Human Capital, Labour Productivity and Employment*

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Abstract

This paper analyses the importance of human capital in determining the inter-state differences in labour productivity and its growth in India. The paper also examines the impact of human capital differences on the growth of employment for a cross section of Indian states for the period 2003-2007. It argues that the current technology is human capital and knowledge intensive and cannot be used in the absence of skill development. Due to the presence of skill bias in the new technology, persons with less education would become victims. The panel model results of Generalised Least Squares using cross section weights show that after controlling for other determinants, variables representing human capital emerge significant determinants of productivity. Furthermore, higher enrolments in high schools not only contribute to higher labour productivity but also to higher growth in productivity. In addition, states that have higher high school enrolment rates have been enjoying higher growth rates of employment. On the whole the results presented show strong skill bias in productivity and employment growths across states.

I Introduction

This paper analyses the crucial role played by human capital in determining the inter-state differences in labour productivity and its growth in India. In addition, the paper deals with the impact of human capital differences on the growth of employment for a cross section of Indian states for the period 2003-2007. Labour productivity has been taken-up for analysis, as sustained growth of per capita income is not possible without growth in labour productivity. It can be shown that per capita income is a product of labour productivity and the share of labour force in

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population.[1] Since the share of labour force in population cannot be altered in the short and medium runs, per capita income cannot increase without an increase in labour productivity. Furthermore, due to the presence of decreasing returns to scale, sustained growth of income is not possible merely by increasing investments in capital stock.

It is, therefore, argued that for sustained growth of per capita income, investment has to be accompanied by technological change. Hence, studies emphasise the crucial role of technology and innovations in promoting growth (Grossman and Helpman, 1991; Mankiw, Romer and Weil, 1992; Romer 1994; Helpman, 1998). In this context it is important to note that the current technology, which is human capital and knowledge intensive, cannot be used in the absence of skill development. Several studies show presence of skill bias in the new technology and argue that persons with less education would remain unemployed (Salvanes and Forre, 2003). Feliciano (2001) found increased wage inequalities in Mexico due to new technology and liberalisation of the economy. For the Latin American countries, in general, Kim (1998) found that the inflow of investments consequent to liberalisation created jobs mainly for skilled labour. For India, Pandit and Siddharthan (2008) showed that employment increased mainly in skill and technology intensive industries.

II Skill Biased Development

The current technological revolution based on knowledge based information and communications technology (ICT) is not confined to a particular sector but cuts across virtually all sectors and industries. It is more of a technological fusion. This characteristic of the ICT

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[1] If Y = income of the state, POP = Total population of the state, LAB = Workforce of the state, then one can write Y/POP = Y/LAB × LAB/POP where Y/POP is per-capital income, Y/LAB is labour productivity and LAB/POP is proportion of workers in total population.

technology has introduced a skill bias across industries and nations. Several studies show that the current technology is more skewed towards more educated workers and the less educated workers could become victims of the new technology. For Korea, Jung and Choi (2006) show skill bias in the use of ICT and consequent structural shift resulting in a higher demand for highly-skilled and high-paid jobs, thereby widening the gap in employment opportunities. This result has been further confirmed for Brazilian and Indian firms by Harrison (2008). His results based on firm level econometric evidence suggest that for Brazil and India new developments in ICT is diffusing rapidly across manufacturing sectors resulting in enhanced demand for skilled workers.

There are several ways of measuring skill content of the work force. One measure that has turned important in analysing skill bias has been percentage of workers who have completed high school education. In the absence of direct information on skill formation in India, Maiti and Mitra (2010) have considered education, specifically, enrolment ratio in engineering and management studies, as a proxy for available skill formation. They argue that with higher levels of education the quality of labour, and thereby their employability in the formal sector of the economy, would be enhanced. Ciccone and Papaioannou (2009) document higher growth rate in schooling intensive industries. To successfully participate in the current revolution it is essential to have significant proportion of the workforce trained to at least high school level. Furthermore, there is evidence to show that international trade, and even trade between identical countries, can raise the relative demand for skilled labour (Epifani and Gancia, 2008). By and large, countries with higher endowments of skilled labour will benefit from the current technological scene.

There is also evidence to show that trade and investment liberalisations undertaken by countries to integrate themselves with the global economy could also increase the skill bias.

Several studies reveal that human capital is a statistically significant determinant of foreign direct investment (FDI) flows. Furthermore, its importance has been increasing over time (Noorbakhsh, Paloni and Youssef, 2001). The inter-industry and country determinants of the US outward FDI flows are also influenced by the skilled labour abundance of the host country and industries (Yeaple, 2003). For ASEAN countries there is evidence that human resource competitiveness influences FDI inflows to various countries (Yussof and Ismail, 2002). Even within a country labour quality could influence inter-province distribution of FDI. Gao (2005) illustrates evidence from Chinese provinces. Furthermore, FDI could also contribute to the skill intensity in countries that already have reasonable skill endowments (Doctor, 2007). Thus, FDI not only goes to countries and regions that have high skilled workforce, it also helps in the further improvement of the skill content of the workforce.

In sum, evidence from earlier studies suggests human capital positively influences productivity, growth, employment and FDI. This relationship is mainly attributed to the skill bias in the use of ICT, which is extensively used in most of the sectors and countries. In this paper we hypothesise a positive relationship between the skill content of the workforce and labour productivity, growth of productivity and employment. We measure inter-state differences in skill intensity through the schooling environment prevalent in the state, namely, percentage of the population attending schools in the age group of 14 to 18 years. We argue that this ratio is an indicator of the importance given by the state government to human capital development and supply of educated workforce to industry. States that have been emphasising secondary and higher education will also experience higher levels of labour productivity, higher growth of labour productivity and higher growth of employment. Indian states that have been neglecting high school education will become victims of the current technological revolution and will not only experience lower productivity levels but also lower growth rates in employment, as employment opportunities for less than high school educated persons are limited.

Two measures are used to indicate labour productivity.

1. Value added divided by the number of workers employed. This measure is used by several studies and we also use this definition. However, this measure has several limitations. Workers differ significantly, and consequently differ in their emoluments. It is important to take into account the heterogeneity of work force in the current context. To overcome this limitation of the first measure of labour productivity some studies have used another indicator (Caves, 1992; Ray, 2004; Siddharthan and Lal, 2004).

2. Value added per unit cost of labour, that is, value added by the amount spent on labour. This measure is the inverse of efficiency wage. It is argued that firms should be more interested in the productivity of the amounts they spend on labour rather than on an indirect measure of productivity of a representative person they have been employing.

In this paper both the measures have been employed. However, the results do not differ much when either of the two measures is employed.

III The Model and the Determinants of Productivity

The model used in this paper follows the standard production function approach, where

$$VA = f(L, C, Z) \qquad \text{--- (i)}$$

VA is value added, L is labour, C is capital, and Z denotes other variables influencing value added (output). Since the dependent variable in this paper is labour productivity, L is brought to the left hand side and labour productivity, VA/L, is expressed as a function of choice of technology as represented by fixed capital-labour ratio (FCL) and other variables that affect labour productivity.[2]

$$VA/L = F(C/L, W) \qquad \text{--- (ii)}$$

The other variables (W) include environmental differences among states relating to human capital. Thus, in addition to capital intensity, state level differences in milieu relating to human capital, presence of foreign direct investments, export orientation, industrialisation and urbanisation will also influence labour productivity. The state level background settings are denoted by:

1. Skill measured by proportion of the age group of 14-18 years attending schools (EDU 14-18).
2. Infant mortality rate (IMR).
3. Foreign direct investment to fixed capital ratio (FDI-FC).
4. Share of industries in the state domestic product (ISHARE)
5. Share of urban population to total population (URBTOT).
6. Ratio of exports to state domestic product (X-INT).

The first two variables are used to indicate the quality of labour force in the state. States with a higher proportion of the population (in the respective age groups) attending high schools are likely to be endowed with better skilled workforce compared to states with poor attendance in schools. Likewise, infant mortality rate captures the general level of health, nutrition and

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[2] Following standard practice (Kokko Tansini and Zejan, 1996; Buckley, Clegg and Wang, 2002; Liu, 2008) one can also derive equation (ii) using standard production function.

wellbeing of the population in the state. Low infant mortality rate would indicate better nutrition, health facilities and hygiene. Workforce from states with better nutrition and health facilities are likely to be of a better quality. Life expectancy could also indicate better health and nutrition among the workforce but annual time series for this variable is not available for all the states, hence this could not be used.

The literature on FDI productivity spillovers is very rich and several studies show a positive relationship between FDI and labour productivity (Kathuria, 2002; Liu, 2008). Hence, in this paper the share of FDI in fixed capital is used to denote the presence of FDI in the industrial sector of the state. We expect states with higher presence of FDI in the industrial sector to have higher levels of labour productivity, given other variables. Studies also link labour productivity with agglomeration effects and expect states with higher urbanisation and higher share of industries to enjoy higher productivity levels (Fujita, Krugman and Venables, 1999; Rosenthal and Strange, 2003; Audretsch and Lehmann, 2005; Okada and Siddharthan, 2008). Variables 4 and 5 have been introduced to capture this effect. Furthermore, some studies link labour productivity with exports. They argue that higher exports reveal international competitiveness and the use of state of the art technology. Variable 6 is used to capture this effect.

The following equations have been estimated:

(1) $LPL = \alpha_0 + \alpha_1 FCL + \alpha_2 EDU14\text{-}18 + \alpha_3 FDI\text{-}FC + \alpha_4 IMR + \alpha_5 ISHARE + \alpha_6 X\text{-}INT + \alpha_7 URBTOT + u_1$

(2) $LPE = \beta_0 + \beta_1 FCE + \beta_2 EDU14\text{-}18 + \beta_3 FDI\text{-}FC + \beta_4 IMR + \beta_5 ISHARE + \beta_6 X\text{-}INT + \beta_7 URBTOT + u_2$

(3) $GLPL = \gamma_0 + \gamma_1 GFCL + \gamma_2 EDU14\text{-}18 + \gamma_3 FDI\text{-}FC + \gamma_4 IMR + \gamma_5 ISHARE + \gamma_6\ X\text{-}INT + \gamma_7 URBTOT + u_3$

(4) $GLPE = \delta_0 + \delta_1 GFCE + \delta_2 EDU14\text{-}18 + \delta_3 FDI\text{-}FC + \delta_4 IMR + \delta_5 ISHARE + \delta_6\ X\text{-}INT + \delta_7 URBTOT + u_4$

(5) $GEMP = \varepsilon_0 + \varepsilon_1 GFCL + \varepsilon_2 EDU14\text{-}18 + \varepsilon_3 GFDI + \varepsilon_4 ISHARE + \varepsilon_5 URBTOT + u_5$

Where, all the five equations are based on the standard panel data regression model (Baltagi, 2005).[3] The dependent variables in these five equations are labour productivity levels (LPL and LPE), growth in labour productivity (GLPL and GLPE) and growth in employment (GEMP). The explanatory variables are fixed capital-labour ratio (FCL and FCE), growth in fixed capital-labour ratio (GFCL and GFCE), skill content of the workforce in the state represented by the proxy variable of enrolment of children in schools in the age group of 14-18 (EDU14_18), foreign direct investments to fixed capital ratio (FDI-FC), infant mortality rate (IMR) representing the general quality of workforce in the state, agglomeration effects captured by industry share in the state's GDP (ISHARE), ratio of urban to total population (URBTOT) and international orientation of the state, namely, exports to state product ratio (export intensity X_INT). The definitions and the sources of data for these variables are discussed in the following section.

We expect α_1, β_1, γ_1, and δ_1 to have positive signs indicating an increase in labour productivity consequent to an increase in capital stock. However, the sign of ε_1 could be negative

[3] For simplicity, the subscripts representing cross-section and time for each of the variables have been dropped. We have used EViews7 software for estimation. We have assumed the presence of cross-sectional heteroskedasticity and hence, the econometric models have been estimated using feasible generalized least squares (FGLS) procedure allowing for cross-sectional fixed effects with cross-sectional weights.

as increase in capital stock need not result in an increase in employment. Growth of capital stock could result in a substitution of capital for labour and this could result in a decline in the growth of employment.

We expect the coefficients of IMR in all the equations to be negative. Here, high infant mortality rate would indicate lower levels of health care and nutrition in the state. We expect higher labour productivity in states having a healthy labour force. The rest of the coefficients should have a positive sign as we expect education (influencing skill intensity of the labour force), FDI, exports, and agglomeration benefits indicated by urbanisation and share of industry in the state income to favourably influence labour productivity and employment.

III Sample, Data and Variables

The sample used in this paper is a balanced panel consisting of 21 states from India for a period of five years (2003-2007). These 21 states are Andhra Pradesh, Assam, Bihar, Chhattisgarh, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttarakhand, Uttar Pradesh and West Bengal. The union territories have been excluded as they have few manufacturing industries. Similarly, all the north-eastern states except Assam have been excluded for the same reason. The data sources used in the study are:

1. Value added, total persons engaged, total emoluments, fixed capital and net fixed capital formation – Source: The annual survey of industries (ASI).

2. Gross state domestic product (GSDP) at factor cost by industry of origin at current prices and share of industry in GSDP – Source: The national accounts data from central statistics office (CSO) under the Ministry of Statistics and Programme Implementation, Government of India.

3. State-wise gross-enrolment ratios, state-wise stock of foreign direct investments, state-wise value of total exports and index numbers of whole sale prices (for all commodities and for machinery & machine tools) – Source: Indiastat.com

4. Infant mortality rate (IMR) – Source: Various issues of sample registration system (SRS) bulletins from Registrar General.

5. State-wise distribution of urban and total population – Source: "Population projections for India and states 2001-2026", report of the technical group on population projections constituted by the national commission on population May 2006, office of the registrar general & census commissioner, India.

The information collected through the above five sources have been used to construct the following variables for each of the 21 states:

LPL = Labour Productivity (Definition 1) = Net Value Added / Total Persons Engaged

LPE = Labour Productivity (Definition 2) = Net Value Added / Total Emoluments

GLPL = Growth in Labour Productivity (Definition 1) = (Labour Productivity (Definition 1) in Current Year – Labour Productivity (Definition 1) in Previous Year) / Labour Productivity (Definition 1) in Previous Year

GLPE = Growth in Labour Productivity (Definition 2) = (Labour Productivity (Definition 2) in Current Year – Labour Productivity (Definition 2) in Previous Year) / Labour Productivity (Definition 2) in Previous Year

GEMP = Growth in Employment = (Total Persons Engaged in Current Year – Total Persons Engaged in Previous Year)/Total Persons Engaged in Previous Year

FCL = Fixed Capital per Labour = Fixed Capital/Total Persons Engaged

FCE = Fixed Capital per Unit Cost of Labour = Fixed Capital/Total Emoluments

GFCL = Growth in Fixed Capital per Labour = (Fixed Capital per Labour in Current Year – Fixed Capital per Labour in Previous Year)/Fixed Capital per Labour in Previous Year

GFCE = Growth in Fixed Capital per Unit Cost of Labour = (Fixed Capital per Unit Cost of Labour in Current Year – Fixed Capital per Unit Cost of Labour in Previous Year)/Fixed Capital per Unit Cost of Labour in Previous Year

EDU14-18 = Skill = Gross Enrolment Ratio in Classes IX-XII (14-18 years)

FDI-FC = Ratio of Foreign Direct Investments to Fixed Capital = Stock of Foreign Direct Investments/Fixed Capital

GFDI = Growth in Foreign Direct Investments = (Stock of Foreign Direct Investments in Current year – Stock of Foreign Direct Investments in Previous Year)/Stock of Foreign Direct Investments in Previous Year

IMR = Infant Mortality Rate which is an indicator of the level of health = Number of Deaths of Infants under one year old per 1000 live births in a given year

ISHARE = Industrialization = Amount of Gross State Domestic Product due to Industry Sector/Gross State Domestic Product

X-INT = International Orientation of the State = Value of Total Exports/Gross State Domestic Product[4]

URBTOT = Urbanization = Urban Population/Total Population

The variables have been used in current and constant prices. Tables 1a and 2a present the results at current prices and Tables 1b and 2b at constant prices. In an era of fast technological changes deflation by price index (constant prices) could create problems as index number of prices does not take into account changes in quality of the goods. The rapid increase in the use of numerically controlled machines and computer aided manufacturing goes against the assumption of 'no change in quality' over the years. Hence, measuring variables at current prices would be more appropriate in the current era of rapid technological change. Nevertheless, we have also estimated the models using constant prices.[5] However, the results do not differ much in both the versions.

IV Results

The panel model results of Generalised Least Squares using cross section weights are presented in Tables 1 and 2. Table 1a and Table 1b present the results of determinants of interstate differences of labour productivity. Similarly, Table 2a and Table 2b present the results of determinants of growth of labour productivity and growth of employment.

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[4] Value of exports was available in the data source only for the years 2003, 2006 and 2007. Hence, first the ratio of exports to gross state domestic product was calculated and then the ratio was interpolated for the year 2004 and 2005 by considering a linear trend between 2003 and 2006.

[5] Labour productivity (definition 1) at constant prices has been calculated by deflating the net value added by the wholesale price index after shifting the index base to the year 2002-03. Fixed capital has been calculated at constant prices using the perpetual inventory method (Liu, 2008).

Table 1a

Determinants of inter-state differences in labour productivity (At Current Prices)

Panel EGLS (Cross-section weights)

Equation No	1	2	3	4
Variables	LPL	LPL	LPE	LPE
C	0.826	-19.651***	1.401	-13.379***
FCL	0.371***	0.259***		
FCE			0.193***	0.162**
EDU 14-18	0.015*	0.024**	0.023*	0.044***
FDI-FC	0.922	-1.375	0.321	-1.418
IMR	-0.053***		-0.055**	
ISHARE	5.429**	3.799	8.401***	5.648**
X-INT	2.961***		2.630**	
URBTOT		0.697***		0.460***
R^2	0.929	0.945	0.884	0.898
NOBS	105	105	105	105

Note: *, **, *** significance at 10, 5 and 1 percent levels. LPL Labour productivity using number of workers and LPE is labour productivity using emoluments (productivity per rupee spent on labour – inverse of efficiency wage).

Table 1b

Determinants of inter-state differences in labour productivity (At Constant Prices with base year 2002-03)

Panel EGLS (Cross-section weights)

Equation No	1	2
Variables	LPL	LPL
C	0.667	-10.048***
FCL	0.208***	0.214***
EDU 14-18	0.014	0.021**
FDI-FC	-0.997	-1.681 **
IMR	-0.021	
ISHARE	5.493***	2.861*
X-INT	2.09***	
URBTOT		0.373***
R^2	0.936	0.955
NOBS	105	105

Note: *, **, *** significance at 10, 5 and 1 percent levels. LPL is Labour productivity using number of workers.

As discussed in the earlier sections, two definitions of labour productivity have been used in the study– 1. Value added per number of workers, and 2. Value added by wages and salaries paid to employees, that is, productivity of rupee spent on workers. In table 1a, equations 1 and 2 present the determinants of LPL (value added per labour) and equations 3 and 4 present determinants of LPE (productivity of rupee spent on labour). All the statistically significant coefficients in table 1a have expected signs. As anticipated, capital intensity as measured by FCL or FCE is an important determinant of labour productivity and has a positive sign. States that have a higher share of urban population and industrialisation enjoy higher productivities due to agglomeration advantages. Furthermore, the states where the firms export more also experience higher productivities. The crucial role of human capital in influencing labour productivity is revealed in tables 1a and 1b. After controlling for other determinants, variables representing human capital status in the state, namely, percentage of population in the age group of 14-18 attending schools and the health and nutrition indicator represented by infant mortality rate emerge significant determinants of productivity.

Most of these results hold true even when the regression models are estimated with labour productivity and fixed capital-labour ratio at constant prices. The only striking difference that emerges is with regards to the statistically significant negative coefficient on FDI-FC variable in equation 2 of table 1b. Having established this, we wish to investigate whether human capital also influences growth of productivity and employment among states. Table 2 deals with these issues.

Table 2a

Determinants of inter-state differences in the growth of labour productivity and employment (At Current Prices)

Panel EGLS (Cross-section weights)

Equation	1	2	3
	GLPL	GLPE	GEMP
C	5.100***	4.044***	-2.980***
GFCL	0.399**		-0.145***
GFCE		0.606***	
EDU14-18	0.014***	0.014***	0.0017**
FDI-FC/GFDI†	0.968*	1.088**	-0.002***
IMR	-0.034***	-0.029***	
ISHARE			0.245**
X-INT	0.374	0.364	
URBTOT	-0.147***	-0.120***	0.104***
R^2	0.706	0.766	0.803
NOBS	84	84	84

Note: *, **,*** significance at 10, 5 and 1 percent levels. GFDI† is relevant to GEMP equations. GLPL Growth of labour productivity using number of workers. GLPE growth of labour productivity using emoluments (productivity per rupee spent on labour – inverse of efficiency wage).

Table 2b

Determinants of inter-state differences in the growth of labour productivity and employment (At Constant Prices with base year 2002-03)

Panel EGLS (Cross-section weights)

Equation	1	2
	GLPL	GEMP
C	3.230***	-2.967***
GFCL	0.237	-0.359***
EDU14-18	0.012***	0.003***
FDI-FC/GFDI†	0.789	-0.003***
IMR	-0.023**	
ISHARE		0.486***
X-INT	0.395	
URBTOT	-0.097***	0.099***
R^2	0.646	0.873
NOBS	84	84

Note: *, **, *** significance at 10, 5 and 1 percent levels. GFDI† is relevant to GEMP equations. GLPL Growth of labour productivity using number of workers.

In Table 2a, the first two equations deal with the growth of labour productivity and the third equation with the growth of employment. The results of the GLPL and GLPE equations are similar. The growth of fixed capital strongly influences labour productivity and the influence is stronger in the GLPE equation. Urbanisation variable has a negative sign, perhaps indicating catching-up of the productivity levels by units in less urban states.

Human capital variable, namely, high school enrolment rate is significant in the growth of productivity equations also. Thus higher enrolments in high schools not only contribute to higher labour productivity but also to higher growth in productivity. This result brings out the crucial role played by the human capital variable in enhancing productivity and its growth. Furthermore, IMR has a strong negative influence on the growth of productivity. Thus states that have been spending on health and hygiene and having healthier population have been experiencing higher productivity growth rates. The policy implication is that the states need to invest in human capital to enhance productivity levels and without enhancing productivity levels per capita income cannot be enhanced and sustained. Thus mere investment in physical capital is not sufficient and investment in human capital is a must.

Equation 3 of table 2a deals with the growth of employment. Increase in capital intensity (GFCL) affects employment adversely due to the substitution of capital for labour. Growth of employment is more in the urbanised states and in the industrialized states. However, FDI does not seem to contribute to the growth of employment. What is more important and of immediate concern for our paper is that education variable has a positive impact on employment growth. Thus states that have higher high school enrolment rates have been enjoying higher growth rates of employment.

On the whole the results presented show strong skill bias in productivity and employment growths. Consequently, states that have been neglecting universal high school education are likely to become victims in the sense they will experience less growth of employment and productivity. They go down on both counts.

V Conclusions

This study shows that after controlling for fixed capital, human capital, in the form of higher education and health infrastructure, is emerging as a significant contributor for labour productivity, its growth and growth of employment.

Labour productivity is high in states where a large proportion of children go to high and higher secondary schools. Likewise, states with healthier population have higher labour productivity. In addition, agglomeration effects are also very important. In particular, urbanization and industrial agglomeration have external economies influencing labour productivity levels.

The results on growth of productivity reinforce the conclusions drawn on the levels of productivity. In addition to the growth of capital stock, states that enjoy higher proportion of higher secondary school enrolment and healthier populations experience higher productivity growth.

The growth of employment has also been high in states where human capital is more developed. In other words, in states where few children go to high and higher secondary schools, the employment growth is low. Employment is also favourably affected by urbanization and agglomeration effects. The results of the paper show that while growth of capital stock positively influences productivity growth, the same is not expected to favour employment growth.

The study by and large supports the skill bias in the current technological revolution where both employment and productivity grow faster in states that are endowed with better human capital. States that have been ignoring secondary and higher-secondary education and health-care seem to have become victims of the current technological revolution. Mere concentration on enhancing physical capital will not lead to a sustainable growth in employment and income.

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