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Forecasting Uganda's Industrial Production Index Using Grey Systems Forecasting

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Abstract

Economic growth is always the ideal for any country, and industrialization is a major pillar for growth and transformation. Although slow, Industrial Production in Uganda is growing and this paper forecasts the country's Industrial Production Index over five years from the year 2016 to 2020. Results and show that farther increase in Total Production can be expected and as most production categories will continue to grow, some will see very little growth and others decline. The paper suggests tighter restrictions on the importation of goods that are already domestically manufactured especially for the case of those in the Textile, Clothing and Footwear category which is forecasted to decline.

Keywords: Forecasting; Grey Systems Forecasting; Even GM (1,1) Model; Industrial Production Index; Manufacturing; Uganda.

1. Introduction

The small landlocked East African country seats on a total area of 241,038 square kilometers with over 21% of the accessible land farmable, arguably reliable rainfall numbers and numerous navigable waters, both lakes and rivers. Although small, Geo-scientific investigations confirm Uganda has a diversity of minerals including phosphate, gold, vermiculite, copper, cobalt, limestone, clay, iron ore and salt [1]. But not much of these resources goes into production as the country's economy has largely hinged on agricultural production for decades. On top of that, being a landlocked country, major expenses on and transportation and taxation make imports more expensive as compared to the neighboring Kenya and Tanzania, this is detrimental considering the country imports a lot more than it exports.

As of the year 2008, Uganda was ranked eighth in the world and number one in sub-Saharan Africa as the country with the most flexible labor markets in terms of "ease of employing workers". [1] But while labour markets in Uganda are flexible, this does not seem to flow through to productivity. The most recently updated population statistics show that the country has up to 39 million people, and according to UNHS 2012/2013, the total working population was estimated at 13.9 million people (35% of the population), but the total employed population was estimated at 7.9 million. A difference of 6 million people, which is high for persons living as subsistence farmers in the economy. [2].

The Ugandan government acknowledges the role of the industrialization in economic development and is keen on bolstering the industrial sector. With the "National Industrial Policy" of the year 2008, the government has put forward measures to invest in and develop natural domestic resource-based industries such as petroleum, cement and fertilizer industries, on top of that, the government promotes competitive industries that use local raw materials. A major step has been taken to create a business friendly environment for private sector led industrialization in order to develop and increase productivity and quality, steps likes investment in transportation infrastructure, encouraging foreign direct investment in Industry and maintaining political stability which are vital for the sector to thrive have been taken to ensure that the desired growth is achieved.

With the help of reviewed literature i.e. government publications and academic articles, using data from the Uganda Bureau of Statistics from the the years 2008 to 2015, this paper forecasts Industrial Production Index (IPI) to estimate Production over the next five years using Grey Systems Forecasting, analyzes the results and makes conclusions as regards to what can be expected in the near future.

2. General Overview of the Industrial Sector in Uganda

According to the Uganda Bureau of Statistics, Industrial Sector data is collected and compiled into the following categories; "Food Processing", "Beverages and Tobacco", "Textiles, Clothing and Footwear", "Sawmilling, Paper and Printing", "Chemicals, Paint, Soap & Foam Products", "Bricks and Cement", "Metal Products" and lastly "Miscellaneous".

In the early years of the National Resistance Movement (NRM) government, specifically the first decade, economic growth averaged at 6.9% per year [1]. Comparing the percentage share of industry to GDP over the years, it's clear that the sector has generally been struggling. In the year 1990, the share of industry to GDP was 11%, ten years later it stood at 22.8% and further increase by 2008 at 27.3% [6]. Looking at the statistics, the year 2009 marks the beginning of the decline as it dropped to 21.8% and has since then averaged at 21.4% over the seven years to the year 2015 and according to the World Bank Databank, as of the year 2015, the contribution of the industrial sector to Uganda's GDP is only 21.3% [6].

For the financial year in 2015/16, the Industrial sector grew by 4.0%, a decline compared to the 7.8% growth from the previous year. The slow growth was largely as a result of poor performance in the manufacturing activities [2]. The general slow growth and stagnation of industrial activity mainly "production and output levels" has been as a result of issues like inadequate infrastructure and according to the World Competitiveness Report, the second pillar of competitive disadvantage is infrastructure related as Uganda ranks very low in areas of electricity supply, an issue which has largely affected and dented manufacturing activity. Port, railroad development and road quality are also areas that are still lacking which makes transportation difficult and therefore expensive thus increasing total production costs, a major competitive disadvantage factor.

Manufacturing in Uganda largely depends on the agricultural sector for raw material supply, and low agricultural productivity generally increases competition for the available agricultural raw materials therefore increasing the costs. Another major factor is the low scale adaptation of technology and scientific research in the manufacturing industry which has kept production on a small scale and therefore the very low numbers as a regards to industrial output.

High levels of underdeveloped human capital has also created the issue of shortages in industrial sector skills, with an efficient education system tailored to meet the sector's demands still lacking. With very few persons of the technical skills and ability to run sector, expansion cannot be expected to be any faster.

And Lastly, financing has proved a pervasive issue. Interest rates are at an estimated 18 to 25% and this makes it hard for micro, small and medium enterprises to grow. Surveys from the World Bank Economic Forum have shown before that small and medium enterprises consistently identified access to proper financing as a major issue. [5]

Actions to counter these challenges are already underway for example economic reforms which were introduced as early as the 90s to create an environment for the private sector to grow. Reforms like the progressive privatization of enterprises, reduction of import tariffs, the elimination of licensing requirements and export taxes, and lastly harmonization of tariffs within the East African community have already proved to be result yielding as they have attracted foreign investment, increased public-private partnerships and also promoted research development which is good for the future of the industrial sector.

Major investment has been directed toward the energy industry for development of infrastructure to address the the power inadequacy issue for example the on going Karuma Hydropower Project which had a US$1.44 billion loan agreed on and is expected to produce up to 600MW.

3. Methodology

Industrial Production Index statistics from the year of the release of the National Industrial Policy (2008), to the latest available data (2015) are used to make the forecast. Statistics are got from the Uganda National Bureau of Statistics and they are from the following manufacturing categories; "Food Processing", Beverages and Tobacco", "Textiles Clothing and Footwear", "Sawmilling, Paper and Printing", "Chemicals Paint", "Soap & Foam Products", "Bricks and Cement", "Metal Products" lastly, Miscellaneous (includes manufacturing like electrical products, vehicle accessories). [3]

Industrial Production Index measures changes in the levels of industrial production covering both the public and private sectors. Monthly data is collected on a quarterly basis from manufacturing establishments that contribute about 80 percent of manufacturing value addition. The index is then computed for the eight categories as shown in table 6 (attachment 1) with the formula.

$$\frac{\sum W\left[\frac{q_1}{q_0} \times 100\right]}{\sum W}$$

Where: q_1 = quantity of current year, q_0= base year and W = weight.

The Grey Systems approach is widely acclaimed across china and has been applied across many sectors including agriculture, ecology, economy, weather and many other fields.

The Grey differential model GM (1,1) which employs only one variable $x^{(0)}$ given by;

$$z^{(1)}(k) = 0.5x^{(1)}(k) + 0.5x^{(1)}(k-1),\ k=1, 2, \ldots, n, \ldots$$

with coefficients ***a*** and ***b*** where ***a*** is called the developing coefficient and ***b*** is known as the grey input, $x^{(0)}(k)$ is a grey derivative which maximizes information density for the given series to be modelled. Model GM (1,1) plays an important role in grey forecasting, grey Programming and grey control. In this paper, the Even GM (1,1) Model proposed by Sifeng Liu et al in 2014 will be applied.

Given an original data sequence

$$X^{(0)} = \left(X^{(0)}(1), X^{(0)}(2), \ldots \ldots X^{(0)}(n)\right)$$

$$X^{(1)} = \left(X^{(1)}(1), X^{(1)}(2), \ldots \ldots X^{(1)}(n)\right)$$

$$X^{(1)}(1) = X^{(0)}(1), X^{(1)}(k) = \sum_{i=1}^{k} X^{(0)}(i) k = 1, 2, n$$

Create matrix B and vector Y_N to build the differential equation of the GM(1,1) model, where a, b are parameters.

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = b$$

$$B = \begin{bmatrix} -X(2) & 1 \\ -X(3) & 1 \\ \vdots & \vdots \\ -X(n) & 1 \end{bmatrix} \quad Y_N = \begin{bmatrix} X^{(0)}(2) \\ X^{(0)}(3) \\ \vdots \\ X^{(0)}(N) \end{bmatrix}$$

Finally, the prediction model

$$\hat{X}^{(1)}(k+1) = \left[X^{(0)}(1) - \frac{b}{a}\right] e^{-ak} + \frac{u}{a}\ k = 0, 1, 2 \cdots, n$$

4. Forecasting, Results and Analysis

The forecasting was done using the Grey System Theory Modeling Software, for forecasting data, refer to Table 6 (attachment 1).

4.1 Total Manufacturing

Table 1: Initial Data Sequence (2008 to 2015)

2008	2009	2010	2011	2012	2013	2014	2015
156.4	174.4	180.8	186.7	193.4	199.0	219.7	222.9

Let the original data sequence of total manufacturing production be $X^{(0)}$, then have an accumulating addition to the original data to generate 1-AGO sequence of $X^{(0)}$, which is $X^{(1)}$. $X^{(0)}$ and $X^{(1)}$ have the same length and are equal data time sequences, get (1) and (2).

$$X^{(0)} = (156.4, 174.4, 180.8, 186.7, 193.4, 199.0, 219.7, 222.9) \quad (1)$$

$$X^{(1)} = (156.4, 330.8, 511.6, 698.3, 891.7, 1090.7, 1310.4, 1533.3) \quad (2)$$

Secondly, create matrix B and vector Y_N to build the differential equation (3) of the GM(1,1) model, where a, b are parameters, to get (4) and (5).

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = b \qquad (3)$$

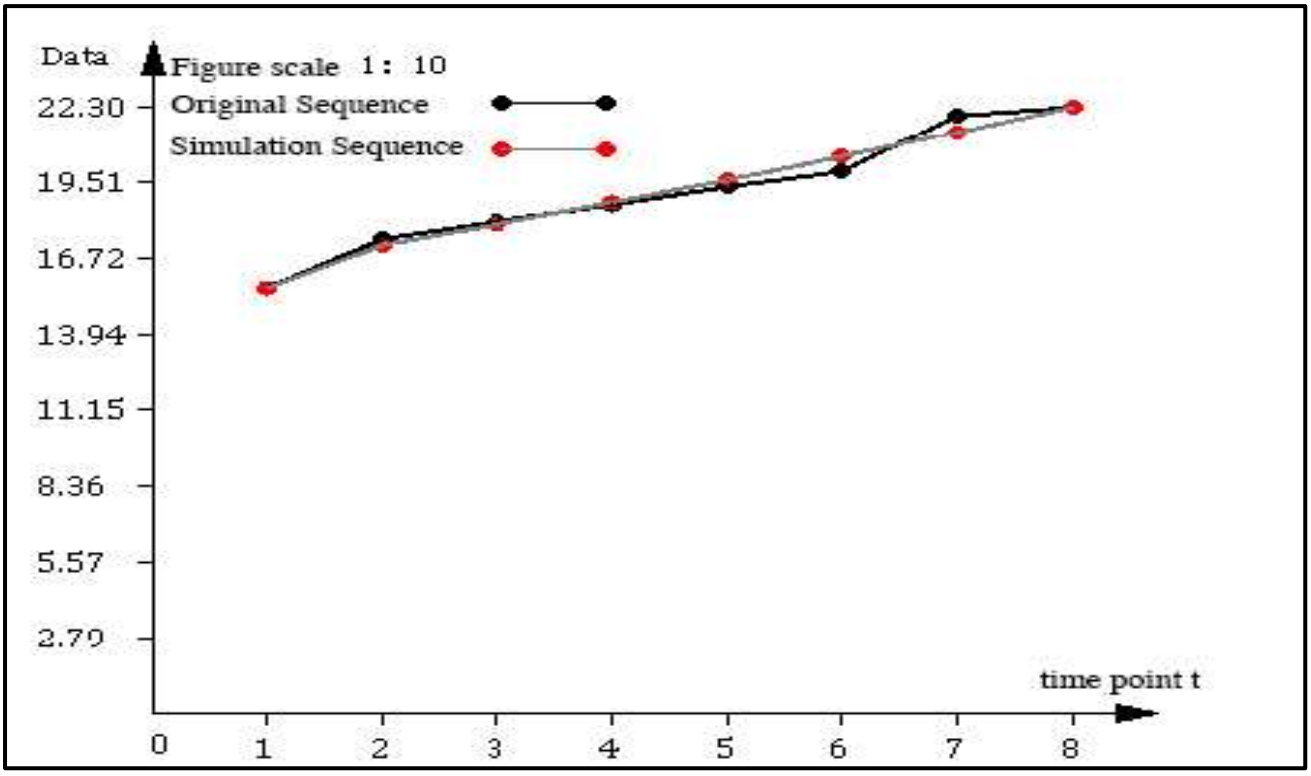
$$B = \begin{bmatrix} -243.6 & 1 \\ -421.2 & 1 \\ -604.95 & 1 \\ -795 & 1 \\ -991.2 & 1 \\ -1200.55 & 1 \\ -1421.85 & 1 \end{bmatrix} \quad (4) \qquad Y_N = \begin{bmatrix} 174.4 \\ 180.8 \\ 186.7 \\ 193.4 \\ 199.0 \\ 219.7 \\ 222.9 \end{bmatrix} \quad (5)$$

Thirdly, put (4) and (5) into the equation $\hat{a} = (B^T B)^{-1} B^T Y_N$ to get the value of parameters a and b which are written as $\hat{a} = (a,b)^T$, get $\hat{a} = (-0.04, 161.7)^T$. Then put the value of parameters a and b into (3), get differential equation $\frac{dx^{(1)}}{dt} - 0.04x^{(1)} = 161.7$. Thus, the forecasting model is as follows.

$$\begin{cases} \hat{x}^{(1)}(k+1) = 4198.9e^{0.04k} + 4042.5 \\ \hat{x}^{(0)}(k+1) = \hat{x}^{(1)}(k+1) - \hat{x}^{(1)}(k) \end{cases} \qquad (6)$$

Finally, examine the precision of this model. As Figure 1 shows, the residual error between realistic value and fitting value is small, which indicates a high fitting degree.

Fig 1: Initial Sequence Graph



The Relative Error test is the most widely used method. The realistic value $x^{(0)}$, fitting value $\hat{x}^{(0)}$, residual error $\varepsilon^{(0)}$ and relative error Δ are shown in Table 2, where residual error $\varepsilon^{(0)} = x^{(0)} - \hat{x}^{(0)}$, relative error $\Delta = \left| \frac{\varepsilon^{(0)}(k)}{x^{(0)}(k)} \right|$.

Table 2: Relative error test of this forecasting model				
Year	Realistic value	Fitting value	Residual error	Relative error
2008	156.4	156.4	0	0
2009	174.4	172.1	2.3	1.30%
2010	180.8	179.7	1.1	0.60%
2011	186.7	187.6	-0.9	0.51%
2012	193.4	195.9	-2.5	1.30%
2013	199.0	204.6	-5.6	2.79%
2014	219.7	213.6	6.1	2.79%
2015	222.9	223.0	-0.1	0.04%

From Table 2, it is clear that average relative error $\overline{\Delta} = \frac{1}{8}\sum_{k=1}^{8}\Delta_k$ = 1.17%, which is slightly below Grade One and accords with the Grade Two of precision in Table 3.

Table 3: Reference of precision grade	
Grade	Relative error
Grade One	0.01
Grade Two	0.05
Grade Three	0.10
Grade Four	0.20

In conclusion, the forecasting model (6) can be used to predict the Industrial Production Index over the next years and the results over five years are as shown in in table 4 below

Table 4: Forecasted data sequence (2016 to 2020)				
2016	**2017**	**2018**	**2019**	**2020**
232.8	243.1	253.8	265.0	276.7

Fig. Total Manufacturing forecast for the years 2016 to 2020.

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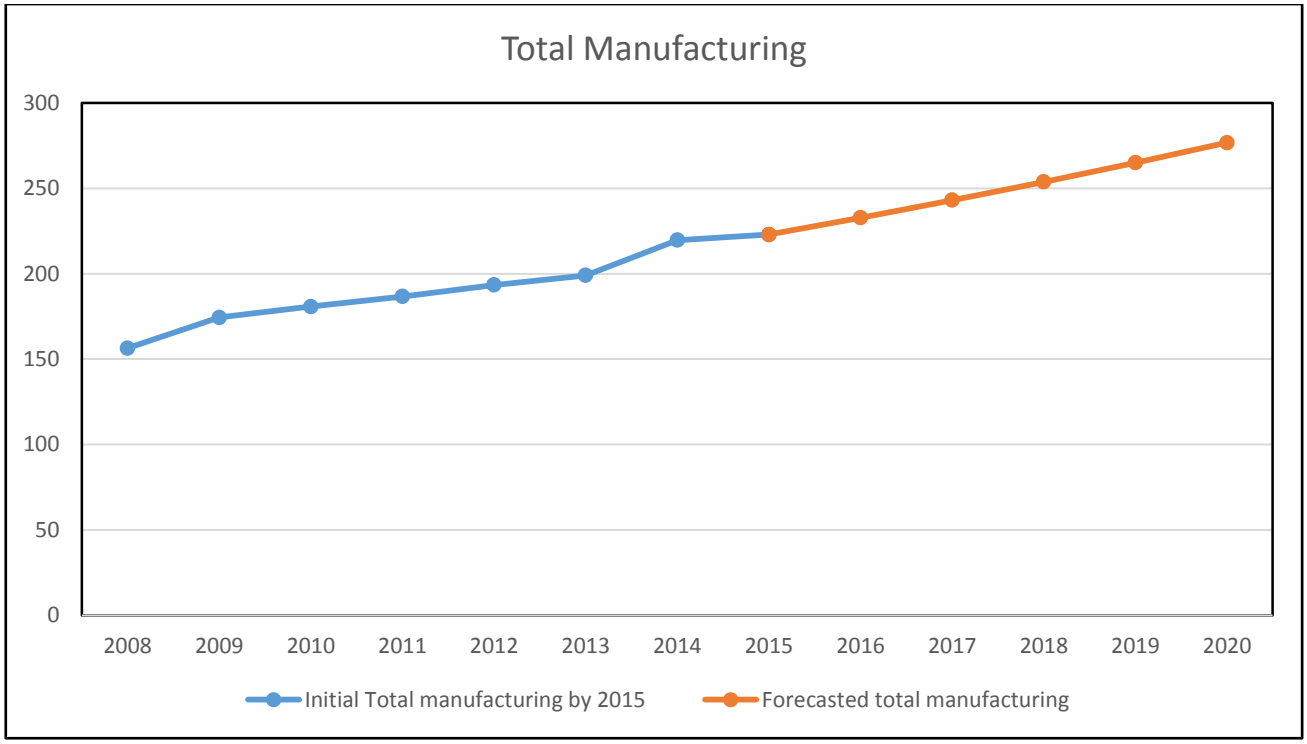

Generally, Total Manufacturing is estimated to gradually increase over the five years and is expected to register a percentage change of up to 18.8% between the year 2015 and 2020.

4.2 Different Manufacturing Categories

The Initial data statistics for the different manufacturing categories over the years 2008 to 2015 is available in table 6 (attachment 1) and the forecasting process is the same as for the Total Manufacturing forecast.

Fig 3: Manufacturing Category Forecast for the years 2016 to 2020.

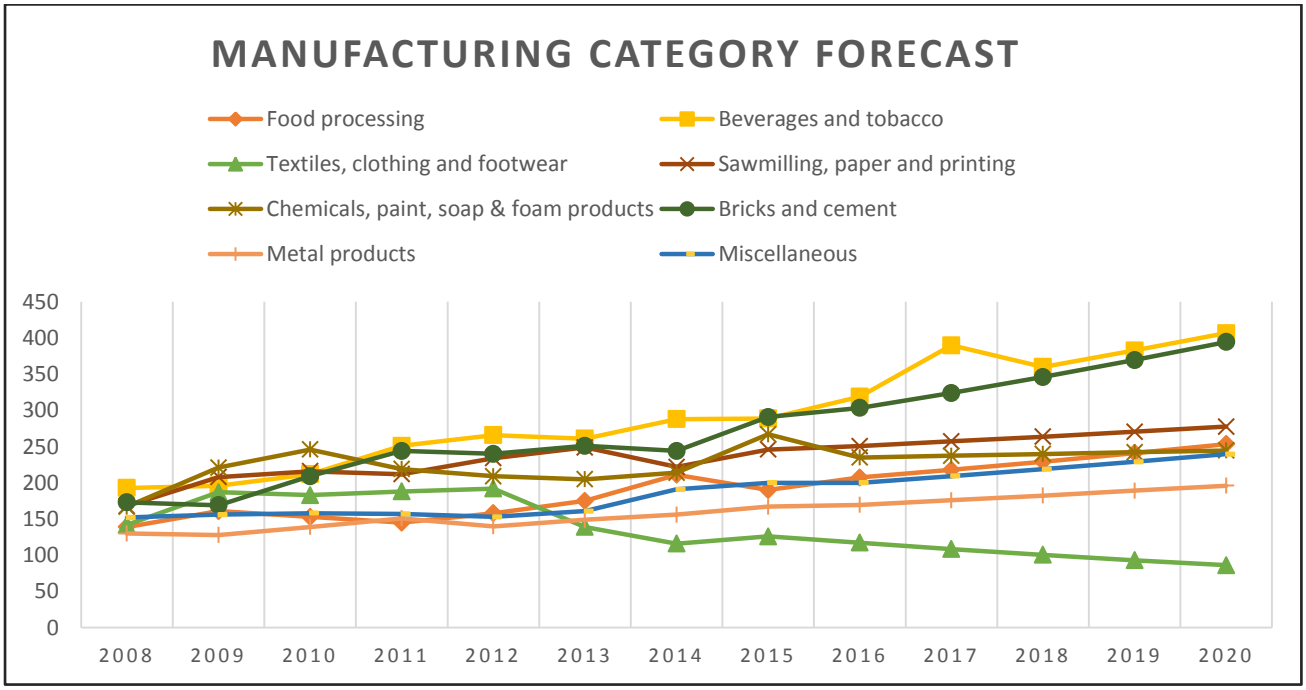

Table 5: Manufacturing Category Forecast for The Years 2016 To 2020					
	Year				
	2016	2017	2018	2019	2020
Food Processing	207.3	218.0	229.2	241.1	253.5
Beverages and Tobacco	318.9	338.9	360.2	382.8	406.8
Textiles, Clothing and Footwear	117.4	108.6	100.6	93.1	86.2
Sawmilling, Paper and Printing	250.7	257 .2	263.8	270.6	277.6
Chemicals, Paint, Soap & Foam Products	235.0	237.4	239.8	242.2	244.6
Bricks and Cement	303.5	324.1	346.1	369.5	394.6
Metal Products	169.6	175.9	182.4	189.1	196.1
Miscellaneous	200.1	209.3	218.9	229.0	239.5

"Beverages and Tobacco" has always registered relatively high numbers as compared to other categories. With the existence of companies like Crown Beverages Ltd. (Pepsi), the Century Bottling Company Ltd. (Coca-Cola), Britannia Allied Industries Ltd., House of Eden (U) Ltd., Rwenzori bottling company, the category is estimated to have the highest production numbers by the year 2020 with an estimated 27.5% increase between 2016 and 2020. But the recent tobacco laws (The Uganda Tobacco Control Bill 2014) and Uganda's newly conceived anti-smoking policy (though not fully implemented), have tightened and will further affect the tobacco numbers in the future as we already witnessed British American Tobacco (BAT) Uganda Ltd, a major producer of up to 85% market share announcing its withdrawal in 2015 and Tobacco registering a decline of -21.1% in real value added. This is expected to be reflected in the production numbers of the Beverages and Tobacco category by the year 2020. Bricks and Cement is also estimated to register major increase with an estimated 30% change between 2016 and 2020, rightfully so as the country is witnessing more construction than ever before.

"Sawmilling, Paper and Printing", "Chemicals, Paint, Soap and Foam products", "Food processing", "Miscellaneous", and "Metal Products" are all forecasted to see some slight growth over the five years.

On the other hand, since 2012, Textiles Clothing and Footwear has been on the decline and this can arguably be blamed on the importation of cheap competitor goods from countries like China. The category is forecasted to see further decline all the way to the year 2020 with an estimated -26.5% change between 2016 and 2020.

4.3 Suggestions

The government should implement tighter restrictions on the importation of goods that are being manufactured domestically especially for the case of those in the Textile, Clothing and Footwear category since it seems to be the most affected. And although in policy, the curbing of smuggling activity and corruption on the borders is still an issue that needs to be carried out rigorously.

Incentives like reduced taxed rates or tax breaks, more favorable interest rates on loans and priority when it comes to a percentage of the government contracts should be provided for the smaller scale domestic manufacturers not only to keep them afloat but to see them widen and compete too which will be good for total production as a whole.

5. Conclusion

This paper uses Industrial Production Index Data from the year 2008 to 2015, got from the Uganda Bureau of Statistics to forecast production over the next five years (2016 - 2020). The Even GM (1,1) model is applied with the help of the Grey System Theory Modeling Software. Forecasts show that Manufacturing will gradually continue to grow with the "Beverages and Tobacco" and "Bricks and Cement" categories leading the growth as compared to the other manufacturing categories. Textiles, "Clothing and Footwear" is estimated to see a major decline and based on the forecasts, it needs more attention when it comes policy making and Investment. It is safe to state that these forecasts are only estimates based and derived from prior historical data and actual events like policy, climate, economic and political

changes over the coming years will actually determine whether or not industrial production increases, stagnates or drops.

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References

[1] Ministry of Tourism, Trade & Industry (2008); National Industrial Policy 2008.

[2] Uganda Bureau of Statistics (2016); 2016 Statistical Abstract, http://www.ubos.org/

[3] Uganda Bureau of Statistics (2003); 2003 Statistical Abstract, http://www.ubos.org/

[4] Uganda Bureau of Statistics (2013); 2013 Statistical Abstract, http://www.ubos.org/

[5] East African Community (2012); East African Community Industrialization Strategy 2012 – 2032.

[6] World Bank (2017); World Bank Open Data, http://data.worldbank.org/country/uganda.

[7] Deng Julong. Introduction to Grey System Theory Department of Automation, Huazhong University of Science and Technology, Wuhan, People's Republic of China, 2008.

[8] Sifeng Liu, Liangyan Tao, Naiming Xie, Yingjie Yang. On the New Model System and Framework of Grey System Theory,2016.

[9] The Tobacco Control Bill, Uganda, 2014.

[10] Liangshan Shao, Liangshan Shao, Wenbin Zhou. The Forecasting For GDP Development of Liaoning Province Based on Grey System Theory College of Business Administration, Liaoning Technical University, Huludao, China, 2013.

Table 6. Industrial Production Index (2008-2015)									
		Years							
Description	**Weight**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Total Manufacturing	**1000**	**156.4**	**174.4**	**180.8**	**186.7**	**193.4**	**199.0**	**219.7**	**222.9**
Food Processing	**400**	139	161	153	145	158	175	211	190
Beverages and Tobacco	**201**	193	196	212	251	266	261	288	289
Textiles, Clothing and Footwear	**43**	142	187	183	188	192	139	116	126
Sawmilling, Paper and Printing	**35**	168	208	216	212	234	249	222	246
Chemicals, Paint, Soap & Foam Products	**97**	167	221	246	219	209	205	214	267
Bricks and Cement	**75**	173	169	209	244	240	251	244	291
Metal Products	**83**	130	128	139	151	140	149	156	167
Miscellaneous	**66**	152	156	158	157	153	161	191	200
Source: Uganda Bureau of Statistics									