levels, respectively.

Table 2: Estimation results for System (4) - Model for university education

Panel (2a). Dependent variable: Industrial output per capita

Variable	Coefficients	Standard error	t-statistics	p-value
University education	.0703**	.0352	1.99	.046
Telecommunication	12.1141**	2.9438	4.16	.000
Infrastructure	4.5582**	.6213	7.34	.000
Private Expenditures	.1645**	.0407	4.04	.000
Initial Level of Industrial Output per person	-.0126**	.0034	-3.71	.000

Root Mean Square Error 1.7408
Adjusted R-squared .8402
p-value for the significance of the model: 0.000
Number of observations: 364
Variance of the residuals: .0198; p-value for White test: .5934
p-value for the AR(1): .3978 and p-value for the AR(2): .5965
p-value for RESET Ramsey test on omitted variables: .671

Panel (2b). Dependent variable: University education

Variable	Coefficients	Standard error	t-statistics	p-value
Industrial output per person	.6803**	.2215	3.07	.003
Private Expenditure	1.199**	.2083	5.76	.000
Telecommunication	33.740**	13.839	2.44	.015
Public expenditure on education	2.0296**	.3616	5.61	.000

Root Mean Square Error 1.2844
Adjusted R-squared .7527
p-value for the significance of the model: 0.000
Number of observations: 364
Variance of the residuals: .0286; p-value for White test: .6487
p-value for the AR(1): .4287 and p-value for the AR(2): .7014
p-value for RESET Ramsey test on omitted variables: .592

Note: * and ** denotes 10% and 5% significant levels, respectively.

Table 3: Estimation results for System (5) - Model for vocational education

Panel (3a). Dependent variable: Industrialization level				
Variable	Coefficients	Standard error	t-statistics	p-value
Vocational education	.0199**	.0043	4.62	.000
Telecommunication	1.451**	.2284	6.35	.000
Infrastructure	.1078**	.0544	1.98	.047
Initial level of industrialization	-.0024**	.0004	-5.76	.000

Root Mean Square Error .1389
Adjusted R-squared .6809
p-value for the significance of the model: 0.000
Number of observations: 349
Variance of the residuals: .0327; p-value for White test: .7013
p-value for the AR(1): .4012 and p-value for the AR(2): .5937
p-value for RESET Ramsey test on omitted variables: .648

Panel (3b). Dependent variable: Vocational education				
Variable	Coefficients	Standard error	t-statistics	p-value
Industrialization level	. 4.1325**	.8211	5.03	.000
Private Expenditure	.0911*	.0524	1.74	.082
Telecommunication	9.6988**	3.769	2.57	0.010
Public expenditure on education	3.0338	1.110	2.73	.006

Root Mean Square Error 2.3816
Adjusted R-squared .7934
p-value for the significance of the model: 0.000
Number of observations: 349
Variance of the residuals: .0235; p-value for White test: .5862
p-value for the AR(1): .4956 and p-value for the AR(2): .6058
p-value for RESET test on omitted variables: .701

Note: * and ** denotes 10% and 5% significant levels, respectively.

Table 4: Estimation results for System (5): Model for university education

Panel (4a). Dependent variable: Industrialization level

Variable	Coefficients	Standard error	t-statistics	p-value
University education	.0139**	.0039	3.58	.002
Telecommunication	1.0641**	.1787	5.96	.000
Infrastructure	.1345**	.0460	2.93	.003
Initial level of industrialization	-.0022**	.0003	-6.93	.000

Root Mean Square Error .1422
Adjusted R-squared .6588
p-value for the significance of the model: 0.000
Number of observations: 364
Variance of the residuals: .0325; p-value for White test: .6498
p-value for the AR(1): .6124 and p-value for the AR(2): .7015
p-value for RESET test on omitted variables: .589

Panel (4b). Dependent variable: University education

Variable	Coefficients	Standard error	t-statistics	p-value
Industrialization level	8.668**	4.1156	2.11	.0035
Private Expenditure	.7044**	.2053	3.43	.001
Telecommunication	13.138**	5.239	2.51	.012
Public expenditure on education	1.501**	.7580	1.98	.047

Root Mean Square Error 1.2973
Adjusted R-squared .7477
p-value for the significance of the model: 0.000
Number of observations: 364
Variance of the residuals: .0226; p-value for White test: .5978
p-value for the AR(1): .4976 and p-value for the AR(2): .5985
p-value for RESET Ramsey test on omitted variables: .723

Note: * and ** denotes 10% and 5% significant levels, respectively.

Table 5.a: VIF Tests for multicolinearity - System (4)
First equation. Dependent variables: Industrial output per capita

Variable	VIF	1/VIF
Telecommunication	4.30	0.2328
Vocational education	2.96	0.3375
Private expenditures	2.30	0.4348
Infrastructure	1.69	0.5926
Initial industrial output per capita	1.17	0.8527
Mean VIF	2.48	
Second equation. Dependent variable: Vocational education		
Private expenditures	2.75	0.3642
Telecommunication	2.47	0.4041
Industrial output per capita	1.57	0.6351
Public expenditure	1.31	0.7633
Mean VIF	1.83	

Table 5.b: VIF Tests for multicolinearity - System (5)
First equation. Dependent variable: Industrialization level

Variable	VIF	1/VIF
Vocational education	3.91	0.2555
Telecommunication	2.94	0.3397
Infrastructure	1.91	0.5226
Initial level of industrialization	1.14	0.8793
Mean VIF	2.48	
Second equation. Dependent variable: Vocational education		
Telecommunication	3.05	0.3275
Private expenditure	2.57	0.3884
Industrialization level	1.80	0.5552
Public expenditure	1.33	0.7518
Mean VIF	2.1	