Educational Administration: Theory and Practice
2023, 29(4), 4589-4596
ISSN: 2148-2403
https://kuey.net/

Research Article

Assessment Of The Elasticity Of Substitution Between Skilled And Unskilled Workers

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Citation: Gargi Boora, et.al (2023). Assessment Of The Elasticity Of Substitution Between Skilled And Unskilled Workers, *Educational Administration: Theory and Practice*, 29(4), 4589-4596
Doi: 10.53555/kuey.v29i4.9547

ARTICLE INFO

ABSTRACT

In this paper, we study the changing composition of the Indian workforce and estimate the elasticity of substitution between skilled and unskilled workers. The data is obtained from surveys by National Sample Survey Office (NSSO), namely Employment and Unemployment Survey (EUS) and Periodic Labour Force Survey (PLFS) for 1993-94, 2004-05, 2011-12, 2018-19 and 2022-23. The workers are dichotomized as skilled and unskilled on the basis of their education levels and are further grouped in 11 industry categories. In each industry, we calculate estimates of the employment and salary ratios between skilled and unskilled workers. On the basis of the profit-maximizing actions of the firms, we figure out a relationship between the employment and salary ratios of skilled and unskilled workers using which we calculate the elasticity. We discover that the elasticity of substitution between the two types of workers varies throughout industries in Indian economy. These estimations of the elasticity of substitution may be useful in developing growth plans for India that would increase employment.

Keywords: Elasticity of Substitution; Indian workforce; Education Levels; Salary Ratios

Introduction

Throughout the late 1980s and early 1990s, the Indian economy expanded at previously unheard-of rates, with manufacturing expansion outpacing overall economic development. Liberalisation policies that reduced state control and opened industries to private and international business were spurred in 1991. Growth erupted as a result, particularly in the IT and services sectors, and GDP(Gross Domestic Product) growth averaged 6–8 per cent. The 2000s brought with it more global integration, a boom in the service sector, and fast urbanisation. Following the global financial crisis of 2008, India went through a brief recession.

In the 2010s, the government implemented a number of reforms, such as the Make in India program, the Goods and Services Tax (GST), and the Insolvency and Bankruptcy Code (IBC) which intended expansion of the Indian economy. One of the greatest recessions in Indian history resulted from the COVID-19 epidemic; in FY 2020–21. Manufacturing, hospitality, and retail were among the most impacted industries. Following the epidemic, India implemented a number of monetary and fiscal policies to boost the country's economy. A robust recovery in services, more digitisation, and resilient industrial activity propelled India's economy's 2021–2022 bounce. New development opportunities are being created by India's continuous digital transformation, which is being facilitated by programs like Digital India, UPI (Unified Payments Interface), and e-commerce. Long-term growth is anticipated to be fuelled by India's enormous customer base, its investment in infrastructure development, and its geopolitical posture in global supply chains.

After analysing the resilient nature of Indian economy, now is the time to look at the performance of the labour market. It is crucial to keep track of labour market dynamics in order to comprehend the state of the economy and other consequences that result from labour market fluctuations. There are concerns regarding the future shape of the Indian labour market due to the country's rapid economic expansion.

If the last several decades' experience is any indication, there will be a significant rise in the need for education(Table1). Having said that and considering the high level of labour market heterogeneity, simply examining the total number of employed or jobless individuals may not be sufficient. It is necessary to examine information on individuals in the labour market according to more informed factors, including degree of education attained and skill level(Table 1 and Table 2).
It is also observed that a worker's productivity and pay are determined by their skill levels. This basis offers a connection between wages and technology, illuminating aspects of the production process through the pay structure. This relationship is frequently used to estimate the parameters of the production function by macroeconomists as well as labour economists (Blankenau and Cassou, 2011).

Table 1: Skilled workers (Usual workers; 15-64 age-group; with higher secondary and above education level+skill-enhancimg courses)

	1993-94	2004-05	2011-12	2018-19	2022-23
Agriculture, Forestry and Fishing	5036663	10237139	14275295	16115230	27205294
Mining and Quarrying	198717	271202	450229	360684	353274
Manufacturing	3145955	6071256	9243420	10794866	14788432
Electricity, Gas and Water	288718	407775	661019	881291	1124296
Construction	481814	1274147	3064052	4397718	6766076
Trade	2924052	7432270	10469066	13003894	17585258
Hotel and Restaurant	141554	493729	1127252	1243790	1999980
Transport, Storage and Communication	1119972	2725247	5463587	7264619	11124020
Finance, Real Estate and Business	1360504	1849143	3492537	4127097	4706330
Services	9397495	15892914	21489322	25968717	28726972
Total	24107524	46782823	69735779	84157906	114379932

Source: *NSSO EUS(1993-94, 2004-05, 2011-12) and PLFS(2018-19, 2022-23) unit level data.*

Table 2: Unskilled workers(Usual workers; 15-64 age-group; with lower than higher secondary education level)

	1993-94	2004-05	2011-12	2018-19	2022-23
Agriculture, Forestry and Fishing	189031145	213002378	178847865	135768490	188432817
Mining and Quarrying	2047145	2014703	1805257	1222232	1193590
Manufacturing	28693076	39640219	41671708	33903068	41226424
Electricity, Gas and Water	879620	682319	1472190	1195769	1542713
Construction	9398154	21036029	40505424	40735309	57666607
Trade	17190850	27705484	27127181	26300333	31624920
Hotel and Restaurant	2426071	4342696	5486816	5630787	7082781
Transport, Storage and Communication	7755571	12764758	14681365	15135208	15932951
Finance, Real Estate and Business	608350	668905	1099583	999471	959548
Services	20901856	18046180	19274257	20339167	21908719
Total	279083847	340116483	331971646	281229834	367571070

Source: *NSSO EUS(1993-94, 2004-05, 2011-12) and PLFS(2018-19, 2022-23) unit level data.*

Finding out what changes are taking place among these groups is crucial. It is vital to regularly monitor labour flows throughout time in order to achieve this. This has become even more apparent in light of the COVID-19 crisis and its profound effects on the employment market and the economy. So, we use surveys by NSSO, namely EUS and PLFS for 1993-94, 2004-05, 2011-12, 2018-19 and 2022-23 to calculate the ratio of skilled and unskilled workers grouped in 11 industry categories. Secondly, we calculate ratio of their wages to analyse the trends in the wage premium.
Just inculcating education in the employment scenario won't suffice unless we talk about a vital concept in labour economics, namely the elasticity of substitution between skilled and unskilled workers. It determines the demand for different kinds of skilled work. It measures the ease with which one type of labour can be substituted for another in the production process. Education helps lower wage disparities within a nation by decreasing the scarcity of skilled workers relative to unskilled workers. To what extent skilled and unskilled workers may be substituted determines the extent of the impact (Behar, 2010). In developing countries like India, where there is a significant disparity in the skill levels of the workforce, understanding this elasticity is crucial for analyzing wage inequality, employment patterns, and the impact of technological change (Unni and Rani, 2004). Therefore, we estimate this important variable of the labour economics for the Indian economy,

both aggregate and industry-wise. For this, we use the profit-maximizing actions of the firms to figure out a relationship between employment and salary ratios of skilled and unskilled workers.
The remaining part of the paper is organised as: the literature on elasticity of substitution between skilled and unskilled workers is reviewed in the next section. Section 3 provides an overview of the data and technique used. The data trends and estimates of the elasticity of substitution between skilled and unskilled workers, both overall and across industries, are covered in 4th Section. The last section provides a summary of all the noteworthy discoveries.

Literature Review

The ease with which one category of labour—skilled or unskilled—can be exchanged for the other throughout the production process is known as the elasticity of substitution between skilled and unskilled workers. It illustrates how flexible firms may be in responding to shifts in the relative salaries or output of the two types of workers.
The assessment of the elasticity is crucial in determining the possibilities of many economic phenomena. It contributes to the discussion of endowments' and productivity's respective roles in explaining national income differences (Hendricks, 2002; Dupuy and de Grip, 2006; Caselli, 2005; Papageorgiou and Saam, 2008; Klenow and Rodriguez-Clare, 1997). The degree to which skilled and unskilled workers may be substituted for one another determines the extent to which education affects employment. Thus, this elasticity has been estimated by economists concerned with education and pay inequality (Bowles, 1970; Psacharopoulos and Hinchliffe, 1972; Tinbergen, 1974). According to Teulins and van Rens (2008), it may be utilised to reconcile the differences between micro and macro educational returns. It sheds light on the possibility of skill-biasing impacts from technology (Acemoglu, 1998; Acemoglu, 2002a; Acemoglu, 2002b; Acemoglu, 2003; Thoenig and Verdier, 2003; Greiner et al., 2004; Stadler and Wapler, 2004; Unni and Rani, 2004; Berman, Somanathan, et al., 2005; Chusseau et al., 2008; Epifani and Gancia, 2008; Zou et al., 2009; Blankenau and Cassou, 2011; Freire, 2017; Hutter and Weber, 2022; Wang et al., 2021). It is used to determine how a change in relative factor pricing affects relative factor demand from a microeconomic standpoint (Hamermesh, 1993; Cahuc and Zylberberg, 2004).
As cited above, elasticity of substitution between skilled and unskilled workers has been the subject of several research in developed countries, leading to a wide range of final estimates. The writers have arrived at a consensus number lying between 1 and 2, which may be credited to Ciccone and Peri (2005), Goldin and Katz (2009) , Katz and Murphy (1992) and Autor et al. (2008). Also, there are recent country specific industry-wise estimates as well (Blankenau and Cassou, 2011; Mollick, 2008). Nothing has been agreed upon as of yet, with an emphasis on developing nations. We have traced a study by Psacharopoulos and Hinchliffe (1972) which estimates values ranging from 2.1 to 2.5 and Tinbergen (1974) suggests values between 0.4 and 2. Behar (2010) and Manacorda et al.(2010) put forth estimates in a range of 2 to 4.
With India's economy predicted to grow at an unprecedented rate and its position as the nation with the biggest working-age population, the country's human capital development is of global significance. A significant momentum for skill development has recently emerged in the nation. The purpose of this work is to significantly add the following to the body of current literature. The majority of labour market elasticity estimates for developing nations date back more than ten years, to the 1970s and 2000s. Research on the most recent advancements in the elasticity of substitution between skilled and unskilled workers in the Indian labour market is lacking. This study aims to provide fresh estimates of industry-wise and aggregate elasticity of substitution for India. Second, it makes use of granular data set. India depended on the NSSO's quinquennial EUS for many years to collect labour market data that was representative of the country and its regions. The National Statistical Commission (NSC) saw the need for more frequent labour market statistics and launched the PLFS. We use the firm level profit maximising methodology developed by Katz and Murphy (1992), a reputable research in this body of literature, to estimate industry-specific and aggregate elasticities for India. Moreover, there is a paucity of comprehensive empirical studies on the idea and how it affects the Indian economy. In this regard, the purpose of our article is to quantify the elasticity of substitution and examine the evolving educational makeup of the Indian workforce. Additionally, this examines and influences an economic phenomenon—Skill-Biased Technology Change(SBTC)—that we will address in our next work.

Data and Methodology

Data

The unit level data from NSSO EUS and PLFS for years 1993–94, 2004-05, 2011–12, 2018-19 and 2022-23 are the sources of the data for workers and earnings. These surveys aim at providing complete socioeconomic data in each survey wave. The purpose of the survey is to gather information about each household member's job status, including age, educational attainment, industry of employment, salaries, and various other factors. The workers' usual principal and subsidiary employment statuses are documented in the survey.
The activity status that an individual occupied for the majority of the 365 days prior to the survey date is deemed to be their principal activity status. A person whose major time criteria is used to assess their customary primary status may also have engaged in economic activity for a shorter period of time during the reference

year—at least 30 days. This economic activity is noted as that individual's subsidiary economic activity status. However, the term "usual activity status" refers to a person's activity status, which is based on their usual principal or subsidiary economic activity. Therefore, the person is a worker who engages in work activities in either the principal or subsidiary status throughout the year. So, for our calculations, we take usual workers and categorize them as skilled and unskilled workers on the basis of their educational attainment.

According to Acemoglu (2002), workers in the US with a high school diploma are unskilled, while those with a college degree are skilled. But according to the majority of international studies, skilled professionals have at least a high school degree. Furthermore, according to a research by Unni and Rani (2004), skilled workers in India are classified as people in the age range of 15 to 64 who have completed at least a higher secondary school education. In addition, the remaining individuals in the age range are viewed as unskilled. Consequently, we choose employees from the survey data who fall within the age range of 15 to 64 after these. We classify the workers with higher secondary education and above—including those who have taken skill-enhancing courses—as skilled and other workers in the age group as unskilled. For industry-wise estimates, the industry groups that are determined by concordance of industries using NIC-1987, 1998, 2004 and 2008 are: Agriculture, Forestry and Fishing; Mining and Quarrying; Manufacturing; Electricity, Gas and Water; Construction; Trade; Hotel and Restaurant; Transport, Storage and Communication; Finance, Real Estate and Business; Services and Total.

The following regarding earnings is included in the surveys: information on earnings from the preceding calendar month is obtained for salaried employees or those with regular salaries. Information on wages was collected for casual labourers for every day of the week prior to the survey date. An average of the earnings for each of the employment categories were determined for the associated industrial groupings.

Lastly, there are concerns with comparison since the EUS and PLFS utilise different approaches. Furthermore, when compared to census figures, these surveys typically underestimate the population. Therefore, in order to eliminate these issues, we estimate the ratios of skilled to unskilled labourers as well as the corresponding ratios of their wages.

Methodology

The elasticity of substitution(e) between skilled and unskilled workers is defined as the change in the ratio of the two factors of production divided by the change in the ratio of their marginal products. The compensation to the factors of production is their marginal products under perfect competition.

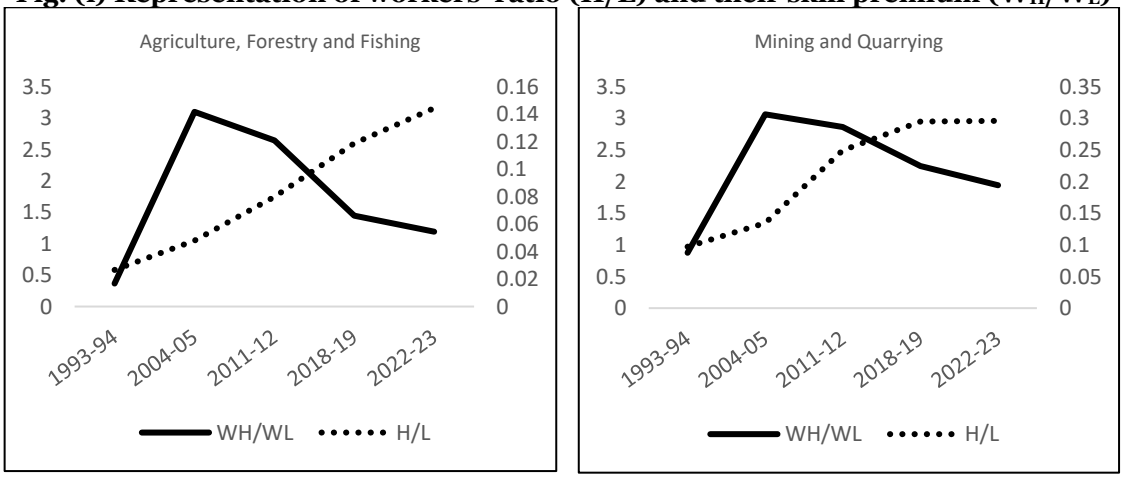
$$e = -\left(\frac{\partial \log(W_H/W_L)}{\partial \log(H/L)}\right)^{-1}$$

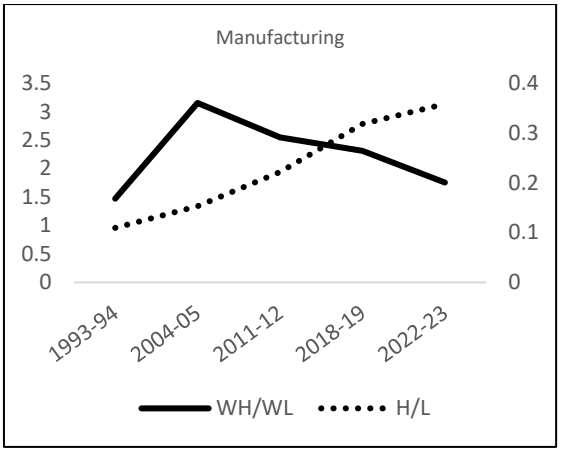
When e > 1, unskilled and skilled workers can act as substitutes for one another. While skilled workers may be called in for menial tasks, unskilled workers can fill positions meant for skilled workers, albeit at a lesser productivity. The demand for unskilled workers declines as the supply of skilled workers rises. When e < 1, unskilled and skilled workers are not substitutable.

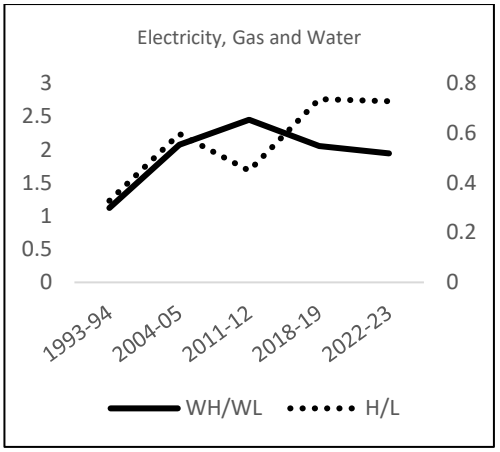
Results and Discussion

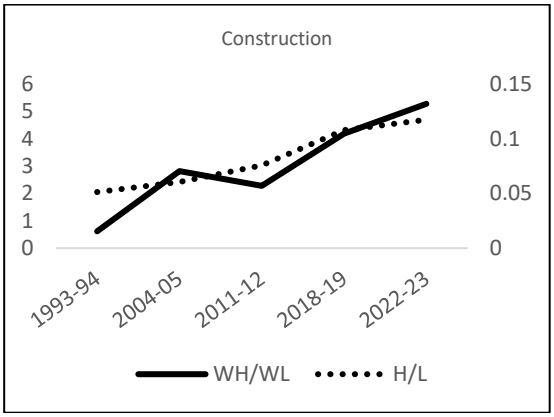
This section helps us analyse how the workforce's makeup is changing. Fig. (i) shows the patterns quite well. Let s_i represent the stated industry i ratio of skilled and unskilled workers. Given its comparatively higher skilled workforce, an industry is considered skilled if $s_i > 1$. To examine this, let's look at our sample's last year, 2022-23, when $s_i > 1$ for two industries: services and finance, real estate and business. Also, the remaining industries have $s_i < 1$.

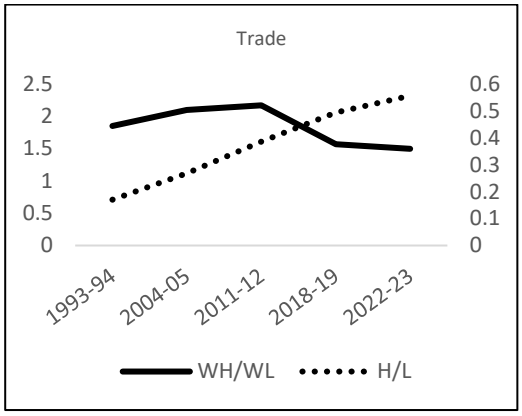
Fig. (i) Representation of workers' ratio (H/L) and their skill premium (W_H/W_L)

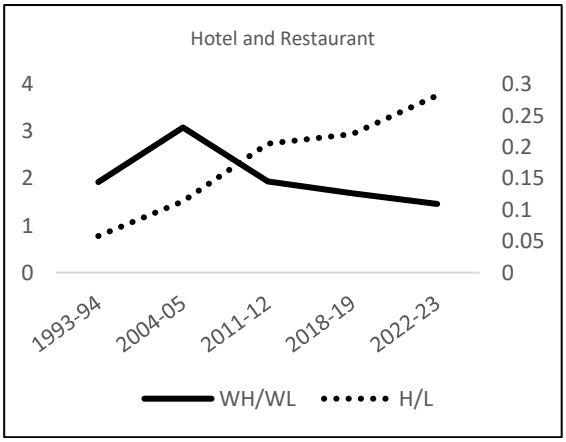


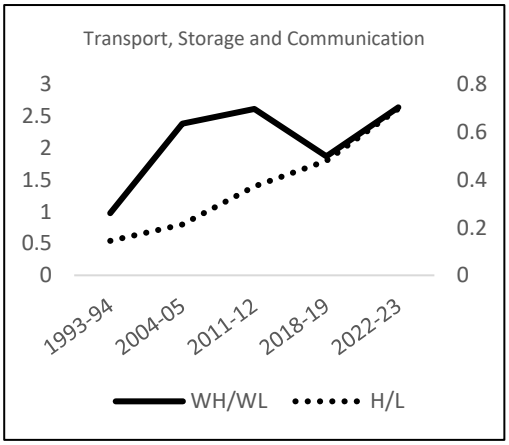

Manufacturing
3.5
3
2.5
2
1.5
1
0.5
0
0.4
0.3
0.2
0.1
0
1993-94
2004-05
2011-12
2018-19
2022-23
WH/WL
H/L

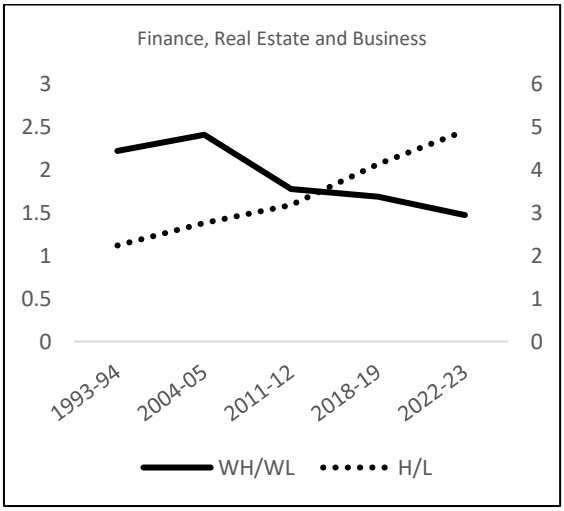

Electricity, Gas and Water
3
2.5
2
1.5
1
0.5
0
0.8
0.6
0.4
0.2
0
1993-94
2004-05
2011-12
2018-19
2022-23
WH/WL
H/L

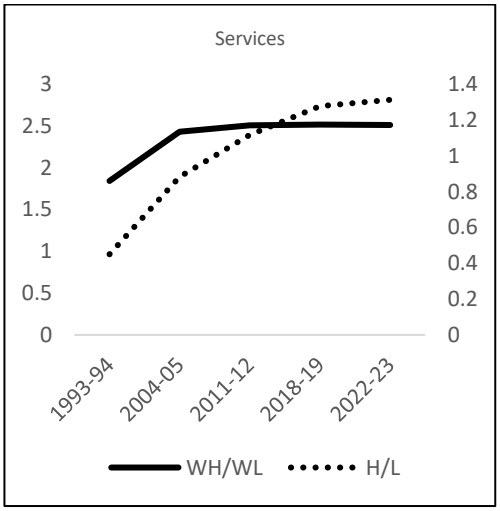

Construction
6
5
4
3
2
1
0
0.15
0.1
0.05
0
1993-94
2004-05
2011-12
2018-19
2022-23
WH/WL
H/L

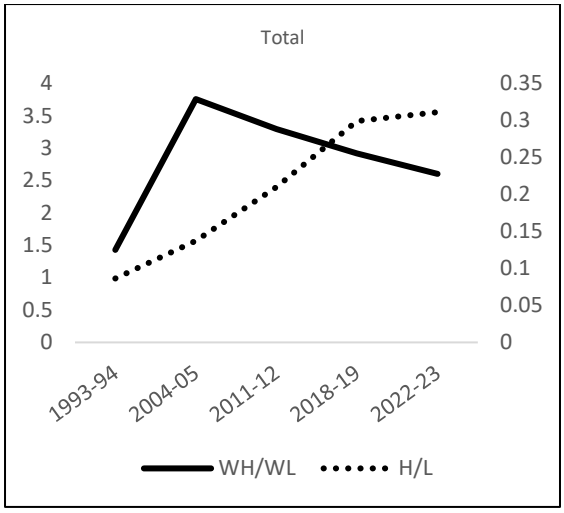

Trade
2.5
2
1.5
1
0.5
0
0.6
0.5
0.4
0.3
0.2
0.1
0
1993-94
2004-05
2011-12
2018-19
2022-23
WH/WL
H/L


Hotel and Restaurant
4
3
2
1
0
0.3
0.25
0.2
0.15
0.1
0.05
0
1993-94
2004-05
2011-12
2018-19
2022-23
WH/WL
H/L


Transport, Storage and Communication
3
2.5
2
1.5
1
0.5
0
0.8
0.6
0.4
0.2
0
1993-94
2004-05
2011-12
2018-19
2022-23
WH/WL
H/L


Finance, Real Estate and Business
3
2.5
2
1.5
1
0.5
0
6
5
4
3
2
1
0
1993-94
2004-05
2011-12
2018-19
2022-23
WH/WL
H/L


Services
3
2.5
2
1.5
1
0.5
0
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1993-94
2004-05
2011-12
2018-19
2022-23
WH/WL
H/L



Source: *The solid line displays W_H/W_L and the units are indicated on the left axis. H/L is displayed by the dashed line, and the units are listed on the right axis. The ratios are calculated by the authors based on NSSO EUS(1993-94, 2004-05, 2011-12) and PLFS(2018-19, 2022-23) unit level data.*

The graphs in Fig. (i) indicate a steady growth in H/L in every industry. The workforce's expansion throughout the later reform era was skill-biased which is in line with the earlier studies. Also, the graphs of the skill premium show a negative tendency in some and positive in others.

Given the magnitude of the elasticity of substitution, a firm will profit by increasing the number of unskilled workers and decreasing the number of skilled workers when the salaries of skilled workers increase faster than those of unskilled workers (Seth and Aggarwal, 2004). In other words, if the two worker categories are completely interchangeable, there is a negative correlation between their ratio and earnings. Because it determines the direction of the relationship between the skill premium and the ratio of the two categories of workers, the elasticity of substitution between skilled and unskilled workers makes research on this topic crucial. Table (i) below displays the elasticity of substitution between skilled and unskilled workers.

Table (i) Elasticity of Substitution between Skilled and Unskilled workers

Sector	Elasticity
Agriculture, Forestry and Fishing	1.1
Mining and Quarrying	2.4
Manufacturing	1.4
Electricity, Gas and Water	0.8
Construction	0.0
Trade	-2.8
Hotel and Restaurant	0.5
Transport, Storage and Communication	-1.7
Finance, Real Estate and Business	1.0
Services	-10.6
Total	1.5

Note*: Authors' calculations based on NSSO EUS(1993-94, 2004-05, 2011-12) and PLFS(2018-19, 2022-23) unit level data.*

Acemoglu (2002) asserts that calculating the elasticity of substitution between skilled and unskilled workers is challenging. Numerous studies in developed nations have examined the elasticity of substitution between skilled and unskilled workers, producing a broad variety of final estimates. The credit goes to Ciccone and Peri (2005), Goldin and Katz (2009) , Katz and Murphy (1992) and Autor et al. (2008) for arriving at a consensus figure that falls between 1 and 2. With a focus on developing countries, nothing has been decided upon as of yet. We have located a paper by Tinbergen (1974) that proposes values between 0.4 and 2, and another by Psacharopoulos and Hinchliffe (1972) that estimates values between 2.1 and 2.5. Manacorda et al. (2010) and Behar (2010) proposed values ranging from 2 to 4. Our estimate of the elasticity of substitution between skilled and unskilled workers, e = 1.5, for all workers, is rather similar to the values discussed in the previously referenced literature.

The negative elasticity levels seen in certain industries result from the method of calculation employed. The elasticity of substitution is defined as the ratio of variations in the relative workers compared to variations in their relative salaries. These industries are progressively hiring more skilled labour, resulting in a decrease in

L/H, while concurrently, the earnings of skilled workers increase in relation to those of unskilled workers. This produces a negative numerator and a positive denominator, eventually resulting in a negative elasticity.
A negative elasticity of substitution often indicates that two inputs function as complements in production, wherein a rise in one results in an increase in the other. Nevertheless, this interpretation requires meticulous consideration. Instead of strict complementarity in the context of a production function, the negative elasticity illustrates how technology developments transform labour markets by disproportionately augmenting the demand for skilled labour. Although unskilled labour may be experiencing a decline or stagnation, the rate of decrease is insufficient to significantly influence the elasticity estimate.
Consequently, instead of implying that skilled and unskilled workers are invariably complementary, the negative elasticity predominantly reflects the structural transformations in labour demand induced by technological change termed as Skill-Biased technological Change(SBTC) in the literature (Acemoglu 1998). Technology does not inherently necessitate the coexistence of skilled and unskilled labour; rather, it enhances the value of skilled labour, resulting in concurrent rises in both skilled employment and salaries. The identified trends highlight how SBTC divides labour markets, concentrating salary increases and job prospects among skilled individuals while diminishing demand for unskilled labour.

Conclusion

Given the trend towards increased education and skill development in the workforce, it is important to understand the possibility for skilled and unskilled workers to be replaced.
Over the course of the fast economic changes in the late 1990s, we see a clear shift towards a workforce that is skill-biased in all industrial groupings.
The total elasticity of substitution that we estimate is approximately 2, suggesting that skilled and unskilled people might be substituted for one another. These findings are based on two non-parametric approach. Furthermore, it is challenging to calculate since elasticity of substitution incorporates substitution across and within industries (Acemoglu, 2002). As a result, these need to be regarded as just symptomatic of the effect of substitution.

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