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# Wage–productivity differentials and Indian economic efficiency

Amarendra Sahoo [a,*], Thijs ten Raa [b]

[a] Institute for Environmental Science (CML), Leiden University, P.O. Box 9518, 2300 RA, Leiden, The Netherlands
[b] Department of Economics, Tilburg University, P.O. Box 90153, 5000 LE Tilburg, The Netherlands

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ABSTRACT

A frontier-general equilibrium analysis with skill transformation evaluates the productivities of skilled and unskilled labor and potential of the Indian economy. We compare the wages of skilled and unskilled labor between 1994 and 2002 with their respective productivities over this period. Education is considered to be responsible for the skill formation over this period: the change in skilled labor supply is endogenous in the model. Compared to its productivity, skilled labor is underpaid in the initial period and overpaid in the second period. Unskilled labor is underpaid in both periods. A decomposition exercise shows that skilled labor gains from free trade, and stands to lose due to education and domestic competition in the second period. The annualized rate of return to education is between 7 and 10%. The economy operates below its potential in both periods, particularly in the second—due to trade limitations and the failure to capture the return to education. Service sectors are found to have potential to grow significantly.



## 1. Introduction

Do wage differentials follow productivity differentials and which economic inefficiencies cause distortions? For long, Indian industries were characterized by inefficiency, high costs and uneconomical means of production with pervasive government control. With a view to improving efficiency and global competitiveness, liberalization policy and economic reforms were introduced at the outset of 1990s. Post liberalization period is marked by much higher productivity growth and increased contributions from the service sector and the skilled-based manufacturing industries (Bosworth et al., 2007; Virmani, 2006), which have possibly increased the wage premium for higher education. It is believed that India still needs a higher pace of reforms towards competitive markets (Bajpai and Sachs, 1997; Fischer, 2002). The resulting competitive factor prices that reflect the factor productivities would determine the returns to education. Our study compares the wages of skilled and unskilled labor between 1994 and 2002, over the decade of strong reform, with the respective productivities and also measures the potential of the economy in these two periods. We conduct a decomposition exercise in order to track the factors responsible for the wage–productivity differentials and observed–potential gap in the economy. Our observations of the study can be indications for the performance of Indian economy in the later periods.

Tinbergen (1975) argued that opposing effects of technology (skilled labor demand) and education (skilled labor supply) determine the relative wage. Between 1987 and 1993, the returns to education in India increased significantly for middle and secondary levels, but not for primary and higher education (Bargain et al., 2006). The returns to middle and secondary level education fell over the next period 1993–2004, while the returns to higher education (college) grew (Asian Development Bank, 2007). Prior to 1993 (the pre-liberalization period) lack of demand for basic education could have been the reason for the high middle and secondary education premiums. Pradhan and Subramanian (2000), based on the MIMAP-India Survey (Pradhan and Roy, 2003) for 1994–95, argue that demand for education was low due to dim expected future

* Corresponding author at: Sabelhof 2, 5044 JR, Tilburg, The Netherlands. Tel.: +31 624187748.
*E-mail addresses:* amar_sahoo@hotmail.com (A. Sahoo), tenRaa@UvT.nl (T. ten Raa).

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earnings. Incomplete markets for higher education depress returns to higher education during this period.

Sectoral skilled–unskilled wage differentials in India depict no clear pattern over time (see Table 1). The gap increased in 'agriculture', 'heavy industries', 'transports and storage', and 'wholesale and retailed trade', but decreased in the other sectors. From 1994 to 2002 the supply of skilled labor increased in all sectors relative to unskilled except in 'construction'. Supply and demand of 'education' increased over this period. The relative wage of skilled to unskilled labor declined marginally from 2.95 in 1994 to 2.91 in 2002. We compare the relative wage with the relative productivity. The relative productivity signals the potentials differential between skilled and unskilled labor.

The productivity and efficiency aspects of growth have attracted attention in the real business cycle (Kydland and Prescott, 1996 and Prescott, 1986) and endogenous growth (Lucas, 1988 and Romer, 1986) literatures. Our model is a dynamic extension of ten Raa and Mohnen's (2002), bringing in dynamic physical capital inefficiency and education inefficiencies. Following Negishi (1960), the efficiency frontier is determined subject to commodity, factor and trade constraints. The distance of the economy towards its frontier determines inefficiency. We make the frontier approach dynamic by incorporating human and physical capital formation. Education process in our model determines the returns to education, skill transformation and productivity of skilled labor. A dynamic framework seems a natural response to the inconclusive literature.

Trade liberalization increased the skilled–unskilled wage gap in Latin America (Hanson and Harrison, 1999), but reduced it in East Asia (Wood, 1994, 1999). Wage differentials between skilled and unskilled labor have been analyzed for both developed and developing countries (Katz and Autor, 1999; Williamson, 1999; Wood, 1999). The explanations include skilled-biased technological change, international trade, and supply–demand factors (Berman et al., 1998; Katz and Murphy, 1992; Kiley, 1999; Krusell et al., 1997; Learner, 1996; Machin, 2002). In the Indian context, studies have shown that trade openness has an exacerbating effect on the skilled–unskilled wage gap (Beladi and Chakraborty, 2004; Dutta, 2004; Marjit and Acharyya, 2003; Pradhan, 2002), but no clear picture has emerged as regards the effect of education on the skill premium during the period of liberalization. Pradhan (2002), with the help of a general equilibrium model, observed that even large increases in the access to education preserve the wage inequality, but an econometric study by Dutta (2005) found that despite the increase in the skill premium education helped reduce the wage gap.

We will assess the contributions of various factors to the productivity–wage differentials. Productivity is determined at the frontier, which is beyond actual output due to four reasons: static inefficiency from domestic allocative inefficiency, i.e. domestic competition, static trade inefficiency, dynamic inefficiency from human capital formation and dynamic inefficiency from physical capital formation. The decomposition is based on an extended Fisher Index approach, to ensure path independence (which is an issue due to the non-linearity of our model). As the elasticity of substitution between skilled and unskilled labor is expected to influence wage differentials, we simulate with different values for this parameter.

The rest of the paper is divided into four sections. The theoretical model is presented in Section 2. Section 3 analyzes the basic data set and calibrates. The model results are discussed in Section 4, while Section 5 concludes.

**Table 1**
Skilled–unskilled wages and labor supply, real output and final demand between 1994 and 2002.
Sources: Pradhan et al. (1999) and Pradhan et al. (2006).

| Sectors | Ratio of skill to unskilled wages | | Ratio of skilled to unskilled labor | | Ratio of 2002 to 1994 | |
|---|---|---|---|---|---|---|
| | 1994 | 2002 | 1994 | 2002 | Real output | Real final demand |
| 1. Agriculture and allied | 1.30 | 1.58 | 0.19 | 0.39 | 1, 19 | 1, 12 |
| 2. Mining and quarrying | 2.03 | 1.91 | 0.33 | 0.57 | 1, 52 | 3, 43 |
| 3. Light manufacturing | 1.98 | 1.84 | 0.37 | 0.69 | 1, 67 | 2, 42 |
| 4. Heavy manufacturing | 2.26 | 2.44 | 0.92 | 1.40 | 1, 94 | 1, 15 |
| 5. Construction | 1.58 | 1.46 | 0.31 | 0.55 | 1, 79 | 2, 01 |
| 6. Electricity, gas and water | 1.72 | 1.64 | 1.75 | 4.42 | 1, 46 | 1, 97 |
| 7. Transports, storage | 1.69 | 1.84 | 0.81 | 1.40 | 1, 67 | 2, 40 |
| 8. Wholesale, ret. trade | 1.78 | 1.83 | 0.81 | 1.31 | 1, 77 | 2, 07 |
| 9. Finance, insurance, real est | 3.39 | 2.97 | 10.19 | 11.70 | 2, 60 | 2, 85 |
| 10. Services | 3.70 | 2.92 | 1.17 | 2.18 | 2, 28 | 2, 19 |
| 11. Education | 3.70 | 2.92 | 1.17 | 2.18 | 5, 65 | 5, 75 |
| All sectors | 2.95 | 2.91 | 0.38 | 0.64 | | |

## 2. The model

We determine the frontier of the economy by maximizing the vector of total final demand excluding the investment demand and net export (which will be endogenous) subject to commodity, factor and trade deficit constraints. There are three types of factors, viz. capital, skilled labor and unskilled labor. We consider a small open economy, where producers of tradable products take the world prices as given, with Leontief preferences. The endogenous pattern of trade is constrained by the observed deficit on the balance of payment. The model computes the economy's production frontier and the competitive factor and commodity prices. The gap between the frontier and the observed total final demands (observed total economic activities) measures inefficiency. The economy is classified into 11 economic activities including education sector (see Table 1).

Human and physical capital formations are modeled as forward-looking processes without adjustment costs. The initial supply of capital and education is fixed by past investments. Households are modeled by means of a forward-looking intertemporal utility-maximizing representative consumer. A commonly used additively separable intertemporal preference function is assumed, where the second period's utility is added with a discount factor, $\beta$ $(0 \le \beta \le 1)$. The implicit discount rate is $\mu = (1-\beta)/\beta$. We maximize the additive intertemporal utility, $D^0 + \beta D^1$, subject to constraints on demand, resources, trade, capital formation and education process. Here $D^t$ is the value of aggregate final demand at the optimum for period $t$. This model is a finite horizon Ramsey model, where a fictitious planning authority splits production between consumption and capital accumulation.

The expansion factor is defined as $c^t = D^t/D_0^t$, where $D_0^t$ is the observed value of aggregate final demand. The inverse of the expansion factor measures the efficiency of the economy in period $t$ and the residual $1 - 1/c^t$ the inefficiency.

In each period producers face a nested production function. A Leontief production function of intermediate inputs and a factor-input aggregate forms the first rung of the nested structure. The aggregate is a Cobb–Douglas function of capital and a labor composite, a CES function of skilled and unskilled labor. Capital is sector specific, in the Ricardo–Viner spirit, but skilled and unskilled labor may move freely between sectors. We assume "downward mobility" of skilled labor, the ability to join the unskilled pool if unsuccessful in the skilled labor search.[1] Here is the model:

$$Max \quad D^0 + \beta D^1 \quad w.r.t. D^t, X_i^t, T_i^t, I^0, K_i^t, L_{s_i}^t, L_{u_i}^t, \sigma^0, \Delta S \ge 0 \quad t = 0, 1$$
$$s.t.$$

[1] This ensures that the competitive skilled wage is at least as big as the unskilled.