Physical Capital and Economic Development in Vietnam

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ABSTRACT

In this paper, we investigate the effect of physical capital on economic growth using sectoral data for Vietnam. A common problem with this topic is the nonexistence of capital data. Hence, we introduce a new method to obtain the coefficient of capital growth without the need to obtain capital data. The results show that the effects of capital growth on economic growth for the period 1990-2002 are higher than those of the period 2000-2010. We also find that the effects are very different for individual sectors in the economy. Based on these results, we offer theoretical and policy implications for capital growth and economic development in Vietnam.

Keywords: capital growth estimation, rate of return, production function.

1. INTRODUCTION

Physical capital, human capital, and labor are the three most important factors affecting economic development in any nation. This paper focuses on physical capital (henceforth called capital) and output per person in Vietnam. Since Vietnam is a developing country, it is very important to see if capital is used efficiently so that improvement in capital management can be carried out.

However, it is not easy to obtain capital data for estimation. Although data about investment are available, "investment" is a flow variable that cannot be used in a production function in lieu of "capital," which is a stock variable. Researchers are interested in estimating capital stocks for different countries, regions, and industries for various reasons and purposes as discussed in Dadkiah and Zahedi (1990), Hulten and Wykoff (1981), C.R. Hulten (1991), Prucha (1997), Gábor Pula (2003), Ward (1973), and OECD manuals (2001, 2009) to name but a few. However, capital estimates are so sensitive to underlying assumptions and definition of capital stock that the estimated capital/output ratios widely vary from 0.8 to 3.2 as observed in Pula (2003). Thus, it would not be an overstatement that capital stock is an economic variable most elusive and agonizingly difficult to measure or estimate.

In this paper, we introduce a new method to obtain the growth of capital per person without the need to obtain capital data. We then analyze the effect of capital growth on the value-added growth for various sectors in Vietnam.

2. MODEL AND DATA

We use the Cobb-Douglas production function with a constant return to scale:

$$Y_t = Ae^{\tau t} K_t^{\alpha} L_t^{1-\alpha} \tag{1}$$

where $\theta \equiv (A, \tau, \alpha)'$ is a vector of unknown parameters whose estimations require observations on Y_t (total value added in this paper), K_t (capital), and L_t (labor). If we can estimate θ in Equation (1) without using K_t, then growth rate of K_t can be deduced from Equation (1) as long as data on Y_t and L_t are available. To demonstrate such a possibility, we first rewrite Equation (1) with subscript t suppressed until necessary:

$$y = Ae^{\tau t} k^{\alpha} \tag{2}$$

where $y = Y / L$ and $k = K / L$.

Then

$$\Delta y = \frac{\partial y}{\partial k}\Delta k = A\alpha e^{\tau t} k^{\alpha-1}\Delta k \ .$$

where Δk denotes change in capital per person or investment per person and Δy the corresponding change in value added per person.

Since investment at the macro level is made ultimately at expense of the *same amount* of consumption in the same period, Δk not only represents investment but simultaneously represents the opportunity cost in terms of consumption foregone. Therefore, the return to investment Δk, denoted by $\Delta \pi$ below, must be equal to the difference between Δy and Δk so that

$$\Delta \pi = \Delta y - \Delta k = Ae^{\tau t}\alpha k^{\alpha-1}\Delta k - \Delta k = \left(Ae^{\tau t}\alpha k^{\alpha-1} - 1\right)\Delta k \ .$$

Hence, the rate of return of investment Δk is expressed as

$$\rho \equiv \Delta \pi / \Delta k = Ae^{\tau t}\alpha k^{\alpha-1} - 1 \qquad (3)$$

If investment in each time period is to maximize the return, the investment must expand up to the point where the rate of return equals annual real interest rate (r), i.e., $\rho = r$, so that ρ in Equation (3) can be replaced by real interest rate r,

$$r = Ae^{\pi}\alpha k^{\alpha-1} - 1. \qquad (4)$$

Solve for k:

$$k = \left(\frac{1+r}{Ae^{\tau t}\alpha}\right)^{\frac{1}{\alpha-1}} = \left(A^{-1}e^{-\tau t}\alpha^{-1}\right)^{\frac{1}{\alpha-1}}(1+r)^{\frac{1}{\alpha-1}} = A^{\frac{1}{1-\alpha}} e^{\frac{\tau}{1-\alpha}t} \alpha^{\frac{1}{1-\alpha}} (1+r)^{\frac{1}{\alpha-1}} \qquad (5)$$

Substitute k into Equation (2) and solve for y:

$$y = A^{\frac{1}{1-\alpha}} e^{\frac{\tau}{1-\alpha}t} \alpha^{\frac{\alpha}{1-\alpha}} (1+r)^{\frac{\alpha}{\alpha-1}} \qquad (6)$$

Take logarithm of Equation (6):

$$\ln y = \beta_o + \beta_1 t + \beta_2 \ln(1+r) \qquad (7)$$

where

$$\beta_o \equiv \frac{1}{1-\alpha}\ln A; \quad \beta_1 \equiv \tau/(1-\alpha); \quad \beta_2 \equiv \alpha/(\alpha-1) \tag{8}$$

Solve for α from Equation (8):

$$\alpha = \beta_2/(\beta_2 - 1) \tag{9}$$

Since the conventional equation for economic growth is

$$G_Y = G_A + \alpha G_K + (1-\alpha)G_L \tag{10}$$

where G_Y is growth of total value added in this paper, G_A is growth of technology, G_K is growth of capital, and G_L is growth of labor, the parameter α is the growth of capital that contributes to growth of total value added. Estimate equation (7) will provide information for calculating capital growth per person using Equation (9) without the need of collecting data on capital.

Data about real value added, employment, and real interest rates for 1990-2002 are from IMF Country Report Annex. Data about value added are for nine economic sectors, but data about employment are only for seven sectors, so we only perform estimations using seven sectors for this period. Data on real value added for nineteen sectors from 2000 to 2010 are from Vietnamese Statistical Yearbook. Data about employment are only available for nine sectors during this period, and only eight sectors match data about value added, so we only perform estimations using eight sectors for the later period. Data about real interest rates from 2000 to 2010 are from the World Bank. We then generate dummies for respective sectors to account for the different effects on individual sectors in the economy.

3. RESULTS AND DISCUSSIONS

We estimated Equation (7) using the aforementioned data. The Hausman tests show that the fixed effect is the most appropriate approach for handling of these two data sets. The modified Hausman tests do not reveal any endogenous variables, so two-stage least square approach (2SLS) is not needed. Feeding elements in $\hat{\beta}$ into Equation (9), we obtain parameters to use in Equation (10) for the effects of capital growth on value-added growth or its per worker form. Im and Vu (2012) have shown that our method yields the empirical results for the US capital data that are very similar to the existing results in Pula (2003) and Summers-Heston (1991) using different methods. Hence, we have a basis to believe that our method will be reliable to estimate capital growth in Vietnam.

The aggregate results for the variables in Equation (7) and derived coefficient for capital growth per person are reported in Table 1. They show that capital growth accounts for 33.59% of value-added growth per person in Vietnam during 1990-2002 (Column 1.1) but only 19.94% of this growth during 2000-2010 (Column 1.2). Since the effect of capital growth on output growth in the world is roughly 33%, it implies that the result for the later period in Vietnam is much lower than the world average. This is not a good sign and reflects either the lack of capital or the inefficient use of capital in the later period. Since Vietnam appeared not in shortage of capital during most years of the period 2000-2010, the second reason might be more acceptable to the researchers.

Using industrial sector as the base group, we generate six sectoral dummies for 1990-2002, consisting of construction, transportation-communication, trade-repair-vehicles, education-health-arts, agriculture-fishery-forestry, and “other economic sectors.” The results for individual sectors are reported in Table 2, Column 2.1. They show that the coefficient of industrial sector is 13% higher than the world average. The most efficient sector is education-health-arts, of which the coefficient is 14% higher than that of the industrial sector and significantly so. The “other economic sectors” has the coefficient statistically similar to that of the industrial sector. The remaining sectors have the coefficients lower than the base group and statistically significantly so. The ranking of the remaining sectors, from the highest to the lowest coefficients, is in this order: trade, construction, transportation, and agriculture-fishery-forestry.

Continuing to use industrial sector as the base group, we generate seven sectoral dummies for 2000-2010, including food-accommodation, construction, transportation-storage-information, trade, education-health-culture, agriculture-fishery-forestry, and “other economic sectors.” The results are reported in Table 2, Column 2.2. The ranking of the sectors is similar to those in Column 2.1 with two exceptions: (1) the food-accommodation is a new sector, which has the coefficient of 19%, lower than that of the base; (2) the education-health-culture sector and trade sector now have coefficient statistically similar to that of the base. Overall, coefficients for all sectors in this period are much lower than those in the earlier period.

There are three possible explanations for this situation. First, high public debt might have caused nominal interest rate to rise during 2009-2010 and so many firms could not afford to borrow. Second, high inflation during 2008-2010 caused real interest rate to fall and made it difficult for banks to attract deposits. Finally, capital was not used efficiently due to economic instability influenced by the worldwide financial crisis of 2007- 2008, corruption, or weak management by Vietnamese businesses. Although Vietnam has relied heavily on capital for its growth, the results imply that businesses might start to face shortage of capital and might suffer the same situation in the near future.

4. CONCLUSION AND POLICY IMPLICATIONS

Theoretically, the results imply that parameters underlying a production function can be indirectly estimated without observations on the capital stock. This in turn facilitates the analysis of capital growth and output growth. The approach can also generate a reasonable capital series as shown in Im and Vu (2012) without having to make one or more disputable assumptions in conventional approaches.

There are several policy implications. First, the Vietnamese government might want to reduce public debt in order to reduce nominal interest rate and make investment affordable to business owners. Second, the central bank needs to control inflation in Vietnam in order to raise real interest rate, attract household savings, and make it easy for the private banks to attract financial capital. Finally, both central and local governments need to strengthen their fights against corruption and encourage business owners to obtain good knowledge of capital management in order to use capital more efficiently. This is especially important for agriculture-fishery-forestry sector, which is usually located in regions far from big cities and comprises a large percentage of poor households. Since poor households do not possess much capital, it is imperative that they learn how to use it efficiently in order to increase capital productivity and the subsequent value added. Physical capital will remain one of the three important factors of production and so using it efficiently will help reduce poverty and strengthen economic development in Vietnam.

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Table 1: Results for Equation (7) and Aggregate Effects of Capital Growth on Growth of Per Capita Output

Dependent variable: log of value added per person.

Variable	**Column 1.1. Period 1990-2002**		**Column 1.2. Period 2000-2010**	
	Coefficient	**p-value**	**Coefficient**	**p-value**
Trend	0.0718***	0.002	0.0795***	0.000
Log of interest rate	-0.5059***	0.010	-0.2491**	0.014
Growth of capital	0.3359**	0.012	0.1994**	0.015
Sample Size	91		87	
Prob. > F	0.000		0.000	
Average R-Square	0.6118		0.6096	
White test: p-value	0.2497		0.3142	
Autocorrelation coefficient	0.3281		0.4765	

Note: ** and *** denote statistical significance at 5% and 1% levels, respectively. Coefficients for growth of capital are calculated using Equation (9), and p-values of the Wald tests for the significance of these coefficients are reported.

Table 2: Sectoral Effects of Capital Growth on Growth of Per Capita Output
Dependent variable: log of value added per person for each sector.

Variable	Column 1.1. Period 1990-2002		Column 1.2. Period 2000-2010	
	Coefficient	p-value	Coefficient	p-value
Industry (base group)				
Log of interest rate	-0.8714***	0.001	-0.5248***	0.001
Capital growth	0.4656**	0.043	0.3442***	0.005
Food-accommodation				
Log of interest rate			-0.1757***	0.007
Capital growth			0.1494**	0.035
Construction				
Log of interest rate	-0.2283***	0.000	-0.2012**	0.012
Capital growth	0.1859**	0.021	0.1675**	0.024
Transportation-communication				
Log of interest rate	-0.1652**	0.031	-0.1606***	0.003
Capital growth	0.1418**	0.016	0.1384**	0.043
Trade-repair-vehicles				
Log of interest rate	-0.2596**	0.048	-0.5648**	0.037
Capital growth	0.2061***	0.009	0.3609***	0.004
Education-culture-health				
Log of interest rate	-10.5233**	0.032	-0.5849**	0.021
Capital growth	0.6037**	0.028	0.3691**	0.038
Agriculture-fishery-forestry				
Log of interest rate	-0.1248**	0.018	-0.1159***	0.003
Capital growth	0.1110***	0.006	0.1039**	0.029
Other economic sectors				

Log of interest rate	-0.9246***	0.007	-0.5752**	0.034
Capital growth	0.4807**	034	0.3648***	0.008
Sample Size	91		87	
Prob. > F	0.000		0.000	
Average R-Square	0.7542		0.7231	
White test: p-value	0.3512		0.4958	
Autocorrelation coefficient	0.2867		0.5201	

Note: ** and *** denote statistical significance at 5% and 1% levels, respectively. Coefficients for growth of capital are calculated using Equation (9), and p-values of the Wald tests for the significance of these coefficients are reported.