How would technological progress impact employment in the manufacturing sector of Bangladesh? An empirical projection

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Background

- **Technological progress eliminates the demand for unskilled/ low-skilled labour for routine tasks while creating new employment for skilled workers to carry out non-routine cognitive tasks.**
- **Developing countries abundant with low-skilled workers will face this challenge more severely compared to the developed countries where the majority of the labour force is highly skilled.**
- **The labour market in Bangladesh is characterised by a large and growing labour force, low wages, limited education, low skill, and informal sector dominance.**
- **The implications of technology for employment can be ambiguous because industries may be shedding labour due to automation, and on the other hand, hiring labour as they expand.**

For example…

- **Technological progress has replaced many workers in the country's large garment industry creating a skill gap, as many workers do not have the necessary skills to work with automated machinery.**

- **Technological progress helped flourish sectors like information technology, telecommunication and e-commerce in Bangladesh, where new job opportunities can be created if proper policies are undertaken.**

Rationale

While technology has provided several benefits to society, it may also have a **negative impact on employment** and job opportunities.

As technology continues to **grow**, more and more jobs are being **automated**, replacing human workers with machines.

"Automation does not need to be our enemy. I think machines can make life easier for men if men do not let the machines dominate them."

- John F. Kennedy

Objective

To investigate the likely scenarios of the impact of technological progress on sectoral employment by divisions in the manufacturing sector in Bangladesh.

- **Forecasting labour demand through the lens of technological progress**
- **Showing the impact of different levels of technological shock on the manufacturing employment of different sub-sectors (even at the 4-digit level of industrial classification)**
- **Analyzing regional (divisional) disparities of the impact**

Literature Review (1/3)

***Theoretical overview*: The labour market impact of technology is a century-old controversial topic in economic theories.**

- **The role of technological change in employment is inconclusive (Vivarelli & Pianta, 2000).**
  - **Optimistic view: Process innovation can cause job loss but it might be offset by various compensation mechanisms:**
    - **New technology >> cost reduction >> profit increase >> new investment >> new job opportunities (Ricardo, 1951)**
    - **Innovation >> price decrease >> new demand >> additional production >> additional employment (Steuart, 1966)**
  - **Pessimistic view: Non-effective compensation mechanism:**
    - **Use of labour-replacing technologies is profitable (Marx, 1961)**
    - **Delay in the compensation mechanism can create structural unemployment**
    - **Compensation mechanisms rely on the degree of competition and demand elasticity (Labini, 1969; Malthus, 1964)**
  - **Positive impact of product innovation on employment: Product innovation and the subsequent emergence of new markets can create jobs (Freeman et al., 1982; Freeman and Soete, 1994, 1987; Vivarelli and Pianta, 2000; Edquist et al., 2001; Bogliacino & Pianta, 2010)**

Literature Review (2/3)

***Empirical studies*: The actual employment impact of new technologies can be diverse and is determined by the balance of process and product innovation, the efficacy of the various compensation mechanisms, and the institutional framework.**

➢ ***As a result, emphasis should be placed on empirical analyses.***

- **Several studies have investigated the relationship between technological advancements and employment (will be discussed in the next slide…)**

- **However, there is no such study forecasting labour demand through the lens of technological progress, in the context of Bangladesh (We aim to fill this research gap).**

Literature Review (3/3)

Empirical studies:

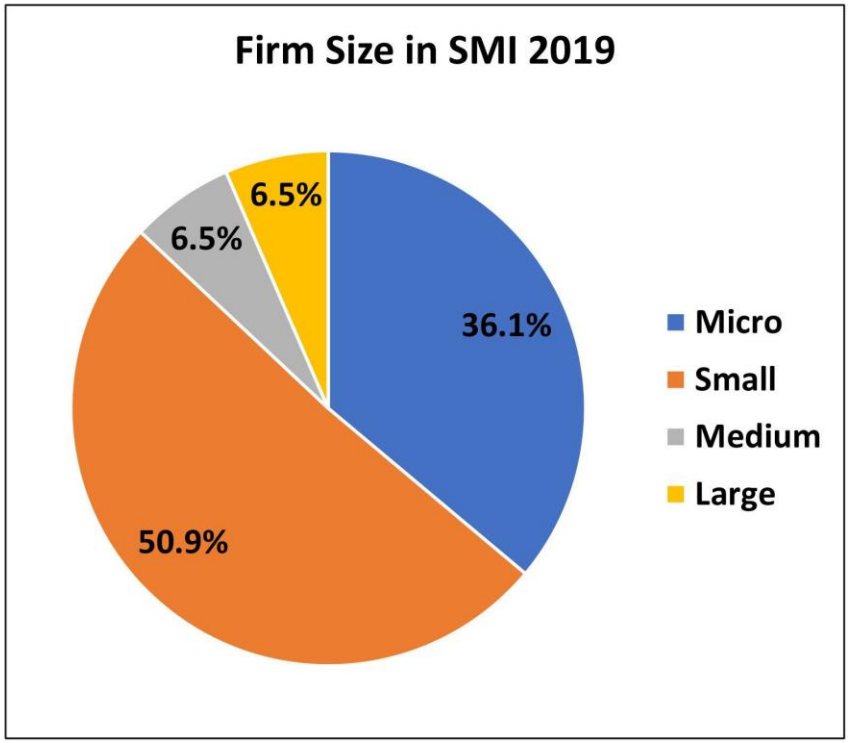
- Technology has led to the displacement of occupations that require routine tasks but created new employment opportunities in high-skilled occupations (Acemoglu & Restrepo, 2018)
- Technology has contributed to a decline in employment opportunities for workers with mid-level skills (Levy & Murnane, 2012)
- Technology has led to the creation of new jobs in various industries and these new jobs require a different set of skills (World Economic Forum, 2018)
- Occupations that require high-level cognitive skills (problem-solving, critical thinking, and creativity) and social skills (empathy, communication, and interpersonal relations) are less likely to be affected by automation. These skills are required in professions like managers and professionals, customer service, healthcare and education (Arntz et al., 2016; Brynjolfsson & Mitchell, 2017)
- Education and training can help workers adapt to the changing demand in the job market (OECD, 2019). Upskilling and reskilling programs can help workers transition to new jobs and industries (Eurofound, 2018)

Data

Survey of Manufacturing Industries (SMI)

Two rounds: 2012 and 2019.

- ✓ **Nationally representative survey on the manufacturing sector in Bangladesh.**
- ✓ **The total number of firms in 2012 and 2019 were 42,792 and 46,291 respectively.**
- ✓ **It covers all 64 districts in Bangladesh and covers output, investment, employment, capital stock, depreciations, etc. in greater detail.**



Methodology (1/5)

Regression to obtain Solow Residual

Assuming Cobb-Douglas production function: $Y_{ijt} = A_{ijt} L_{ijt}^{\alpha} K_{ijt}^{\beta}$

Y_{ijt} = output in industry *i* from region j in year t, is a function of capital (K_{ijt}), labour (L_{ijt}) and technology (A_{ijt}).

$$ln\, Y_{ijt} = lnA_{ijt} + \alpha lnL_{ijt} + \beta lnK_{ijt}$$

A_{ijt} is the technological parameter which is not observed from industrial output data, it is measured from the residual of the regression (Solow residual).

$$ln\, A_{ijt} = ln\, Y_{ijt} - \alpha lnL_{ijt} - \beta lnK_{ijt}$$

If we know the values of L, K, Y, α, β we can easily account for the existing value of technological parameter A.

Methodology (2/5)

Impact on employment parameter (L) due to increase in technology parameter (A)

$$ln\, A_{ijt} = ln\, Y_{ijt} - \alpha ln L_{ijt} - \beta ln K_{ijt}$$

$$\Rightarrow \%\,\Delta\, A_{ijt} = \%\Delta Y_{ijt} - \alpha\%\Delta L_{ijt} - \beta\%\Delta K_{ijt}$$

$$\Rightarrow \alpha\%\Delta L_{ijt} = \%\Delta Y_{ijt} - \beta\%\Delta K_{ijt} - \%\,\Delta\, A_{ijt}$$

Remember that capital and output are constant, that means, for producing the same level of output (Y) with the same level of capital stock (K),

An increased technological efficiency (A) would mean a fall in employment (L):

$$\alpha\%\Delta L_{ijt} = -\,\%\,\Delta\, A_{ijt}$$

This would provide us with a percentage change in employment due to a percentage increase (shock) in technology parameter.

$$\Rightarrow \alpha\ \%\Delta L_{ijt} = -(1+g)$$ **[A increases by g%]**

$$\Rightarrow \%\Delta L_{ijt} = -\frac{1+g}{\alpha}$$

Methodology (3/5)

Estimating the value of technology parameter A empirically

To obtain the Solow residual, we regress output on labour, capital stock, region fixed effects (at the district level), time fixed effect (year), and cluster our robust standard errors at the four-digit industrial classification (BSIC-4):

$$\ln Y_{ijt} = intercept + \alpha \ln L_{ijt} + \beta \ln K_{ijt} + \gamma dist_k + \theta T_t + \epsilon_{ijt}$$

Where, $dist_k$ is the district dummy (region fixes-effect)

And, T is the year dummy (year fixed-effect)

ϵ_{ijt}, or the residual of this regression entails us with the technology parameter.

Based on the regression, we can obtain Solow residual:

$$\hat{\epsilon_{ijt}} = \ln Y_{ijt} - \widehat{\ln Y_{ijt}}$$

Methodology (4/5)

We can also estimate the values of α and β from this regression result:

$$ln\,Y_{ijt} = intercept + \alpha lnL_{ijt} + \beta lnK_{ijt} + \gamma dist_k + \theta T_t + \epsilon_{ijt}$$

So, we can estimate A from→ $ln\,A_{ijt} = ln\,Y_{ijt} - \alpha lnL_{ijt} - \beta lnK_{ijt}$

Finally, using all these values, we can estimate the change in the labour market outcome L due to an advancements (positive shock) in the technology parameter A while keeping α, β, K, and Y fixed:

$$lnL_{ijt} = \frac{1}{\alpha} ln\,Y_{ijt} - \frac{\beta}{\alpha} lnK_{ijt} - \frac{1}{\alpha} ln\,A_{ijt}$$

For all divisions and by sector.

Methodology (5/5)

Three assumptions on technology parameter A

The effects on the labour force are calculated based on three assumptions:

1. **an increase in technological parameters by 15% (g = 15%)**
2. **technological enhancement by 30% (g = 30%)**
3. **technological enhancement by 50% (g = 50%)**

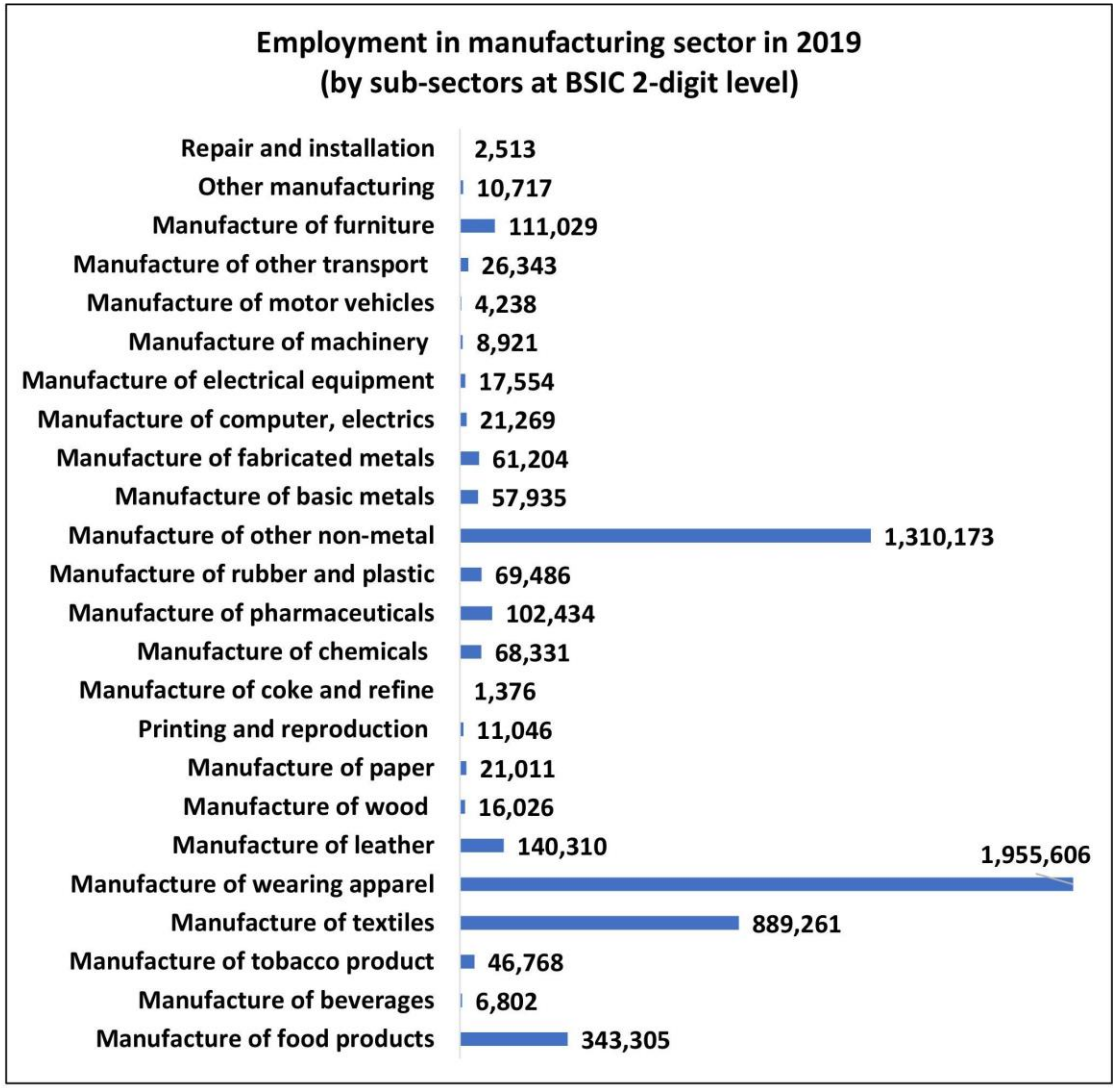
Findings (1/10)

Table 1: Regression results to obtain Solow residual

Explanatory variables (Dependent variable: Output (lnY))	Barishal	Chattogram	Dhaka	Khulna	Mymensing	Rajshahi	Rangpur	Sylhet	National
Intercept	10.80*** (0.583)	9.912*** (0.491)	10.75*** (0.287)	10.55*** (0.601)	10.74*** (0.859)	11.22*** (0.379)	11.06*** (0.580)	9.979*** (0.354)	11.02*** (0.252)
lnL Labour coefficient, α	1.046*** (0.162)	0.662*** (0.0491)	0.856*** (0.0466)	0.825*** (0.0509)	0.612*** (0.0907)	0.749*** (0.0722)	0.706*** (0.105)	0.635*** (0.0981)	0.784*** (0.0385)
lnK Capital stock coefficient, β	0.199** (0.0821)	0.285*** (0.0286)	0.204*** (0.0264)	0.264*** (0.0367)	0.250*** (0.0769)	0.252*** (0.0314)	0.222*** (0.0595)	0.298*** (0.0361)	0.236*** (0.0224)
Industry fixed effect (BSIC 4 digit)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect (Year)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effect (District)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.693	0.640	0.757	0.661	0.757	0.724	0.600	0.677	0.740
Adjusted R^2	0.684	0.638	0.756	0.658	0.756	0.723	0.595	0.673	0.739
Observations (N)	289	2,934	7,289	1,339	7,289	2,488	767	463	16,006

Findings (2/10)

- **The total number of employment in the manufacturing industries is 5.3 million.**
- **Out of them, almost 3 million are in the textile and wearing apparel industries.**
- **The other major employing industries are food processing, leather and leather goods, chemicals, pharmaceuticals, other non-metal items, etc.**



Findings (3/10)

- **The assumption that there is a 15% increase in productivity due to technological advancement would result in the elimination of 688,000 jobs in Bangladesh. The most affected sectors would be textile (-115,247), wearing apparel (-254,616) non-metals (-169,665), food products (-44,554), leather and leather goods (-17,881), furniture (-14,211) and pharmaceuticals (-13,361) amongst others.**

BSIC 2 digit industry code	Job loss for a 15% increase in technological efficiency	Job loss for a 30% increase in technological efficiency	Job loss for a 50% increase in technological efficiency
Manufacture of food products	-44,554	-78,827	-113,861
Manufacture of beverages	-887	-1,570	-2,267
Manufacture of tobacco product	-5,715	-10,111	-14,604
Manufacture of textiles	-115,247	-203,899	-294,521
Manufacture of wearing apparel	-254,616	-450,473	-650,684
Manufacture of leather and related	-17,881	-31,636	-45,697
Manufacture of wood	-2,045	-3,617	-5,225
Manufacture of paper	-2,741	-4,849	-7,004
Printing and reproduction	-1,282	-2,268	-3,275
Manufacture of coke and refine	-179	-318	-459
Manufacture of chemicals	-8,913	-15,769	-22,777
Manufacture of pharmaceuticals	-13,361	-23,639	-34,145
Manufacture of rubber and plastic	-9,063	-16,035	-23,162
Manufacture of other non-metal	-169,665	-300,176	-433,587
Manufacture of basic metals	-7,557	-13,370	-19,312
Manufacture of fabricated metals	-7,983	-14,124	-20,401
Manufacture of computer, electrics	-2,774	-4,908	-7,090
Manufacture of electrical equipment	-2,290	-4,051	-5,851
Manufacture of machinery	-1,164	-2,059	-2,974
Manufacture of motor vehicles	-553	-978	-1,413
Manufacture of other transport	-3,313	-5,862	-8,468
Manufacture of furniture	-14,211	-25,143	-36,317
Other manufacturing	-1,376	-2,434	-3,516
Repair and installation	-328	-580	-838
Total	-687,697	-1,216,694	-1,757,446

Findings (4/10)

- With a 30% increase in technological efficiency, the total fall in manufacturing employment could be estimated as 1.22 million. Out of this, almost 650,000 falls, will be from the textiles and wearing apparel. The other major affected sectors would be the manufacturing of non-metals (-300,176), food products (-78,827), leather and leather goods (-31,636), furniture (-25,143), pharmaceuticals (-23,639).

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Findings (5/10)

- A 50% increase in technological efficiency would result in a more dire consequence with a total job loss of 1.8 million. The largest affected sector remains as similar as in the previous cases: Textile and RMG would see a fall in employment close to 1 million followed by: manufacturing of other non-metals (-433,587), food products (-113,861), leather and leather goods (-45,697), furniture (-36,317), pharmaceuticals (-34,145), plastic and rubber manufacturing (-23,162), amongst others.

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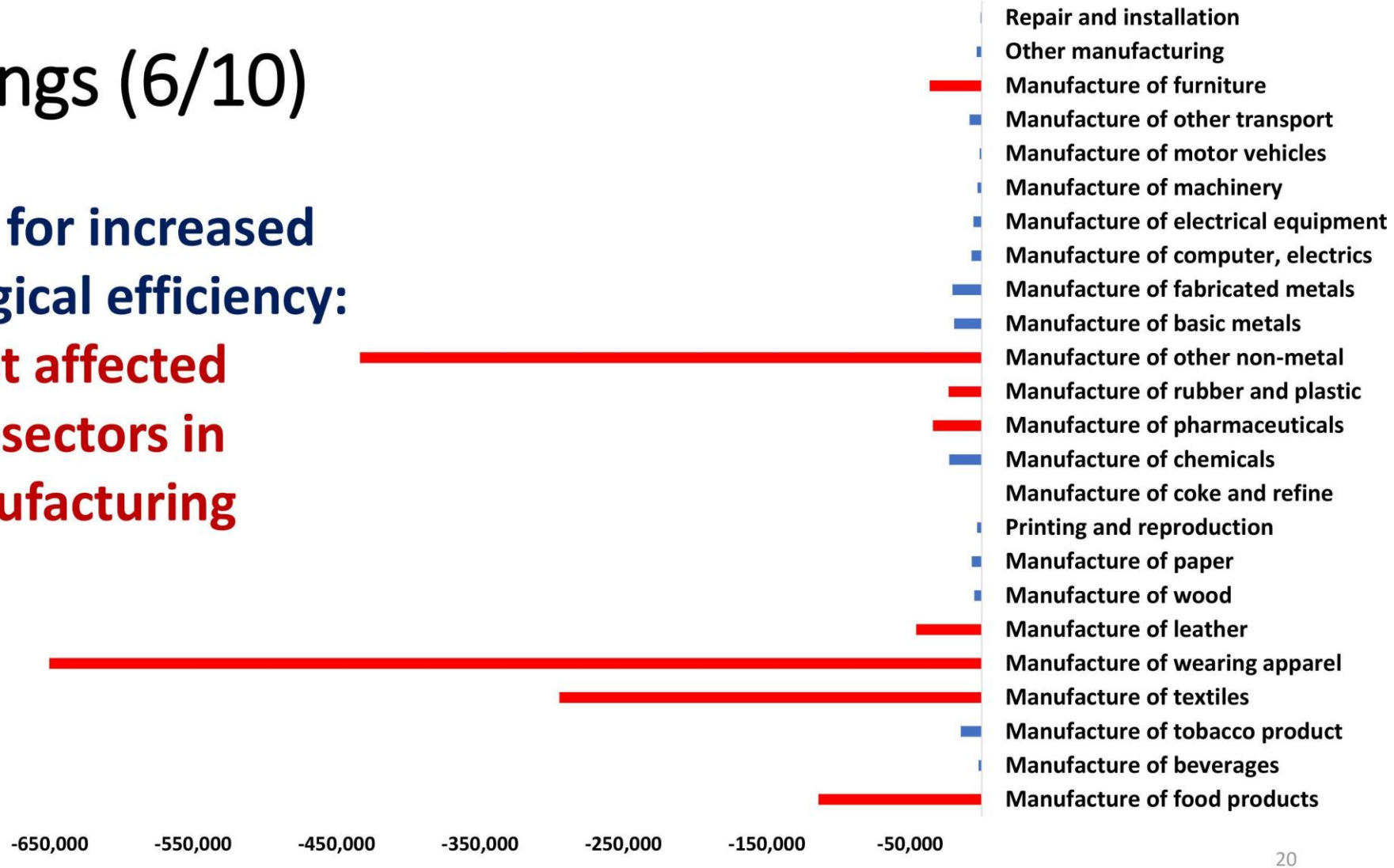
Other manufacturing	-1,376	-2,434	-3,516
Repair and installation	-328	-580	-838
Total	-687,697	-1,216,694	-1,757,446

Findings (6/10)

Job loss for increased technological efficiency:

Most affected sub-sectors in manufacturing



Findings (7/10)

With a 10% annual growth in the manufacturing sector where a 50% increase in technology is induced – (increase in jobs in terms of number)

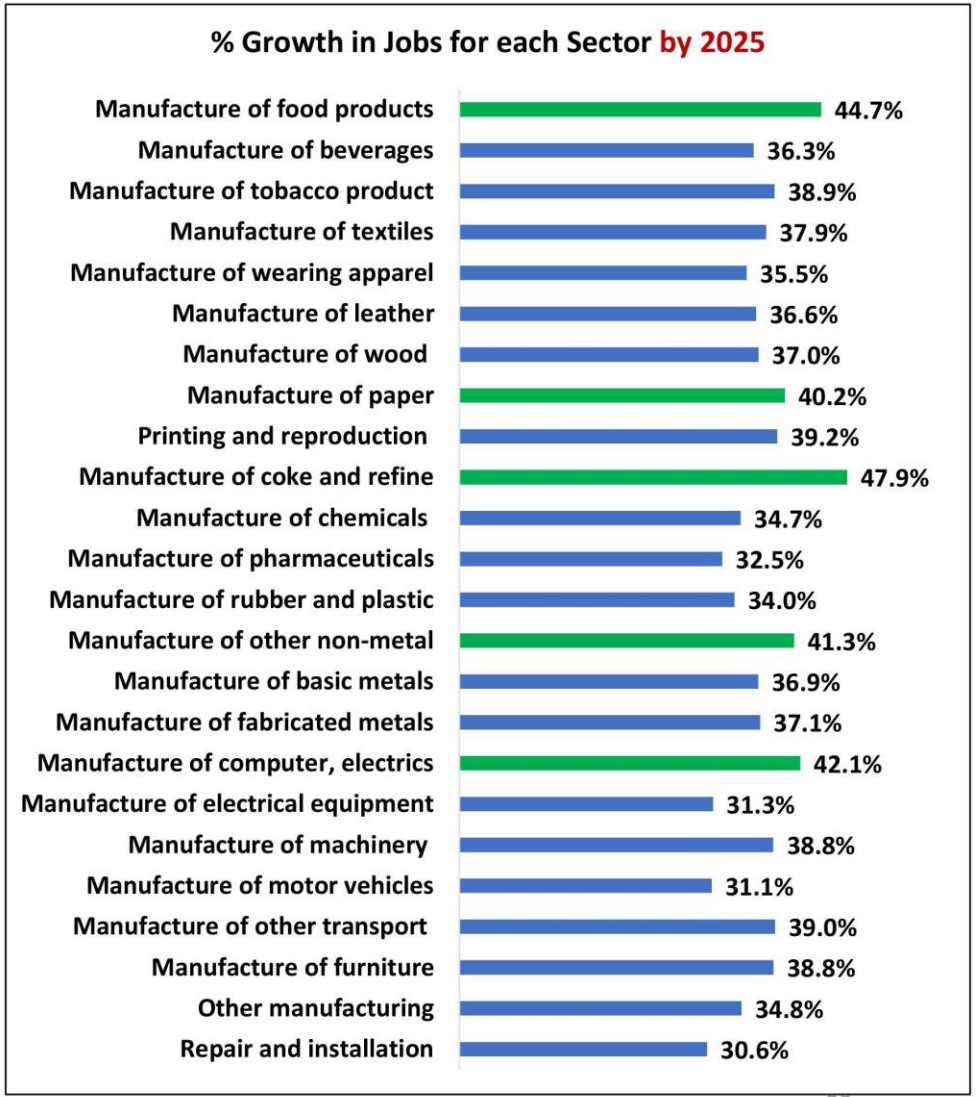
The total employment in the manufacturing sector would increase by 2.02 million in 2025. Almost half of this increase would be observed in the textile and RMG sectors. The other leading sectors with greater employment generation would be food processing (153,340), leather and leather goods (51,411), pharmaceuticals (33,258), other non-metal manufacturing (541,435), and furniture (43,055).

BSIC 2 digit industry code	New jobs by sector in 2025
Manufacture of food products	1,53,340
Manufacture of beverages	2,472
Manufacture of tobacco product	18,197
Manufacture of textiles	3,36,879
Manufacture of wearing apparel	6,93,917
Manufacture of leather and related	51,411
Manufacture of wood	5,923
Manufacture of paper	8,447
Printing and reproduction	4,335
Manufacture of coke and refine	659
Manufacture of chemicals	23,742
Manufacture of pharmaceuticals	33,258
Manufacture of rubber and plastic	23,612
Manufacture of other non-metal	5,41,435
Manufacture of basic metals	21,388
Manufacture of fabricated metals	22,734
Manufacture of computer, electrics	8,953
Manufacture of electrical equipment	5,499
Manufacture of machinery	3,458
Manufacture of motor vehicles	1,320
Manufacture of other transport	10,272
Manufacture of furniture	43,055
Other manufacturing	3,734
Repair and installation	769
Total	20,18,809

Findings (8/10)

With a 10% annual growth in the manufacturing sector where a 50% increase in technology is induced – (increase in jobs in terms of %)

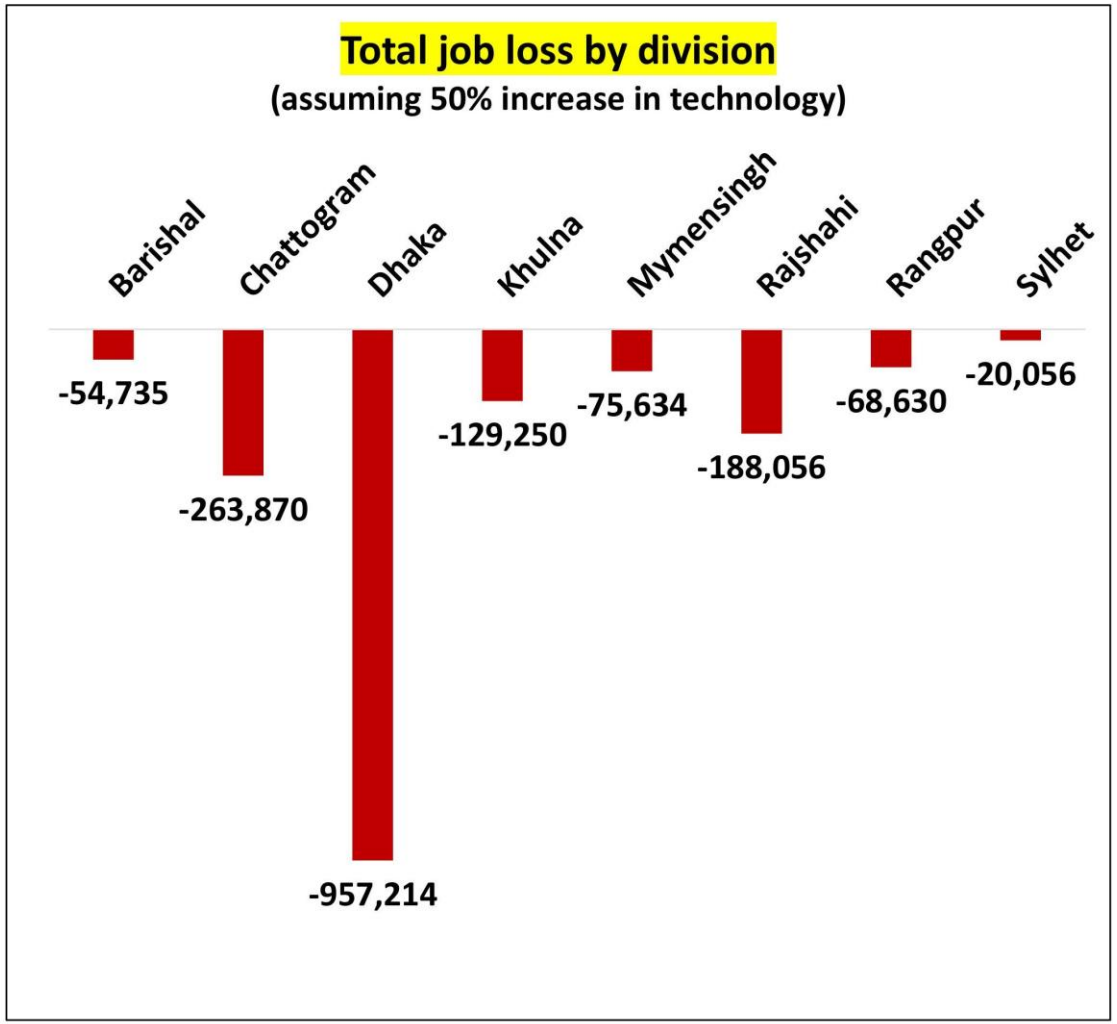
The highest job growths will happen in food processing, paper products, coke and refined petroleum, other non-metal mineral products, and computer and electronic products.



Findings (9/10)

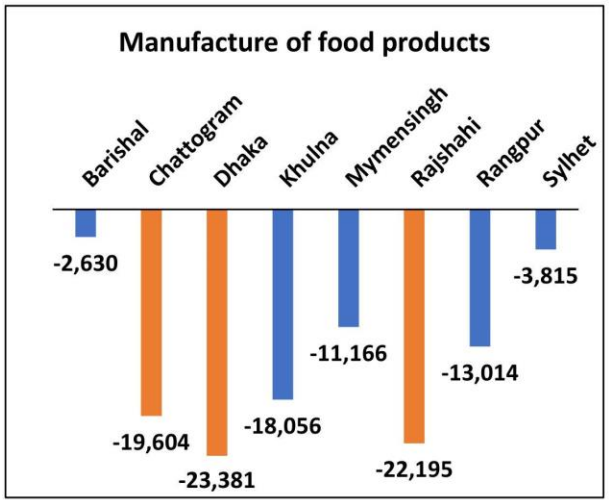
- **Regional disparities:**

In terms of total impact, Dhaka would be affected most followed by Chattogram, Rajshahi, Khulna, etc.

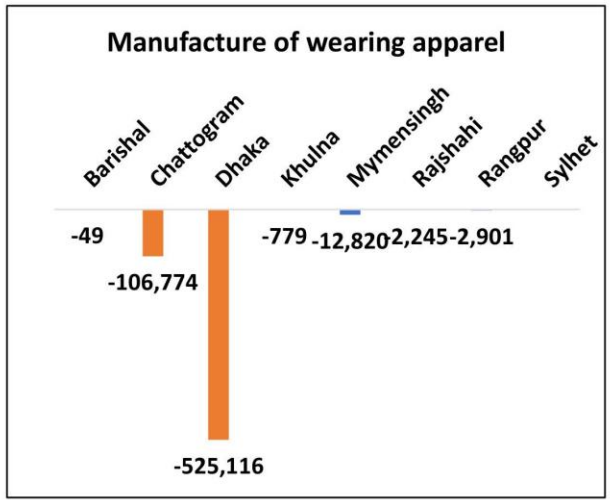


Findings (10/10)

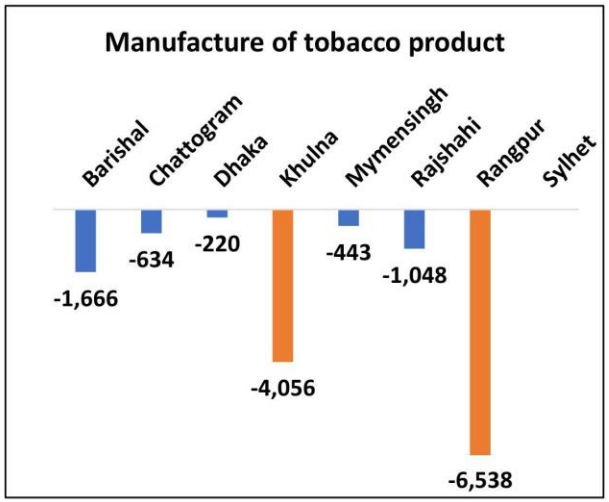
Regional disparities due to the existing industrial clusters/agglomeration



Most of the fall in employment in the agro-processing in Rajshahi, Dhaka, and Chattogram



In wearing apparel, almost the entire shock would be in Dhaka and Chattogram



Fall in tobacco employment would be more prominent in Rangpur and Khulna

Limitations

1. **We assumed the firms are producing at their full efficiency level- A typical assumption for such analysis.**
2. **The nature of our data does not allow us to determine the necessary skills for the specific industries.**
3. **The technology is labour-replacing in our assumption. So, the study only highlights the number of lost jobs due to technological advancement in specified manufacturing sectors, whereas, technology also creates jobs. The number of new jobs could not be captured.**
4. **This is a conservative estimate based on a basic model. An endogenous growth model might produce different results but we could not do that due to data limitations.**

Despite such limitations, our exercise shows the sectors where more labour would be demanded if the robust manufacturing growth is sustained.

Conclusion

The unemployment we have forecasted will be much lower with the rise in technology if the technology is labour augmenting instead of labour replacing.

- **But the labour force would not be adequately skilled to use the technology as labour augmenting unless we update our technical education.**
- **If we can skill up the labour force, we will be able to boost output while also preserving jobs.**
- **So, we recommend that the government should take more measures to skill up the labour force.**

Thank you.