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Impact of Macroeconomic Factors on Manufacturing Productivity in Ethiopia

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Abstract
This study examines the main impacts of macroeconomic factors on manufacturing productivity in Ethiopia using a time series analysis from 1980 to 2020. The study reveals short-term and long-term determinants of manufacturing industry development. The Ethiopian manufacturing sector was able to achieve a vast change in value-added, especially between 1999 and 2020. However, from 1980 to 1999, the growth rate was erratic and slow, and around 1995 it recorded its worst performance. In the short term, the vector error correction model (VECM) results show that the first lag of manufacturing value added and real interest rates greatly impact manufacturing productivity, but other variables have no short-term impact. In the long run, variables such as the balance of payments, external debt, and real interest rates contribute to the positive development of the manufacturing sector, while other variables such as the exchange rate, monetary sector credit, and broad money balance affect manufacturing sector productivity negatively. Therefore, the Ethiopian government should pay due attention to improving the sector. Although the government is making great efforts to establish various industrial parks in the country, it lacks policies and subsidies for specific manufacturing sectors that can produce necessities. As the level of inflation and cost of living in the country intensify, targeting and prioritizing the manufacturing sector's production and productivity will be the best and most recommended solution so far.
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1. Introduction

In most cases, economic growth and recovery processes require increased productivity of factor inputs such as land, labor, capital, and technology (Alao, 2010). However, changes in macroeconomic policy variables such as interest rates, exchange rates, gross domestic product size, and foreign direct investment are now increasingly important to manufacturing productivity. Increasing productivity is therefore a surefire way to boost economic growth and improve living standards in any country. The design and implementation of effective productivity programs have helped many economies emerge from global recessions and put them on growth trajectories (Ernest Simeon Odior, 2013). According to Anyanwu, (2004), & Alao, (2010), post-World War II Japan and the United States in the post-1970s made high productivity a focal point of economic planning, and the results were evident.

The productivity of Ethiopia's manufacturing sector lags. The industries, mainly construction and services, accounted for most of the growth. Agriculture and manufacturing made a lower contribution to growth in 2017–18 compared to the previous year. Ethiopia's main challenges are sustaining its positive economic growth and accelerating poverty reduction (World Bank, 2019). Since the manufacturing sector plays a marginal role in employment generation, exports, output, and inter-sectorial linkages. The government of Ethiopia has taken different policy measures to sustain the country's economic growth so far. The main target is to increase the manufacturing sector's competitiveness by identifying the constraints. To that end, the government decides to raise the real effective exchange rate, implement a growth and transformation plan (GTP), increase wage competition, increase the economy's ability to supply the needed skills, mobilize private investment, both domestic and foreign, and an industrial park (IP) development program to address investment-climate-related issues such as land access, infrastructure, logistical, and customs processes, and to increase the attractiveness of profit But a real effective exchange rate did not result in the manufacturing sector being competitive. Even though maintaining a competitive exchange rate is an important component of maintaining external competitiveness, its macroeconomic effects, for instance on import prices and inflation, need to be managed closely. The growth and transformation mechanism in the manufacturing sector does not show significant change. The Growth and Transformation Plan (GTP) seeks to transform the economy from agriculture toward an industrialized economy to increase the per capita income of its citizens by 2025. Targeting small and medium enterprises (SMEs) is important as they are an engine for job creation and booming the economy. But unfortunately, Ethiopia has not made significant progress in pulling labor out of agriculture and into more productive and industrial jobs. Since then, the share of employment in the manufacturing sector has changed only slightly and is virtually unchanged since 1999 at below 5 percent of total employment (World Bank, 2014).

Ethiopia's manufacturing sector growth has been generally lagging. So for a clear understanding and effective policy intervention, studies were required. Only a few scientific studies were conducted relating to the manufacturing sector in Ethiopia. Those are Arkebe (2019), Tekleselassie et al. (2018), and Bigsten et al. (2008). Arkebe's (2019) study shows the manufacturing sector might be coming out of its doldrums and showing positive dynamics, but there are growing challenges in building an industrial workforce and domestic capability, together with export capacity. Studies by Tekleselassie et al. (2017) show that labor and material inputs drive firm-level outputs, while the elasticity of output to capital input is weak, due to the labor- and material-intensive nature of the textile and garment sector. Bigsten et al. (2008) found that geographical agglomeration of own-sector firms has a positive impact on firm-level productivity. However, the main motive for conducting this study is to examine the impact of macroeconomic factors on the productivity of Ethiopia's manufacturing sector. All, the aforementioned studies rely on a partial consideration of the sector, specifically the textile and garment industries, on the contribution of the manufacturing sector to economic growth, and on the structure and agglomeration of the sector's own effects. Consequently, this study answers the main research question, "To what extent do macroeconomic variables like the balance of payments, exchange rate, and credit to the manufacturing sector, real interest rate, broad money supply, foreign direct investment, and gross domestic product determine the productivity of the manufacturing sector in Ethiopia?" The next section of the study is a review of recent related literature on the topic, the methods of study, and the empirical results of the study, and the last section is about the conclusion and recommendations.

2. Literature Review

There are few theoretical and empirical studies that investigate the relationship between manufacturing sector productivity and macroeconomic factors. One way to connect the dots is to regress some of these selected macroeconomic factors on manufacturing productivity. However, manufacturing and productivity must be clearly defined. The manufacturing sector can be defined as "comprising establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products." Moreover, those engaged in "assembling of component parts of manufactured products" for purposes other than construction typically, manufacturing establishments are referred to as "plants," "factories," or "mills" (U.S. Census Bureau, 2012). But this definition is of limited usefulness in understanding how manufacturers and workers create economic value. According to Levinson (2017), the economic value of a manufactured good and the employment related to the production of that good may be derived from a wide variety of specific activities in addition to physical transformation. These nonmanufacturing activities contribute to value creation and employment in the process of creating manufactured goods and delivering them to end users. Those are business services such as research, design, marketing, logistics, and information technology, and the other is software development. These nonphysical inputs may be produced within the manufacturing firm itself or may be purchased from other firms.

The search for an exact definition of the concept of productivity has been complicated by studies. Productivity is a measure of the efficiency and effectiveness with which organizational resources (inputs) are utilized for the creation of products and/or services (outputs). Productivity measurement is both a measure of input utilization and an assessment of whether or not input utilization is growing faster than output. There are many different productivity measures. The choice between them depends on the purpose of productivity measurement and, in many instances, on the availability of data. Broadly, productivity measures can be classified as single-factor productivity measures (relating a measure of output to a single measure of input) or multifactor productivity measures (relating a measure of output to a bundle of inputs). Another distinction, of particular relevance at the industry or firm level, is between productivity measures that relate some measure of gross output to one or several inputs and those that use a value-added concept to capture movements of output (Baily et al., 1995). However, among those measures, the capital-labor multifactor productivity (MFP) approach is used since such measurement captures the value added only by avoiding double counting rather than gross output. Furthermore, because the study is being conducted at the level of a single sector (the manufacturing sector), the value-added approach is the most advantageous.

2.1. Manufacturing Sector in Africa

It is widely acknowledged that a competitive and private sector-led manufacturing sector plays a key role in the socio-economic transformation of the economy and the development of the sector as a whole. It is also the heart and soul of many developed and developing countries' economies, and it has the highest multiplier effect of any other sector (Teshome, 2014; Rama, 2015). In Africa as a whole, the growth of the manufacturing sector was largely state-led, either via the nationalization of pre-existing firms owned by foreigners or via Greenfield investment in large, capital-intensive, state-owned enterprises (Yaw et al., 2016). However, the manufacturing sector in Eastern Africa is not as important as it should be as to demand and its contribution to GDP (ranging from 3.8 to 11%), employment is small in the region, diversification is limited, and the level of technological

development is low. Much of the activity still consists of minimal processing of agricultural and mineral sources (ADB, 2014; Rioba, 2015). On the other hand, quantitative and qualitative accounts of the manufacturing sectors and the policy context in Sub-Saharan African countries suggest there are now excellent experiences and opportunities in a range of manufacturing subsectors such as garments and textiles, agro-processing, automobiles, and consumer goods in countries such as Ethiopia, Kenya, Mozambique, Nigeria, and Zambia (Balchin et al., 2016). Such unprogressive growth in the manufacturing sector requires systematic investigations and studies. Nevertheless, there is an attempt to do different studies relating to macroeconomic factors and manufacturing sector productivity in the world, and in particular in Africa. The following literature states the empirical studies and reports reviewed below.

Recent studies such as Syverson's (2011) revealed that one of the most significant findings in the productivity literature is the existence of wide variations in productivity and efficiency levels across establishments and firms. Abegaz (2013), in his study of technical efficiency and total factor productivity (TFP) in the Ethiopian manufacturing sector, found wide dispersion of efficiency and TFP levels among firms. Similarly, Hailu and Tanaka (2015) presented evidence of substantial technical efficiency variations in the sector. This prompts the question, "What explains such productivity differentials among firms?" The literature provides various factors affecting productivity and productivity growth in firms. These include factors internal and external to the firm.

On the issue of interest rates and manufacturing productivity, Sundararajan (1987) examined the linkages among interest rates, the debt–equity ratio of firms, the overall cost of capital, savings, investment, and growth in the Korean economy during 1963–1981. He used a dynamic framework that recognizes the complex interactions among these variables. According to him, a change in the unregulated rate, the overall cost of capital, the real interest rates, and the debt-equity choice of firms thereby set in motion a chain of responses influencing the desired level of the capital stock and its profitability, as well as the availability of savings and the consequent speed of adjustment of the actual capital stock to the desired level. Regarding the provision of credit and broad money balance, studies in Nigeria show that credit to the manufacturing sector in the form of loans and advances and foreign direct investment has the capacity to sharply increase the level of manufacturing productivity, while broad money supply has less impact (Odior, 2013).

Regarding access to and consumption of electricity and other infrastructure, Ayodele (2001) reiterated that electricity consumption is positively related to economic growth and that it is the nucleus of operations and thus the engine of growth for the manufacturing sector. He concluded by saying that electricity consumption has a diverse impact on the range of socio-economic activities and, consequently, the living standards of Nigerians. According to the World Bank (2015), in Ethiopia, the poor reliability record of electricity can be attributed to poor maintenance and a lack of upgrades to transmission and distribution grids. Ethiopia has the lowest electricity tariff in comparison to its comparator countries. This low pricing undermines the capacity of the national electricity company to finance network maintenance and upgrades of transmission and distribution grids. The strengthening of the grid network is an essential part of EEPCO’s strategy. The upgrading of the network by reinforcing existing (and adding new) transmission and distribution lines to provide energy access to high energy-consuming industrial areas and promote electricity exports is a major focus of the sector strategy. The success of this strategy will be instrumental in reducing the additional costs that are being borne by the private sector and, thereby, profitability due to poor reliability and quality of electricity supply.

Human capital, as measured by educational attainment, plays a crucial role in determining a firm’s performance, such as output, productivity, and profit (Honig 2001). Recently, Raggl (2015) investigated the relationship between human capital and total factor productivity in the Middle East and North Africa region, covering the period between 1980 and 2009. His findings suggest that human capital plays an important role in changing the efficiency with which existing input factors are used. The author emphasizes the need to achieve a certain threshold level of educational attainment if domestic innovations are to be efficient. The World Bank (2012) studied the investment situation of Chinese FDI in Ethiopia. The study found labor productivity to be very low due to inadequate education. Hailu and Tanaka (2015) also showed that, despite Ethiopia’s abundant human resources, the quality of the labor force is generally low. There is a lack of practical, systematic, and targeted worker training programs and implementation methods that can improve workers’ production efficiency and productivity in companies. Also, Omojimite (2011), in his study of human capital development in Nigeria, posits that the level of available human capital is low and there is a need for more emphasis on training to enhance its potential to contribute to economic development. Skills shortages in Ethiopia constitute a key constraint to growth and improved productivity in the manufacturing sector, although data demonstrates variation by firm size, age of the firm, and other characteristics. The analysis demonstrates that larger and foreign-owned firms are significantly more likely to cite poor skills as an impediment to increased productivity in the manufacturing sector. This observation resonates with the findings of an analysis of light manufacturing in Africa by the World Bank (2012), which highlighted the poor supply of appropriately skilled labor as a major obstacle to improving the competitiveness of the manufacturing sector in Ethiopia.

McKinnon (1973) and Shaw (1973) emphasized the importance of internal and external finances in the development of the manufacturing sub-sector in developing countries. While McKinnon emphasizes the significance of internal finance, where investors accumulate savings before obtaining lumpier capital goods, Shaw stresses the importance of external finance and the development of financial institutions in capital accumulation. Parsaei & Mital (1992) observe that small enterprises are most likely to face credit rationing because most potential lenders have little information on the managerial capabilities or investment opportunities of such firms and are unlikely to be able to screen out poor credit risks or have control over borrowers' investments.

In an earlier study on export orientation, Bernard & Jensen (1999) found that US firms increased their productivity after entering international markets. Using data on Slovenian manufacturing firms operating in the period 1994–2000, De Loecker (2007) explored the effect of exporting on productivity. He discovered that exporting firms gained more productivity than non-exporting firms, and that productivity increased over time. Moreover, in a sub-Saharan African manufacturing firm, Van Biesebroeck (2005) reported that productivity appears to be strongly associated with exporting. Similarly in Ethiopia, Bigsten and Gebreeyesus (2009) studied the relationship between exports and firm productivity using firm-level panel data for the Ethiopian manufacturing sector and reported that productivity appears to be strongly associated with exporting. They concluded that exporting firms pay higher wages, have more workers, and have more capital per worker.

Studies on the effect of management practices on manufacturing productivity by Bloom et al. (2013), Iddrisu et al. (2012), and Syverson (2011) show management practices play an important role in firm productivity. Bloom et al. (2013) investigated whether managerial skill explains productivity differentials among Indian textile firms using a randomized field experiment. The researchers provided free consulting on management practices to randomly chosen treatment plants and compared their performance to a set of control plants. Their finding shows that adopting these management practices "raised productivity by 17% in the first year through improved quality and efficiency and reduced inventory" and within three years led to the opening of more production plants. A cross-country study by Bloom et al. (2005) looking at medium-sized manufacturing firms in Europe and the US found that good managerial practices are strongly associated with superior firm performance in terms of productivity, return on capital employed, and sales growth. Goldfarb & Xiao (2011) assessed the effect of managerial capability on firm performance among US telephone service providers. The authors found that enterprises run by high-ability managers were more likely to survive and have higher revenue. Using longitudinal data in the metalworking sector in Addis Ababa, Abebe (2012) finds that foreign-owned firms had better productivity due to their superior management practices.

To examine the firm size and productivity relationship, Leung et al. (2008) explored the relationship between firm size and productivity using a Canadian administrative dataset during the 1984–1997 period. The authors also tried to gauge the magnitude of the firm-size productivity relationship and found a significant size-productivity relationship in terms of both labor productivity and total factor productivity. The size-labor productivity relationship is stronger in the manufacturing sector, while a positive and stronger relationship between firm size and total factor productivity was found in non-manufacturing. Evidence from Van Biesebroeck (2005) also indicated significant variation in the total factor productivity distributions of large and small African manufacturing firms. Using data on publicly traded manufacturing firms, Lee and Tang (2001) found that firms with more than 500 employees and firms employing between 100 and 500 employees are 17 percent and 15 percent more productive than firms with less than 100 employees, respectively. On the contrary, Taymaz (2002) found a negative relationship between productivity growth rates and firm size.

Additionally, some studies show that firm age and productivity are related. A study by Jensen et al. (2001) on productivity levels of different age cohorts suggests that new entrants are more productive compared to established firms. According to the authors, surviving cohorts tend to increase productivity levels over time, while productivity levels of entering cohorts are observed to converge after five to ten years. In line with this, Taymaz (2002) argues that new firms are likely to experience higher productivity growth rates than existing firms. Other studies by Celikkol (2003) found a positive relationship between age and firm productivity growth rates in the U.S. food and related products industries. Other firm productivity determinants, which are external to the firm, include firm infrastructure facilities, regulations, trade policies, development, and access to finance (Bloom et al., 2010).

Another macroeconomic factor influencing firm productivity is the effect of the exchange rate. For instance, Fong and Liu's (2009) finding shows the relationship between the exchange rate and firm performance in Taiwan. They claimed that currency depreciation increased the value added and productivity. Besides, the productivity growth of firms was found to be affected by the depreciation of the exchange rate through firm-scale expansion. Furthermore, Caglayan and Demir (2014) investigated the impact of exchange rate volatility and real exchange rate appreciation on manufacturing firm productivity. The study was conducted in Turkey, and the results showed that changes in the exchange rate (appreciation) have a negative impact on the growth of firm productivity.

Tomlin and Fung's (2010) study shows that when the real exchange rate appreciates, the number of firms that stay in the market goes down, which also reduces the growth of firm productivity. On the other hand, the studies of Dhasmana (2013), Tsui (2008), and Swift (2007) show the impact of exchange rates is ambiguous. Dhasmana (2013) investigated the determinants of the exchange rate in Indian manufacturing firms, and the result indicates exchange rate movements significantly affect industrial productivity. Tsui (2008) studied exchange rates and profit margins in terms of export rate, imported input rate, and external exposure index, which affect revenue and costs in manufacturing sectors, in order to find a relationship. He found that the appreciation of the home currency in Taiwan has a positive impact on the manufacturing sector when profit margins are high. Swift (2007) examined the relationship and found that when the real exchange rate appreciates, the number of firms that stay in the market goes down, which also reduces the growth of firm productivity. On the other hand, the studies of Dhasmana (2013), Tsui (2008), and Swift (2007) show the impact of exchange rates is ambiguous. Dhasmana (2013) investigated the determinants of exchange rates in Indian manufacturing firms, and the result indicates exchange rate movements significantly affect industrial productivity. Tsui (2008) studied exchange rates and profit margins in terms of export rate, imported input rate, and external exposure index, which affect revenue and costs in manufacturing sectors, in order to find a relationship. He found that the appreciation of the home currency in Taiwan has a positive impact on the manufacturing sector when profit margins are high. Swift (2007) examined the relationship between exchange rates and investment in individual and whole manufacturing sectors in Australia. The results of the study showed that total manufacturing sector growth responded in terms of investment to the currency changes, positively impacted export share, and negatively impacted imported input costs. So the review of the literature provided various results since the relationship between exchange rate and manufacturing value added shows different and ambiguous results.

Regarding manufacturing sector productivity and inflation (the Consumer Price Index), the studies of Vaona (2012) confirm that inflation negatively affects the growth of the manufacturing sector. Mwakanemela's (2014) study in Tanzania from the period of 1980 to 2012 indicates that the inflation rate negatively impacts manufacturing performance. Inflation has a negative effect on manufacturing sector growth and economic growth in general, according to Chaudhry, Ayyoub, and Imran (2013), Gumbe and Kaseke (2011), Gopakumar and Salian (2010), and Medee (2015). Contrary to this negative effect of inflation, the study of Adaora (2013) states the positive relationship between inflation and manufacturing sector growth in Nigeria, and the Kumar, Webber, and Perry (2012) studies indicate the limited statistical significance of inflation on manufacturing sector productivity in Australia. Generally, the review of the studies shows an indefinite relationship between inflation and manufacturing sector performance.

The effect of broad money supply on manufacturing sector growth is shown by the studies of Athukorala (1998), Saygin and Evren (2010), Shaw (1973) and Mckinnon (1973), and Rina, Tony, and Lukytawati (2010). According to Athukorala's (1998) research, any discretionary change in the supply of money will have a permanent impact on real output by lowering interest rates and stimulating investment and output growth through the marginal efficiency of capital. According to Shaw and Mckinnon (1973), market forces induce higher interest rates, which increase investment by channeling savings to efficient investments and stimulate the growth of real output in capital-intensive sectors such as manufacturing. They came to the conclusion that the money supply has a positive effect. The study by Saygin and Evren (2010) in the Turkish manufacturing sector found that all the manufacturing sectors responded to a tightening of the money supply with an absolute reduction in total output. Opposing the positive relationship between money supply and manufacturing sector growth, the study of Alam and Waheed (2006) supports the negative relationship. Alam and Waheed's (2006) studies in Pakistan found that by causing shocks to the interest rate, the change in the money supply caused the manufacturing sector to decline. According to the literature, the money supply has both positive and negative effect.

According to the World Bank's (2015) 4th Ethiopia Economic Update, overcoming constraints in the manufacturing sector shows the variation of some macroeconomic variables and their relation to the manufacturing sector of Ethiopia. Private investment, both domestic and foreign, is crucial for developing the manufacturing sector. A better investment climate that fosters the growth of existing firms while encouraging the creation of new ones is key to attracting and increasing private sector investments in particular and manufacturing sector growth in general. The World Bank shows in its report that macro variables like inflation, broad money, government budget, current account, and exchange rate fluctuated over time and had their own significant effect on sector growth. For instance, in May 2015, headline inflation continued its upward trend, albeit at relatively low levels, and reached 9.4 percent. Low inflation over the past two years contributed to lower real interest rates, which meant that the maximum lending rate remained positive since December 2012 and the real minimum deposit rate was close to zero in September. Broad money is growing relatively faster, and credit growth at state-owned enterprises (SOEs) is the major contributor to that growth. Looking at broad money growth, it shows a consistent upward trend from 21% in March 2014 to 30% in November 2014. Net domestic credit growth reached 31 percent in November 2014. Public sector credit continues to be the main driver, with

credit to SOEs increasing by 37 percent (year-on-year) in November 2014. The budgetary stance at the general government level has been cautious. The general government fiscal deficit (excluding SOEs) remained modest at 2.6 percent of GDP but increased by 0.7 percentage points of GDP in 2013–14. On the other hand, the chronic current account deficit deteriorated in 2013/14 due to trade balances and declining transfers. The current account deficit (including official transfers) reached 8.6 percent of GDP, up from 5.3 percent in 2012/13. Again, the real effective exchange rate continued to appreciate into 2014/15. The real exchange rate appreciated by 22.5 percent (year over year) at the end of April 2015, showing a cumulative appreciation of 71 percent since the nominal evaluation in October 2010.

Generally, all the aforementioned studies and reports provide some clues on the relationship between macroeconomic factors, manufacturing growth, and GDP growth. Some macroeconomic factors have a positive effect on manufacturing sector growth on the one hand and a negative effect on the other, which is inconclusive. Moreover, as the World Bank report in Ethiopia shows, macroeconomic factors are reluctant to vary through time. Such variation probably has its own effect on the business environment, especially on manufacturing firms' productivity. So it requires studies to investigate the impact of those macroeconomic variables on manufacturing sector productivity in Ethiopia.

3. The Data Set

From 1980 to 2020, 40 years of time series data were used. The data used for this study was obtained from the national central statistical agency, the World Bank, and the Ethiopian macrodata set. This means manufacturing productivity and the determinant factors (macro-economic variables) obtained from;

- https://www.indexmundi.com/facts/Ethiopia,
- Federal Reserve Economic Data, 4/15/2020, Link: https://fred.stlouisfed.org,
- Central Bank Latest actual data (2018/19).
- International Monetary Fund, World Economic Outlook Database, April 2020 were referred.

4. Methodology of the Study

In this study, different inferential and econometric models were used to examine the relationship between manufacturing sector productivity and macroeconomic factors. The preliminary tests, like the stationarity test by an augmented-ducky fuller, the lag selection criteria by Bayesian-Schwarz criteria, and the co-integration test by Johnson co-integration, have been done. After those preliminary tests, the main estimation of the model was conducted. The estimation model is a restricted vector auto regression (VAR) model (i.e., a vector error correction model (VECM)) because the dependent and independent variables are stationary under I (1) and there is co-integration (long-run association) among variables. Finally, the diagnostic testing that will be used includes the Breusch-LM test for variable autocorrelation and the stability test.

A VECM model is a model in which all of its variables are not only influenced by its own history but also the histories of all the other variables.

Hence, the VECM model can be expressed as,

$$\Delta Yt = \delta + \sum\beta 1\Delta Yt - 1 + \sum\beta 2\Delta Xt - 1 + \gamma ECTt - 1 + Ut \quad \text{..... (1)}$$

Where,

Yt is the dependent variable

Yt-1 is the lag of the dependent variable

Xt-1 is the lag values of other explanatory variables.

δ = the constant,

$\sum\beta i$ = the short run coffiecents,

γ = the speeed of adjustment,

Ut =the error term and,

ECTt=error correction term which is the lag value of the residual.

So far we can re-specifying the equation (1) as;

$$Yt = \delta + \sum\beta_i Xt + £_t, \text{ so } \quad ECT_{t-1} = Y_{t-1} - \sum\beta_i X_{t-1} - \delta \quad \text{..... (2)}$$

This shows the co-integrated equation and the long-run model. So to examine how foreign direct investment, exchange rate, the balance of payments, the external debt stock, monetary sector credit, the real interest rate, and the broad money supply from 1980–2020 affect the value added to the manufacturing sector in Ethiopia, we can have the following short-run model.

$$\mathbf{ln}MVA\boldsymbol{t} = \delta + \mathbf{ln}MVA_{t-1} + \beta_2 \boldsymbol{ln} FDI_{t-1} + \beta_3 \boldsymbol{ln} REER_{t-1} + \beta_4 \boldsymbol{ln} BOP_{t-1} + \beta_5 EDS_{t-1} + \beta_6 RealR_{t-1} + \beta_7 CMS_{t-1} + \beta_8 BMB_{t-1} + ECT_{t-1} \quad \text{..... (3)}$$

Where,

lnMVAt = logarisim of Value added to manufacturing sector at time t-1 lag , measured at current US$

lnFDIt = logarisim of net inflows of foreign direct investment at time t-1 lag, measured at current US$

lnERt = logarisim of effective exchange rate at time t-1 lag, measured by national currency per USD, IMF based.
lnBOPt = logarisim of balance of payment at time t-1 lag, measures the Net trade in goods and services at current US$.
EDSt =external debt sock at time t-1 lag, measured by % of GNI.
CMSt = credit to manufacturing sector at time t-1 lag, measured by % GDP.
RealRt =real interest rate at time t-1 lag, measured in percentage/%
BMB = Broad money balance at time t-1 lag, measured by % GDP.
ECTt= the error correction term at time t-1 lag.
δ: The constant
$\beta_{1,2.....8}$=the coefficients/parameters
While, the long run model can be written as,

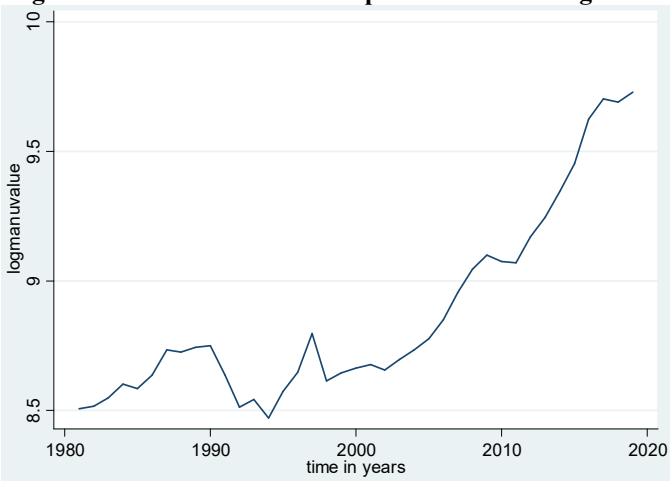
$$ECT_{t-1} = \mathbf{ln}MVA_{t-1} - \beta_2 \boldsymbol{ln}FDI_{t-1} - \beta_3 \boldsymbol{ln}ER_{t-1} - \beta_4 \boldsymbol{ln}BOP_{t-1} - \beta_5 EDS_{t-1} - \beta_6 RealR_{t-1} - \beta_7 CMS_{t-1} - \beta_8 BMB_{t-1} - \delta \quad (4)$$

5. Results of the Study

5.1. The performance of Ethiopian manufacturing sector

Even if the manufacturing sector of underdeveloped economies like Ethiopia is fragile with weak and unbalanced linkages and spillover effects, producing unsophisticated basic consumer goods, the growth of the sector is progressing over time. As the government of Ethiopia is focusing on transforming the economy using agriculture-led industrialization and transformation strategies, the performance of the manufacturing sector has shown great improvement over the past three decades. As shown in the graph below, the value added in the manufacturing sector increased significantly after 1999 and will continue to do so until 2020. However, between 1980 and 1999, the growth was not stable, especially around 1995, when it was at its lowest.

Figure 1: Performance of Ethiopian manufacturing sector



5.2. Stationarity test

A stationary time series is one whose statistical properties, such as mean and variance, are all constant over time. Most statistical forecasting methods are based on the assumption that the time series can be rendered approximately stationary; however, the data were not always stationary. The Augmented Dickey-Fuller test (ADF test) is the most common statistical test used to test whether a given time series is stationary or not. To do so, the first step is to determine the number of differences required to make the series stationary because a model cannot forecast on non-stationary time series data. As a result, as shown by the estimate below, all variables are not stationary at the level because the p-value is not significant at any percent of the critical value. All are nonstationary at 1% or higher since the test statistics, or z(t), are greater than the critical values at a different level of significance (1%, 5%, and 10%), or all p-values are > 0.05.

Variable	Test statistic z(t)	1% critical value	5% critical value	10%critical value	P-value
Stationarity test at level					
Manufacturing value added	1.408	-3.662	-2.964	-2.614	0.9972
Real interst rate	-2.387	-3.662	-2.964	-2.614	0.1454
Broad money balance	-1.882	-3.662	-2.964	-2.614	0.3406
External debt shock	-1.399	-3.662	-2.964	-2.614	0.5827
Monetary sector credit to manufacturing	-1.227	-3.662	-2.964	-2.614	0.6621
Balance of payment	-0.28	-3.662	-2.964	-2.614	0.9283
Foreign direct investment	-1.28	-3.662	-2.964	-2.614	0.6382
Exchange rate	-1.431	-3.662	-2.964	-2.614	0.5674

Table 1: The Augmented Dickey-Fuller stationarity test at level.

As a general rule, non-stationary time series should not be used in regression models to avoid spurious regressions, so we have to make the data stationary by differencing at a different level. Unfortunately, as the test result below shows, the variable is stationary at the first difference. So we can conclude that the dependent variable "manufacturing value added" is stationary at 1, and all the independent variables also become stationary at 1.

Variable	Test statistic z(t)	1% critical value	5% critical value	10%critical value	P-value
Stationarity test of first difference					
Manufacturing value added	-4.936	-3.668	-2.966	-2.616	0.0000
Real interest rate	-7.031	-3.668	-2.966	-2.616	0.0000
Broad money balance	-5.125	-3.668	-2.966	-2.616	0.0000
External debt shock	-5.112	-3.668	-2.966	-2.616	0.0000
Monetary sector credit to manufacturing	-4.411	-3.668	-2.966	-2.616	0.0003
Balance of payment	-11.36	-3.668	-2.966	-2.616	0.0000
Foreign direct investment	-5.018	-3.668	-2.966	-2.616	0.0000
Exchange rate	-4.774	-3.668	-2.966	-2.616	0.0001

Table 2: The stationarity test at first difference

5.3. Co-integration

If our variables are discovered to be co-integrated, that is, if there is a linear, stable, and long-run relationship between them, the disequilibrium errors will tend to fluctuate around the mean zero. In the literature, co-integration tests, e.g., Engle and Granger (1987), Johansen (1988), Johansen and Juselius (1990), Pesaran et al. (2001) are used to confirm the presence of a potential long-run equilibrium relationship between two variables. We used Johansen's technique in order to establish how many co-integration equations exist between variables. The results show that the maximum eigenvalue statistic suggests the presence of one co-integrating equation among the four variables in the Romanian economy at a 5% level. The test suggests that our set of co-integrated time series has an error-correction representation that reflects the long-run adjustment mechanism. As the result in the table below shows, there are six co-integrated equations. This is because, as the asterisk (*) under trace statistics shows, we cannot reject the null hypothesis that says there are only six co-integrated equations. Because the result shows that the trace statistics are greater than the 5% critical value, if we get one or more co-integrated vectors (error terms) in the model, we say that there exists a long-run relationship among the variables.

Rank	Parms	LL	eigen value	trace statistic	5% critical value
0	72	-207.43	.	258.617	156
1	87	-170.2	0.8663	184.168	124.24
2	100	-144.06	0.75666	131.875	94.15
3	111	-121.98	0.69669	87.7341	68.52
4	120	-105.46	0.59073	54.6786	47.21
5	127	-93.92	0.46401	31.6042	29.68
6	132	-84.902	0.38583	13.5673*	15.41
7	135	-78.287	0.30059	0.3389	3.76
8	136	-78.118	0.00912		

Table 3:Co-integration test

Note: the * shows the number of co-integrated equation.

Hereafter, if there is co-integration and the data is stationary at the first difference the appropriate model is the VECM or restricted VAR model. Now let us estimate both the short-run and long-run models.

5.4. VECM estimation

If a set of variables is found to have one or more co-integrating vectors, then a suitable estimation technique is a VECM (Vector Error Correction Model), which adjusts for both short-run changes in variables and deviations from equilibrium. Lag length criteria also suggest the choice of one lag for estimating VECM.

5.4.1. Short run model

As per Ahmed (2001), the main feature of the ECM (Error Correction Model) is its capability to correct for any disequilibrium that may shock the system from time to time. The error correction term picks up such disequilibrium and guides the variables of the system back to equilibrium. The short-run model fits well, and the adjustment parameter (_cel) is also significant. The result shows that the coefficient of the error term (or the speed of adjustment term) for the estimated manufacturing productivity equation is statistically significant and negative, as expected. The coefficient of 0.0633 shows that it is significant at a 10% level of significance, and it can be interpreted as 6.33%, meaning that frequent downward adjustments take place each year from the long-run equilibrium. Or the precious year error (deviation from the long-run equilibrium) is corrected within the current year at a convergence speed of 6.33%.

As per the result, the only 1st lag of manufacturing value added and real interest rate is significant at 1% (p-value is less than 0.01); apart from that, no other lag is significant even at the 10% significance level. That is, the only first lag of lnMVA and RealR has a short-term causality with growth in the manufacturing sector. The significant variables are interpreted as follows: if the previous year's manufacturing sector growth increased by 1%, the current year's manufacturing sector will grow by 1.1637 percent on average, holding other things constant. This implies that the future growth of the sector is highly dependent on its previous performance. So far, when the real interest rate increases by 1%, Ethiopia's manufacturing sector growth will decline by 0.1256% on average. Assume other factors other than the real interest rate remain constant. This implies that when the cost of capital or interest rate is higher, investment in the manufacturing sector shrinks, and thereby the performance of the sector is going to be reduced.

D_lnMVA	Coef.	Std. Err.	Z	P>z	[95% Conf.	Interval]
_ce1						
L1.	-0.0633	0.03412	-1.85	0.064	-0.1302	0.0036
lnMVA						
LD.	1.16367	0.44523	2.61	0.009	0.29105	2.0363
lnBOP						
LD.	-0.0073	0.08879	-0.08	0.934	-0.1813	0.16671
lnFDI						
LD.	0.02228	0.02072	1.08	0.282	-0.0183	0.06289
lnER						
LD.	-0.0077	0.07808	-0.1	0.921	-0.1607	0.14533
CMS						
LD.	0.00529	0.00906	0.58	0.559	-0.0125	0.02305

EDS						
LD.	-1E-05	0.0014	-0.01	0.994	-0.0028	0.00274
BMB						
LD.	0.00732	0.00675	1.08	0.278	-0.0059	0.02056
RealR						
LD.	-0.1256	0.04957	-2.53	0.011	-0.2227	-0.0284
_cons	-0.0062	0.02032	-0.31	0.76	-0.046	0.03363

Table 4: The estimation result of short run model

5.4.2. Long run model

As discussed by Johansen (1995), if there are r co-integrating equations, then at least r2 restrictions are required to identify the free parameters. Johansen proposed a default identification scheme that has become the conventional method of identifying models in the absence of theoretically justified restrictions. We are interested only in the estimates of the parameters in the co-integrating equations, so we can specify the notable option to suppress the estimation table for the adjustment and short-run parameters. So that the estimate below is the long-run or Johansen normalization. The Johansen normalization coefficient is interpreted in the opposite direction (the negative sign as positive and vice versa).

Beta	Coef.	Std. Err.	Z	P>z	[95% Conf.	Interval]
_ce1						
Logmanuvalue	1	.	.	.	.	.
Logbop	-0.7276	0.10046	-7.24	0.000	-0.9245	-0.5307
Logfdi	-0.0165	0.01546	-1.06	0.287	-0.0468	0.01384
Logexchange	0.31175	0.05714	5.46	0.000	0.19976	0.42373
nmontarysectrcredit	0.02628	0.00783	3.36	0.001	0.01094	0.04163
Nexternaldebtshock	-0.0085	0.00119	-7.19	0.000	-0.0109	-0.0062
Nbroadmoney	0.01663	0.00278	5.97	0.000	0.01117	0.02208
nrealR	-0.1908	0.01891	-10.09	0.000	-0.2279	-0.1537
_cons	-2.675	.	.	.	.	.

Table 5: The estimation result of long run model

In the long run, the balance of payments, exchange rate, monetary sector credit, external debt stock, broad money balance, and real interest rate are significantly related to manufacturing sector growth. In the long run, the productivity of the manufacturing sector increased by 0.7276% as the balance of payments increased by 1% on average under ceteris paribus conditions. This is because the balance of payment (export-import) has an immense effect on the manufacturing sector's advancement. Even though Ethiopia's balance of payments is usually in deficit, even a small improvement would have a significant impact on the development of the manufacturing sector. When the exchange rate and the level of monetary sector credit given to private sector investment increase by 1 percent, the productivity of the manufacturing sector declines by 0.31175% and 0.02628% on average, respectively. This is due to the fact that when the exchange rate increases, the cost of imported capital goods becomes very expensive, which will discourage investors. This, combined with investors' limited access to financial and credit services from local banks, has slowed the manufacturing sector's performance thus far. Still, there is strong evidence that lending to small-scale enterprises is left behind. State-owned banks, on the other hand, are better at providing credit, particularly to large manufacturers.

The real interest rate and external debt stock have a positive contribution to the productivity of the manufacturing sector. When external debt stock and the real interest rate increase by 1%, the manufacturing sector's development will increase by 0.0085% and 0.1908%, respectively. This is most likely due to an increase in interest rates, which may result in more capital inflows as capital flows to the point where it yields a high return. Debt may also have a positive influence on the sector's performance because most of the debt agreement is between the government and the loan provider, while the manufacturing sector in Ethiopia is multi-type, which means private (domestic or foreign) and public-owned. So far, the government has worked to develop the manufacturing sector through efficient loan provisions and subsidies. So the debt stock may be high, but the sector may upturn. Also, the broad money balance as a percent of the country’s GDP has a negative effect on the manufacturing sector's development, and the coefficient is interpreted as follows: when the broad money balance increases by 1%, the productivity of the manufacturing sector decrease by 0.01663% on average, holding other

things unchanged. This is most likely due to the birr's declining purchasing power, as an investment in the sector requires a large amount of working and start-up capital, which the majority of investors lack.

5.5. Post estimation test

5.5.1. Autocorrelation test

When a model for the data generation process of a time series or a set of time series has been constructed, it is common to perform checks on the model's adequacy. Tests for residual autocorrelation (AC) are prominent tools for this task. A number of such tests are in routine use for both stationary and nonstationary processes with integrated or co-integrated variables. Well-known examples are the portmanteau and Lagrange multiplier (LM) tests for residual AC. As the test results in the table below show, there is no autocorrelation since prob>chi2 is greater than 0.05.

Lagrange-multiplier test

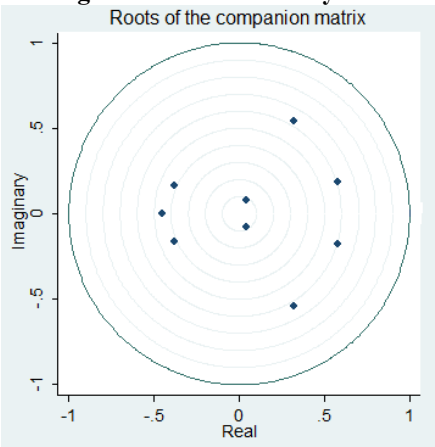
lag	chi2	df	Prob > chi2
1	59.2024	64	0.64646
2	56.8015	64	0.7265

Table 6: Autocorrelation test

5.5.2. Stability test

All the eigenvalues lie inside the unit circle. VAR satisfies the stability condition. Because the modulus of each eigenvalue is strictly less than 1, the estimates satisfy the eigenvalue stability condition. The graph plots the eigenvalues of the companion matrix, with the real component on the x-axis and the imaginary component on the y-axis. The graph clearly shows that there is no close relationship between the root and modulus on the unit circle. If any of the remaining moduli computed by vecrank, graph is too close to one, either the co-integrating equations are not stationary or there is another common trend, and the rank specified in the model is too high (Johansen, 1995). But the graph below shows that the moduli computed are not close to 1.

Figure 2: Model stability test



6. Conclusion and Recommendation

This study investigates the main impacts of macroeconomic factors on manufacturing sector productivity in Ethiopia using a time series analysis starting from the years 1980–2020. The research identified the short- and long-run determinants of manufacturing sector development. Ethiopia's manufacturing sector undergoes significant value-added changes, particularly between 1999 and 2020. However, there was an unstable and low growth rate between 1980 and 1999, and around 1995, there was the lowest performance. In the short run, the VECM result shows the first lag of manufacturing value added and the real interest rate has a significant impact on the manufacturing sector's productivity, while other variables have no short-run impact. The first lag in manufacturing sector productivity has a positive effect on future productivity, while the real interest rate has a negative influence. But In the long run, many macroeconomic factors have a significant relationship with the manufacturing sector's productivity. The balance of payments, exchange rate, monetary sector credit, external debt stock, broad money balance, and real interest rate are significantly related to manufacturing sector growth. Variables such as the balance of payments, external debt stock, and real interest rate contribute positively to the manufacturing sector's development, whereas other variables like the exchange rate, monetary sector credit, and broad money balance have a negative effect on the sector's productivity.

Hence, the government of Ethiopia needs to pay due attention to the enhancement of the sector. Even if the government is putting much effort into establishing different industrial parks in the country, it lacks the resources

to do so and subsidize specific manufacturing sectors that can produce more basic goods. As the level of inflation and cost of living in the country intensify, targeting and prioritizing the manufacturing sector's production and productivity will be the best and most recommended solution so far. This can be done by improving the balance of payments, increasing interest rates, especially deposit rates, and increasing debt gains from different lending agencies.

7. Competing Interests

The author declares that there is no financial and nonfinancial competing interest related to this work.

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