APORDE AFRICAN PROGRAMME ON RETHINKING DEVELOPMENT ECONOMICS

Estimating Labor Demand using Dynamic Framework: Evidence from Manufacturing Firms in Ethiopia

By: Eyayu Tesfaye Mulugeta

Conference on Industrial Development in Africa

March, 2025

Outline

1. Introduction
- ✓ Facts about Ethiopian Manufacturing Firms

2. Research Questions and Motivations
- ✓ Research Questions
- ✓ Motivations

3. Data Description and Empirical Methodology
- ✓ Data Description
- ✓ Empirical Methodology
- ✓ Empirical Results and Findings

4. Conclusion and Policy Recommendations
- ✓ Conclusion
- ✓ Policy Recommendations

Introduction

- ✓ The Ethiopian government has implemented a set of structural reforms and industrial policies during the past two decades (Oqubay, 2018).
- ✓ A full-fledged IDS was formulated in 2002/03 and attracting FDI is at the core of industrialization strategy (UNIDO, 2018).
- ✓ The country achieved significant progress in attracting FDI caused by its low wage and generous incentives for investors (Diao et al., 2021).
- ✓ Foreign firms accounted for 21% of the manufacturing VA in 2016 and more than 13% of employment (Sanfilippo and Sundaram, 2021).
- ✓ There has been an increase in the demand for both production and non-production labor in the sector (PSI, 2020).

Facts about Manufacturing Firms in Ethiopia

1. Huge capital investment as a main driver of labor productivity:

- ✓ Increase in labor productivity was mainly the result of capital deepening

2. Diverse performance within manufacturing sector

- ✓ Relatively high labor productivity: Motor vehicles, basic metals, fabricated metal, and food & beverages
- ✓ Lower labor productivity: garment, wood, textiles, furniture, and leather & footwear sub sectors (PSI, 2020)

3. High import intensive nature of manufacturing Firms

- ✓ More than 65 % of firms rely on imported inputs
- ✓ Foreign owned firms takes the largest share (> 80%) (CSA, 2016).

4. Only 5 % of firms participated in exports between 1995- 2020

5.Large firms are significantly capital-intensive.

- ✓ Larger firms exhibit smaller employment growth (1% to 5 %)
- ✓ Small and Medium firms - employment growth of 20 % (UNDP, 2023)

Facts about Manufacturing Firms in Ethiopia Cont'd

6. The risk of losing wage-productivity growth balance

- ✓ Labor productivity and labor cost are lower than those of China, Kenya, Vietnam, Indonesia, Malaysia and Sri Lanka (PSI, 2020)
- ✓ Low productivity growth (3.2%)–high real wage growth (6 %) paradox in the last two decades(PSI, 2020; Diao et al., 2021)
- ✓ High labor costs (relative to productivity) are often cited as constraints on employment growth in Africa (Gelb et al., 2020).

7. Labor turnover is the most common and costly labor issue (Abebe et al., 2018; Halvorsen, 2021)

- ✓ As a result firms incur labor adjustment costs involving costs of search, selection, training, firing, productivity losses

Research Questions and Motivations

Research Questions:

- *Does the labor adjustment cost for non-production workers exceed the adjustment cost for production workers?*
- *How elastic is labor demand? Does it differ across occupational categories?*
- *Does capital complements or substitute labor in the manufacturing firms in Ethiopia*

Motivations Cont'd

A. Studies on labor demand mainly rely on static models (Jia & López, 2021; Nazier, 2019; Teal, 1996)

- ✓ Static models fail to capture adjustment costs (Falk and Koebel, 2001).
- ✓ Adjustment costs differ by workers category (Arnd, 2018).

B. Employee Intensity, Employment Protection Legislation and Labor Skills Index used as proxy for labor adjustment cost (Golden et al., 2020)

- ✓ Identifying reliable proxies remains challenging (Banker et al., 2014)
- ✓ Estimation of labor demand model using firm level observations provides new insight to adjustment costs (Cooper et al., 2015).

C. Elasticity of labor demand to wage changes is studied extensively

- ✓ Despite extensive research, elasticity estimates exhibit substantial heterogeneity (Behar, 2023; Popp, 2023).
- ✓ Difference in empirical specification, datasets used, sectors considered explains more than 80% of variation in estimates (Lichter et al., 2015)

Motivations Cont'd

D. Previous studies relies on the assumption that labor supply is perfectly elastic, rendering wages exogenous to individual firms (Chen, 2019).

- ✓ This assumption may still be violated when the model is run on data (Popp, 2023)

E. The relationship between capital and various labor types also lacks conclusive findings (Nazier, 2019)

- ✓ Estimates of such phenomena at the firm level are rare for developing countries context (Yasar and Paul, 2008; Akay and Yuksel, 2009)
- ❖ Little has been done to estimate the labor demand for manufacturing firms in Ethiopia using dynamic framework.
- ✓ This paper aims to provide quantitative evidence on labor demand estimation for production and non-production workers using a dynamic framework.

Contributions to the Literature Cont'd

- Dynamic framework is used to estimate labor demand models, addressing limitations in previous research
- Studies often rely on proxies for labor adjustment costs .This study provides corroborative evidence by estimating adjustment costs.
- Estimation of wage elasticities is critical for labor market analysis, policy-making and workforce planning
- Test the validity of the assumption that wage is exogenous to individual firms, an aspect rarely explored in the literature
- Research on manufacturing firms in Africa is often limited due to data constraints. This study addresses this gap by utilizing long panel data

Data Description and Empirical Methodology

- Nationally representative firm level panel dataset collected by (CSA) for the period 1996 – 2016
- The censuses is basically restricted to Ethiopian Large and Medium Scale Manufacturing Industries (LMSMI)
- The census is conducted annually and includes both public and private industries across all regions
- Firms in the census account for 50% of total employment and more than 70% of value added in the sector (Diao et al., 2021)
- The dataset provides information on establishment-level output, sales, employment, location, wages, and other firm characteristics.

✓ Non Production Workers consist of directors and managers, technicians, research workers, engineers, chemists, accountants, sales men etc. who are not directly engaged in the production

✓ Production workers consists of workers directly engaged in production i.e., persons engaged in fabricating, processing, assembling, maintenance and associated activities (CSA, 2018)

Data Description Cont'd

- ✓ This dataset has been used in several studies to analyze various aspects of firm performance in Ethiopia, including firm performance (Aberha, 2019; Bigsten et al., 2016; Bigsten and Gebreeyesus, 2007; Erena et al.,2021; Fiorini et al., 2021; Haile et al., 2017; Shiferaw and Söderbom, 2018; Söderbom, 2012; Tsaedu and Chen, 2021), firm entry and survival (Shiferaw, 2006), Africa's manufacturing puzzle (Diao et al., 2024), and productivity report (Gebreeyesus et al., 2020).

Empirical Methodology Cont'd

- This study employs a two-step system GMM estimator, developed by Arellano and Bover (1995) and Blundell and Bond (1998)
- The strength of this method lies in its ability to address endogeneity issues and account for time-invariant effects (Blundell & Bond, 2000).
- A dynamic specification is used to incorporate adjustment costs (Lachenmaier & Rottman, 2011; Conte & Vivarelli, 2011)
- The coefficient of the lagged dependent variable captures the adjustment cost (Popp, 2023).

Empirical Methodology Cont'd

We adopted models used by Haile et al. (2017), Conte and Vivarelli (2011), and Meschi et al. (2016).

Demand for Non-Production Workers

$$lL_{ijt}^{NP} = \beta_0 + \beta_1 lL_{ijt-1}^{NP} + \beta_2 lL_{ijt-1}^{P} + \beta_3 lW_{ijt}^{NP} + \beta_4 lW_{ijt}^{P} + \beta_5 lK_{jit-1} + \beta_6 lTFP_{ijt-1} + \beta_7 lage_{ijt} + \beta_8 lexport_{ijt} + \beta_9 Location_i + D_i + D_f + D_t + \varepsilon_{ijt}$$

Demand For Production Workers

$$lL_{ijt}^{P} = \beta_0 + \beta_1 lL_{ijt-1}^{P} + \beta_2 lL_{ijt-1}^{NP} + \beta_3 lW_{ijt}^{P} + \beta_4 lW_{ijt}^{NP} + \beta_5 lK_{jit-1} + \beta_6 lTFP_{ijt-1} + \beta_7 lage_{ijt} + \beta_8 lexport_{ijt} + \beta_9 Location_i + D_i + D_f + D_t + \varepsilon_{ijt}$$

- $\boldsymbol{\beta_1}$ is adjustment cost expected to be higher for non-production labor .
- (1- $\boldsymbol{\beta_1}$) is the adjustment speed of employment (Hamermesh, 1991)
- $\boldsymbol{\beta_3}$ is own-wage elasticity of demand for labor
- $\boldsymbol{\beta_4}$ is cross wage elasticity of labor demand
- $\boldsymbol{\beta_5}$ shows capital-labor complementarity or Substitutability.

Summary Statistics (Cont'd)

	N	Mean	Median	SD	Min
Ln(Labor)	13886	3.761	3.555	1.132	1.099
Ln(Production Labor)	13886	3.238	3.091	1.195	.693
Ln(Non-Production Labor)	13886	2.6	2.398	1.269	0
Ln(Nominal Wage)	13886	8.833	8.812	0.967	3.29
Ln(Real Wage per Labor)	13886	4.762	4.785	.844	-.469
Ln(Real Wage per Production Labor)	13886	4.666	4.672	.902	-.284
Ln(Real Wage per Nonproduction Lab)	13886	4.879	4.958	1.108	-1.218
Ln(Capital Stock)	13886	9.963	10.114	2.114	5.084
Ln(TFP)	13781	1.945	1.996	.694	-.776
Ln(export)	13886	.641	0.000	2.644	0
Firm Age	13886	15.439	10.000	15.17	0
Firm Size	13886	89.481	35.000	140.573	3

Source: Author's calculation based on the CSA census data 1996-2016

Summary Statistics (Cont'd)

	N	Mean	Median	SD
Labor share of production workers	13886	.631	0.655	.191
Labor share of non-production workers	13886	.369	0.345	.191
Share of production labor wage from total wage	13886	.585	0.600	.205
Share of nonproduction labor wage from total wage	13886	.415	0.400	.205
Share of wage from Value added	12754	.315	0.229	.274
Share of wage of production labor from value added	12754	.191	0.125	.191
Share of Wage of Non-Production labor from value add	12754	.124	0.080	.136
Share of wage from sales	13664	.159	0.087	.207
Share of Wage of Prod. from sales	13664	.096	0.048	.138
Share of Wage of Non- Prod. from sales	13664	.063	0.031	.102

Source: Author's calculation based on the CSA census data 1996-2016

Estimation Result – Total Labor Demand (Cont'd)

	Capital, TFP and Export dated at t-1			*Capital, TFP and Export dated at t*		
	(1)	*(2)*	(3)	(4)	(5)	(6)
VARIABLES	*OLS*	*FE*	*GMM*	*OLS*	*FE*	*GMM*
$Ln(Labor)_{t-1}$	0.864***	0.385***	0.483***	0.836***	0.386***	0.492***
	(0.008)	(0.023)	(0.032)	(0.008)	(0.022)	(0.030)
$Ln(wage\_cost)_t$	-0.070***	-0.101***	-0.126***	-0.088***	-0.113***	-0.150***
	(0.007)	(0.010)	(0.013)	(0.008)	(0.010)	(0.013)
Ln(capital)	0.053***	0.038***	0.037***	0.076***	0.075***	0.053***
	(0.004)	(0.007)	(0.010)	(0.004)	(0.007)	(0.011)
Ln(TFP)	0.035***	0.080***	0.064***	0.014***	0.025***	-0.052**
	(0.007)	(0.011)	(0.020)	(0.006)	(0.013)	(0.021)
Ln(Export)	0.004***	-0.002	0.004	0.008***	0.008**	0.015**
	(0.001)	(0.003)	(0.005)	(0.001)	(0.003)	(0.006)
$Ln(age)_t$	0.030***	0.136***	0.212***	0.042***	0.153***	0.198***
	(0.009)	(0.023)	(0.022)	(0.006)	(0.022)	(0.021)
Location	0.030***	0.092	0.024	0.032***	0.119 (0.124)	0.020
	(0.009)	(0.127)	(0.033)	(0.009)	1.746***	(0.032)
Constant	0.166***	2.007***	1.564***	0.142***	(0.145)	1.744***
	(0.040)	(0.144)	(0.182)	(0.041)	Yes	(0.184)
Year Fixed Effects	Yes	Yes	Yes	Yes	10,588	Yes
Observations	10,595	10,595	7,987	10,588	0.249	7,964
R-squared	0.859	0.228		0.865		
F_Statistics	2224	27.33	3599	2450	28.95	3933
Number of Groups		2,137	1,986		2,141	1,982
Instrument Count			31			31
AR(1)			0			0
AR(2)			0.248			0.192
Hansen Statistics			0.114			0.285

Estimation Result – Disaggregated by Occupational Category Cont'd

	Production Labor			Non-Production Labor		
	(1)	*(2)*	(3)	(1)	(2)	(3)
VARIABLES	*OLS*	*FE*	*GMM*	*OLS*	*FE*	*GMM*
$Ln(prod)_{t-1}$	0.670***	0.248***	0.350***	0.211***	0.162***	0.152***
	(0.012)	(0.020)	(0.028)	(0.009)	(0.016)	(0.024)
$Ln(nonprod)_{t-1}$	0.177***	0.131***	0.113***	0.661***	0.210***	0.342***
	(0.008)	(0.014)	(0.020)	(0.010)	(0.018)	(0.024)
$Ln(wage\_prod)_t$	-0.240***	-0.257***	-0.285***	0.168***	0.163***	0.166***
	(0.010)	(0.013)	(0.016)	(0.009)	(0.011)	(0.014)
$Ln(wage\_nonprod)_t$	0.141***	0.137***	0.137***	-0.187***	-0.224***	-0.250***
	(0.007)	(0.009)	(0.012)	(0.009)	(0.011)	(0.014)
$Ln(capital)_{t-1}$	0.040***	0.045*** (0.008)	0.039***	0.068***	0.031***	0.030***
	(0.005)		(0.013)	(0.004)	(0.007)	(0.012)
$Ln(TFP)_{t-1}$	0.016***	0.096*** (0.015)	0.078***	0.058***	0.065***	0.054**
	(0.009)		(0.025)	(0.010)	(0.015)	(0.024)
$Ln(Export)_{t-1}$	0.006***	-0.001	0.004	0.001	-0.005	0.001
	(0.002)	(0.004)	(0.006)	(0.002)	(0.004)	(0.006)
$Ln(age)_t$	0.027***	0.137*** (0.026)	0.202***	0.037***	0.137***	0.238***
	(0.007)		(0.025)	(0.007)	(0.029)	(0.026)
Location	0.039*	0.054	0.066*	0.013 (0.014)	0.205 (0.145)	-0.033
	(0.013)	(0.123)	(0.037)	-0.502***	1.154***	(0.041)
Constant	0.522***	1.759*** (0.153)	1.397***	(0.057)	(0.159)	0.738***
	(0.057)	Yes	(0.168)	Yes	Yes	(0.167)
Year Fixed Effects	Yes	10,595	Yes	10,595	10,595	Yes
Observations	10,595	0.232	7,987	0.799	0.209	7,987
R-squared	0.800					
F_Statistics	1142	33.60	2094	1193	33.06	1156
Number of Groups		2,137	1,986		2,137	1,986
Instrument Count			35			35
AR(1)			0			0
AR(2)			0.698			0.675
Hansen Statistics			0.123			0.229

Findings Con't'd

- Firms incur lower adjustment costs (higher adjustment speed) for both non-production workers and production workers
- Adjustment costs tend to be similar due to overlapping job roles and uniform labor policies (Porto and Hoekman, 2010).
- Labor demand is more elastic for production worker than for non production workers (Hamermesh, 1993; Popp, 2023)
- The overwhelming majority of estimates of wage elasticity fall with in the range [-0.75 -0.15] (Hamermesh, 2021; Popp, 2023).
- The best inference from these studies is that a 10% increase in labor costs will lead to a 3% decrease in number of employees.
- Cross wage elasticity coefficient show possibility of substitutability (Bognanno et al.,1987; Kölling's, 2018)
- Capital is complementary for both categories of workers but the coefficient is marginally higher for production workers

Findings Cont'd

- Labor-complementary dynamic promotes job creation in production roles within Ethiopian manufacturing firms (Soderbom et al., 2018).
- The findings align with strong capital-labor complementarity in labor-intensive manufacturing sectors (Chen et al., 2020; Curtis, 2021).
- TFP improvements primarily benefit production labor due to their direct involvement in manufacturing process (Dai et al. (2022)
- The coefficient of lag of alternative category of workers shows the two labor categories complement each other in production process
- For Brazilian and Mexican manufacturing firms, both tend to expand together in response to operational needs (Almeida and Carneiro, 2009).
- Firms located in the capital city exhibit a higher demand for production workers compared to those located outside the capital (Elvery and Dunn, 2021; Aghion et al., 2023).

Long-Run Estimates of Labor Demand

Variables	Non-production Workers	Production Workers
Ln(wage_nonprod)	-0.38***	0.21***
Ln(wage_prod)	0.25***	-0.44***
Ln(capital)	0.05***	0.06***
Ln(TFP)	0.08***	0.12**
Ln(age)	0.36***	0.31***
Location		0.10*

Empirical Evidences- Lon-Run Wage Elasticity

			Estimated Own-wage elasticity	
Country/Study	**Data**	**Frequency /Time Period**	**Non-production (Blue-collar)/ Skilled Labor**	**Production (White-collar)/ Skilled Labor**
Colombia/ Roberts& Skoufias (1997)	Firms	Annual/1981–86	-0.42	-0.65
Ghana/ Teal(2000)	Firms	Annual/1969–94	-0.44	-0.52
Chile/Fajnzylber & Maloney(2005)	Firms	Annual/1981–86	–0.32	–0.48
Mexico/Fajnzylber & Maloney(2005)	Firms	Annual/1986–90	–0.42	–0.44
Germany/ Falk and Koebel (2001)	Indust.	Annual/1976–95	-0.10	-0.21

Robustness Checks

To further validate the main results presented in above, we perform a series of robustness checks.

- ✓ *Re-estimating the model after excluding control variables*
- ✓ *Estimating the model with control variables dated at time t instead of t-1*
- ✓ *Estimating the level and differenced equations separately using instrumental variables or 2SLS estimators*

- The estimates for our key variables of interest remain consistent and robust

Conclusion and Policy Recommendations

- ✓ Our findings indicate that adjustment costs for both production and non-production workers are low and nearly identical
- ✓ Demand for non-production workers is less responsive to own-wage changes than for production workers which suggest that higher fixed costs associated with hiring or firing each additional non production workers both in short and long-run.
- ✓ The result also suggest that these two worker categories are both substitute and complement each other in the production process
- ✓ An increase in capital and TFP boosts the demand for both types of labor, with a relatively higher magnitude on production workers

Policy Implications Cont'd

- ✓ Low wage advantage alone is not enough to attract manufacturing FDI unless labor productivity is also enhanced
- ✓ Understanding labor adjustment costs helps policymakers design better interventions such as employment protection laws and training programs
- ✓ Policymakers must be mindful of the potential negative impacts of policies that raise labor costs, such as increase in minimum wage
- ✓ Occupation-based labor demand estimation helps to allocate resources towards education and training programs that are tailored to meet the needs of the labor market.
- ✓ Strengthening collaboration between higher education institutions and industry is crucial for boosting employment and productivity

Thank You