

**Summary:**

*According to Martin Ford (Author of the book, “The Rise of the Robots”) the term Productivity does not mean the measure of what a business can produce but how much it actually produces and that Productivity is directly influenced by demand. In this Study the order book of a business is treated as a reflection of market demand. So to test the premise that the productivity of a business is determined by market demand; a one-off sample study is undertaken. The study shows that productivity declines exponentially when the order book of a business comes down and this has a cascading impact on the functioning of the business organization.*

**Key Words:** Productivity, Order-Book

**Introduction**

In his work “The Rise of the Robots”, Ford (2015) states that Productivity is influenced by Demand. The market demand will loosely translate into the order book of an organization. In this article an attempt is made to test this statement with a one-off data, as a prelude to a more detailed data collection and research as to assess whether the order book size influences the productivity in an organization.

**Literature on definition of Productivity**

There are different definitions of Productivity.

According to Ford (2015) Productivity is measured by dividing the economy’s output by the number of hours worked.

Anil Kumar and Suresh (2009) state that Productivity refers to the ratio between values of output per work hour to the cost of inputs that is in simple terms, they say that productivity is the ratio of output to input.

Prokopenko (1992) defines productivity as the relationship generated by a production or service system and the input provided to create this output. Productivity is defined as the efficient use of resources – labor, capital, land, materials, energy, information in the production of various goods and services, and is stated as  $\text{Productivity} = (\text{Output}) / (\text{Input})$ .

According to Pritchard (1995), the first definition of Productivity is an efficiency measure, the ratio of outputs over inputs expressed in dollar (money) terms. The Second definition of Productivity is a combination of efficiency (Output / Input) and effectiveness (Output / Goals). The third definition of Productivity is anything that makes the Organization function better. In this definition productivity would not only include efficiency and effectiveness but also things like absenteeism, turnover, morale, innovation etc.

According to the Organization for Economic Co-operation and Development (OECD), Productivity is commonly defined as a ratio between the output volume and the volume of inputs. In other words, it measures how efficiently production inputs, such as labor and capital, are being used in an economy to produce a given level of output.

Tangen (2002) says that productivity is the ratio of output quantity (i.e. number of correctly produced products which fulfils their specifications) divided by input quantity (i.e. all type of the resources that are consumed in the transformation process).

Owyong says that defining productivity in terms of one factor (of input) would be incorrect and so advocates the use of total factor productivity. He defines total factor productivity as the weighted average productivity of all inputs, where the weights to these inputs are their shares in the total cost of production.

As seen in the text book of Operations Management released by ICMR, Productivity is a tool of measurement that determines the efficiency of the organization in terms of the ratio of output produced with respect to inputs used. Various factors like technology, plant layouts, equipment, and machinery affect productivity. Productivity can be either measured as total productivity or as partial productivity where single variable or multiple variables are considered.

According to Singh (2014), the ILO (International Labor Organization) defines productivity as the ratio between the “output of work” and “input of resources”, in the process of creating wealth.

The definition according to the organization for European economic cooperation (OECE), productivity is the quotient obtained by dividing the output by one of the factors of production.

Sharpe (2002) says that the most readily available and widely used measure of productivity is labor productivity, the ratio of output to some measure of labor input (employment or hours).

According to Syverson (2011) productivity is efficiency in production: how much output is obtained from a given set of inputs. As such, it is typically expressed as an output–input ratio. Single-factor productivity measures reflect units of output produced per unit of a particular input. Labor productivity is the most common measure of this type, though occasionally capital or even materials productivity measures are used. Of course, single factor productivity levels are affected by the intensity of use of the excluded inputs. Because of this, researchers often use a productivity concept that is invariant to the intensity of use of observable factor inputs. This measure is called total factor productivity (TFP) (it is also sometimes called multifactor productivity). Conceptually, TFP differences reflect shifts in the isoquants of a production function: variation in output produced from a fixed set of inputs.

### **Calculating Productivity**

According to Johnston, The simple method of calculating productivity is to divide the output by the input. For example, 100 units of output completed in eight hours of input equals and employee productivity of 12.5 units per hour.

According to Investopedia, another common way to measure a company's productivity level is to divide the total sales by the total amount of hours worked. For example, company ABC had net sales of \$15 million and its employees worked a total of 20,000 hours over the last fiscal year. The output is the company's net sales and the input is the number of hours. The productivity of the company is 750 (15 million divided by 20,000). This means that for each hour of total labor, company ABC's employees produced \$750 in sales.

Eposito (2015) blogs that one could also look at labor productivity in terms of individual employee contribution. In this case, instead of using hours as the input, one would use number of employees. For example let's say a company generated \$80,000 worth of goods or services in one week with 30 employees. One would divide 80,000 by 30, which equals 2,666 (meaning each employee produced \$2,666 for the company per week).

Asif writes that the formula for computing multi-factor productivity is:  $\text{Output} / (\text{Labor} + \text{Materials} + \text{Overheads})$ . Thus if the output is 7040 Units and the price per piece is Rs. 10/\_ and Labor, Materials and Overheads are respectively Rs. 1000/\_ , Rs. 520/\_ and Rs. 2000/\_ respectively then the productivity is  $(7040*10) / (1000+520+2000) = 20$  Units output / Re input.

Some of the single factor measures of Productivity presented by the California State University (CSUN) in their presentation on Productivity are: Output / labor, Output / Machine, Output/capital, Output / Energy. Thus If we produce only one product, the numerator can be either the total units of the product or the total Re value of the product. If we produce several products, the numerator is the total \$ value of all products. The denominator can be the units of input or the total Re value of input. Therefore Labor Productivity would be: Quantity (or value) of output / labor hrs or Quantity (or value) of output / shift, Machine Productivity would be: Quantity (or value) of output / machine hrs, Energy Productivity would be: Quantity (or value of output) / kWh and Capital Productivity would be: Quantity (or value) of output / value of input. Training, Methods, Technology and Management are other factors that affect Productivity.

According to Heizer and Render, Total factor productivity is arrived at by using the formula:  $\text{Output} / (\text{Labor} + \text{Material} + \text{Energy} + \text{Capital} + \text{Miscellaneous})$

Lieberman and Kang advance a framework in which productivity corresponds to the total economic value created by the capital and labor employed within the enterprise.

### Data Presentation

To study the statement of Ford, data of orders available for liquidation and production output of a typical manufacturing company is analyzed. Since the data are proprietary to the organization and revealing the actual numbers would be detrimental to the commercial interests of the company, to protect the privacy of the organization taken up for the analysis, absolute values are not used but only percentages of the base year (first year)

The physical output of the production shop measured in terms of Metric Tonnes (MT) is given in Table 1. The man-hours spent for producing this output is given in Table 2.

Table – 1: Physical Output (approximate)

Sl. No.	Year	Production (MT)
1	Year 1	p
2	Year 2	0.82p
3	Year 3	0.39p
4	Year 4	0.49p
5	Year 5	0.42p

**Table 2: Man-Hours consumed**

Sl. No.	Year	Time (Hrs.)
1	Year 1	t
2	Year 2	1.1460*t
3	Year 3	1.1211*t
4	Year 4	0.9878*t
5	Year 5	0.9315*t

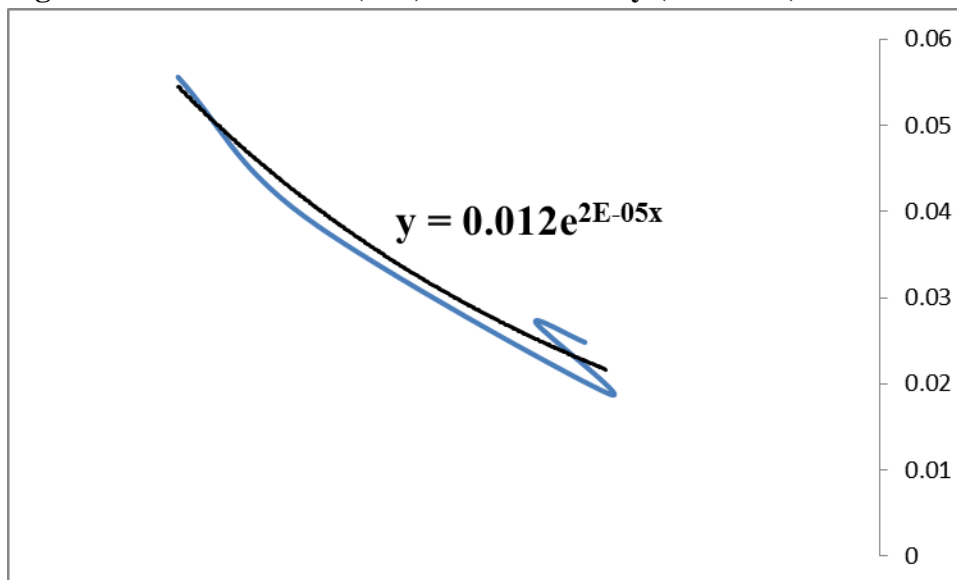
From the data available in Table 1 and Table 2, the labor productivity of the Unit under Study is computed in terms of Physical Output of Metric Tonnes per hour of engagement. This is given in Table 3.

**Table 3: Labor Productivity**

Sl. No.	Year	Productivity MT / Hr.
1	Year 1	P
2	Year 2	0.7093*P
3	Year 3	0.3418*P
4	Year 4	0.4881*P
5	Year 5	0.4464*P

Using the data available in Table 1 and Table 3 a plot of the Production (MT) against Productivity (MT / Hour) is made and this is shown in Figure 1.

**Fig 1: Plot of Production (MT) Vs Productivity (MT / Hr.)**



The trend line is superimposed on the graph.

Since the Unit under Study has not only in-house manufacturing but also substantial levels of out-sourcing; the total production and sales are taken up for Study. The total output and the corresponding total earning are given in Table 4.

**Table 4: Overall Operational Result of the Company (approximate)**

Sl. No.	Year	Overall output (MT)	Overall Earnings (Rs. Cr.)
1	Year 1	O	E
2	Year 2	0.766667*O	0.8810*E
3	Year 3	0.433333*O	0.4762*E
4	Year 4	0.466667*O	0.3810*E
5	Year 5	0.500000*O	0.3333*E

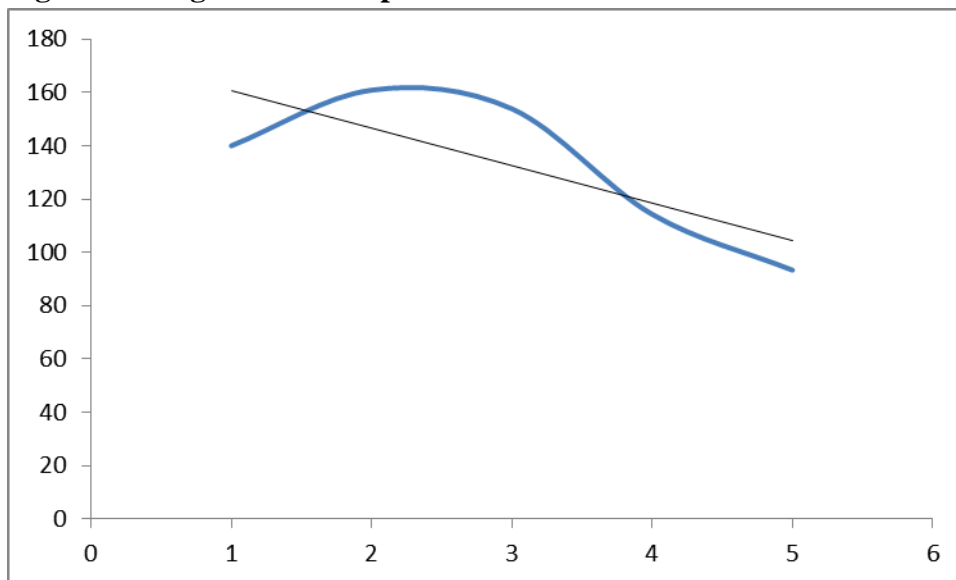
From data of Table 4 the earnings per kilo of output is computed and is given in Table 5 and the same is given pictorially in Fig 2 (including the trend line)

**Table 4: Earnings per Unit of output**

Sl. No.	Year	Earning Rs. / Kg of Sale
1	Year 1	e
2	Year 2	1.1491*e
3	Year 3	1.0989*e
4	Year 4	0.8164*e
5	Year 5	0.6666*e

The orders booked by the company which was available for execution is given in Table 5 and the pictorial is given in Figure 3

**Fig 2: Earnings of the Unit per Unit of Sale**



**Table 5: Orders in hand for execution (Rs. Cr.)**

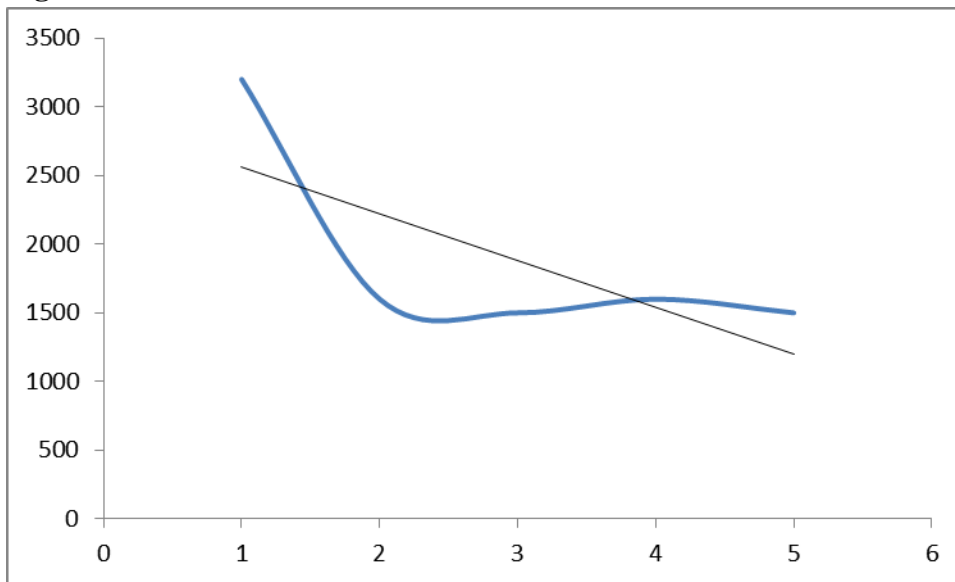
Sl. No.	Year	Orders available for execution (Rs. Cr.)
1	Year 1	A
2	Year 2	0.5000*A
3	Year 3	0.4688*A
4	Year 4	0.5000*A
5	Year 5	0.4688*A

The change in the productivity and the orders available for execution on year over year basis is given in Table 6 and Table 7

In Table 8, the ratio of the Profit before Tax with respect to the overall financial turnover is given.

In Table 9 the annual spend on Research and Development (R&D) by the Company and in Table 10 the earnings coming out of the implementation of the new products or innovations developed through R&D is given.

**Fig 3: Trend of orders in hand for execution**



**Table 6: Trend of Productivity Change (%)**

Sl. No.	Year	Change in Productivity %
1	Year 1	
2	Year 2	-29%
3	Year 3	-52%
4	Year 4	+43%
5	Year 5	-9%

**Table 7: Trend of change of orders available for execution (%)**

Sl. No.	Year	Change in orders available for Execution %
1	Year 1	
2	Year 2	-50%
3	Year 3	-6%
4	Year 4	+7%
5	Year 5	-6%

**Table 8: Profit Ratio with respect to Turnover**

Sl. No.	Year	%
1	Year 1	+31%
2	Year 2	+31%
3	Year 3	+16%
4	Year 4	-10%
5	Year 5	-27%

**Table 9: R&D Spend (sample)**

Sl. No.	Year	R&D Spend (Rs. Cr.)
1	Year 1	R
2	Year 2	0.9600*R
3	Year 3	0.5200*R
4	Year 4	0.4000*R
5	Year 5	0.4800*R

**Table 10: Earnings from R&D (Sample)**

Sl. No.	Year	Earnings from R&D (Rs. Cr.)
1	Year 1	S
2	Year 2	0.9091*S
3	Year 3	0.4545*S
4	Year 4	0.4545*S
5	Year 5	0.4454*S

**Data Analysis, Interpretation and Findings**

Analysis of the Data shows that progressively down the years:

- orders in hand available for liquidation is coming down
- realization per unit of output is coming down
- overall turnover of the company is coming down,
- profitability is coming down
- physical output of the factory is coming down and

- Productivity of the labor is coming down.

The decrease in the orders available for execution and the dip in labor productivity show a strong correlation of 0.88 from which we derive that the depleting order book, drives down the labor productivity.

There is an exponential decay in the productivity levels. With exponential curve fitting on the data and extrapolating the curve with the equation obtained one can compute the production levels for estimated productivity levels.

While the major factor that determines the profitability is the decrease in the realization per unit output, the decreasing productivity is also to be considered as a contributory cause.

It is also seen that with the downward trend in the operations of the company, the spend on R&D and consequently the benefit that accrues out of the investment in R&D in the subsequent years is also on the downturn.

### **Potential Results of dipping Productivity.**

With diminishing productivity,

Induction of additional manpower can (will) get stopped.

Natural attrition by way of retirement, resignations would not be filled in with replacements by the organization.

The labor content of such wastages would have to be shouldered by the existing employees without any additional remuneration, which can lead to frustration and low motivation and can lead to further exit of (competent) man power (those who are capable / having capability to land jobs in other organizations would desert the company) leading to accumulation of low productivity workers.

With such a work force which would be low on morale would lead the organization into a further downward spiral of lower and lower productivity.

With low morale, absenteeism in the organization can increase.

Any existing non-essential manpower would get weeded out, like temporary staff (or employees on contract)

Caught in this cycle, the organization may try to bring harsher measures in order to increase the productivity, leading to further frustration and decreasing morale of the left out work-force.

The organization in an effort to augment the productivity may try to fill the gaps with low cost automation or full scale automation, which would lead to destruction of potential jobs in the organization for the future job-aspirants.

With lower productivity, the organization may not be able to service the customer orders on time. Such failures will further shrink the ability of the company to garner more orders since delayed supplies to customers relay the message to the market the company's inability to deliver the ordered goods on time further aggravating the capacity of the organization to book more orders.



With a dwindling order book, just to sustain the operations, the organization would not be able to price their product competitively as they would need the orders of higher values to keep the plant/s running leading to a situation where their products are out-priced by competition.

Caught in such a vicious vortex, the organization would decay and ultimately would fold down and would have to close down its operations throwing all the existing workers into the unemployed fold.

With lowering order book, the organization would not have enough funds to invest in augmenting or modernizing or upgrading its manufacturing capacity with the result that over a period of time, compared to its competitors their installed capacity would be lagging behind that of the competitors. While the competitors would have invested in higher productive resources, the organization with the lower productivity would not be able to sustain their operations at the efficiency and effective level of the competitors.

Neither would the organization be able to find resources to invest in Research and Development (R&D) of new products. While their competitors may be forging ahead with introduction of upgrades, through investments in R&D, the organization with low productivity would be saddled with outdated product/s and internal systems which would drive the existing customers away from them and into the fold of the competitors. The result would be dwindling order booking for the organization which would culminate in the demise of the low productive organization.

The labor force ejected out of such closing organization (closed down due to poor productivity) would be without the necessary skills to get employed in the newer areas, leading them to be a burden on the society and the government which may have to support them either trying to re-skill them (which may not be successful seeing that by their inherent nature they are a less productive lot) or giving them unemployment dole. They would also be a burden to their families which may be left with no income.

For the families, it would have a big effect and may lead to the personal deterioration of the unemployed who may be forced into unsavory habits like alcoholism or drug addiction and thereby adding to problems of the society at large.

Various researches done on the effect of lower productivity is also supporting the above surmise.

### **The up and downside of high / low productivity**

According to Kokemuller<sup>1</sup> “Low productivity has a number of negative impacts on a workplace, including economic effects on profitability and systemic implications for worker morale. Productivity and profit have a strong correlation. When resources produce a relatively low amount of goods, services or sales for the money spent on them, the profit margin for the company is low. Low productivity also contributes to downsizing, which most often means layoffs. However, the employees left after such moves often suffer from low morale based on lost relationships and fear of losing their own jobs. Companies with low productivity often suffer from high rates of absenteeism and turnover. Rigid production benchmarks and performance standards are common responses of some company leaders to broad productivity problems. However, employees already struggling with motivation to work hard often wilt under the pressure of challenging benchmarks. Collectively, the pinch felt by such workers only exacerbates the problems of low morale and poor productivity.”

According to Pettinger,<sup>2</sup> “Countries with strong labor productivity growth tend to benefit from high rates of growth, strong export demand and low inflation. Increased labor productivity can enable a higher long run trend rate of growth.”

According Koesterich<sup>3</sup> the productivity of workforce determines the economy’s long-term growth. If lower productivity is here to stay, it will affect future output levels, which, in turn, will negatively affect stock markets. Usually, wages align with productivity. This trend has led to poor wage rates lately, which have led to poor consumption in the US economy. Poor consumption could negatively affect consumer-related segments like retail, consumer staples, and consumer discretionary spending.

As seen from the Doubleglist web-site: “The effect of Low Productivity in Public Organizations<sup>4</sup> is as follows: 1. Unwarranted Losses: Low productivity or capacity utilization of public organization lead to unwarranted losses for the establishment and the economy as a whole. Large sum of money that could have accrued to the government is cost due to this problem. 2. Waste of Scarce Foreign Reserve: Foreign reserves that could have been used to importing certain goods and services that cannot be produced now are being used in importing goods that can easily be produced here e.g. Oil. 3. Loss of Confidence: The public has lost confidence in these organizations. Instead of placing orders for the supply of goods, with them, they prefer doing that abroad, thereby denying our economy the money that could have accrued to it.

According to a study done by Highfill (2002)<sup>5</sup>, using the REMI economic model, MERIC studied the potential economic effects associated with an increase in labor productivity in the Chemical sector in Missouri, a sector vital to the state’s economy. According to this Study, in general, this leads to temporary decline in employment statewide: as the industry becomes more efficient, fewer employees are needed, resulting in lower income, which leads to less consumer spending, which leads to additional employment declines. However, these declines are eventually offset and exceeded by output and employment gains in the Chemicals sector and those industries that supply the sector with resources. These gains also lead to eventual increases in tax revenues for the state. Clearly, then, increasing labor productivity is an important step for making economic gains in the state.

A global review by ILO<sup>6</sup> (2013) examines the impact of labor productivity on growth. It finds that increases in labor productivity within economic sectors are the main driver of economic growth (rather than sectoral re-allocation). In particular, growth in industry and services play an important role for aggregate economic growth.

According to an open source study done by the International Finance Corporation (IFC)<sup>7</sup>, assessing private sector contributions to job creation / “Impact of labor productivity on job creation: evidence from global enterprise surveys” the results and the analysis suggest that higher labor productivity, is associated with higher employment growth rate in the subsequent 2 to 3 years. More specifically, in the country fixed-effects model, a 1 percent increase in labor productivity was associated with a 1.8 percent increase in employment growth. This finding is consistent with the one from Dutz and others (2011), who also used Enterprise Surveys data to identify a positive role of labor productivity in job creation. The analysis suggests that increasing

labor productivity has a significant positive effect on job growth, after controlling for other relevant factors.

### **Solution and Recommendation**

While the traditional HR practices should be adopted to motivate the employees to function towards higher productivity, the aim of the top management should be to augment the order booking so as to load the shop floor fully.

With the shop floor fully loaded and with the right HR practices the levels of employee productivity would be increased.

However in this particular case, it is seen that the sales realization per unit of product sold is coming down for the company which is also a contributory factor for diminishing bottom line apart from the dip in productivity.

The general tendency of labor, when orders are getting down-sized is to stretch the work to fill the shift time. This may be ascribed to the fear of the employee of becoming redundant. The pervasive feeling (usually stoked by the Union leaders) would be that once the work is completed fast and the labor remains idle past the job completion, it would be a signal to the management that there is an excess of manpower which is amenable for trimming. Therefore the expectation of the labor from the management would be that, the top management should get them jobs to do.

A feasible way out for the management for increasing the orders would be to diversify into other areas and products where the value addition can be higher or to find newer markets for the existing products (for example looking towards exports).

The other method would be to look inward. All major manufacturing organizations, when their capacity is fully utilized have the practice of outsourcing manufacture of some of the non-core, low value items. In the times of poverty of order book for their manufacturing shops, organizations can fill up the available capacity by reducing such outsourcing and resorting to in-sourcing.

Another area that organizations can work towards is engaging in backward integration or forward integration with no or very minimal investments in the manufacturing resources. Instead of buying some of the components and parts, the organization can consider manufacturing them in-house (backward integration) for their own consumption to fill-in their manufacturing capacity, which should be an easier option than forward integration where the downstream customers can react to the entry of the organization into their domain. The authors recommend backward integration as a viable option for filling the manufacturing capacity.

### **Limitation**

This is a one sample-study with very minimal data and therefore the result from this Study cannot be taken as confirmation evidence of the statement that “Productivity is affected by Demand.” A more detailed Study and analysis with much more data seeking disconfirming evidence is required before we can accept the statement.

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