# The Destruction of Price-Representativeness

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***Abstract***

The development of industry 4.0 and e-commerce destroy the traditional mechanism of price determination, the rigidity of supply in the short run and the idea of price representativeness. Industry 4.0 has changed the traditional view of price formation. Firms know the individual purchasing history of customers. Firms can extract the reserve price for each individual due to big data. Price is no more the encounter of supply and demand, but it is determinated considering the maximum amount that individuals can pay. The combination of data, dynamic pricing and price discrimination has destroyed one of the pillars of the mainstream economics: price representativeness. Dynamic pricing is the ability to change prices. Price discrimination is the ability to apply different prices for different customers for the same product or service.

*Keywords: Industry 4.0, Customer Behavior, Supply, Demand, Digital Economy, Nudge*

*JEL CODE: E21, E31, E64, E70, E71.*

## *1. Introduction*

The development of industry 4.0 has changed the way in which demand and supply are related in the market. Data driven firms use data to predict the demand and consumer behavior (Goel, et al., 2010). The estimation of demand is used as a tool to determine short term production programs (Choudhary, et al., 2009). Innovations have a destruptive impact of existing technologies (Schumpeter, 1942). In this case the development of innovation has a destruptive impact on the mainstream economics and a new theory is needed to analyze and describe the change.

One of the main assumptions of the economics is the fact that supply is fixed in the short run (Varian, 2014). Classics axioms in micro-economics deny the existence of any possibility to change the level of investment in fixed assets the short period. These basic assumptions are effectively destroyed by the large usage of data. In effect new managerial tools generated in connection with the *Fourth Industrial Revolution* (Schwab, 2017) such as for example *Business Intelligence-BI* (Larson & Chang,

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2016) and *Business Analytics-BA* (Duan, 2015) are able to offer quasi-instantaneous information about consumer behavior changing immediately the productive plans of the firm.

Due to the presence of tools such as *Decision Support Systems-DSSs* (Arnott & Pervan, 2016) , there is the possibility for the firm to change the level of raw materials in the warehouse, to manage efficiently production outputs and workforce, in accordance to change in the demand side.

The first paragraph of this article affords the question of data and their relevance for the strategic programming and planning of the firm. A definition of data environment is offered: data environment is constituted by the sum of endogenous data and exogenous data. Endogenous data are generated in connection with the inner economic organization of the firm i.e. data produced by corporate functions and departments. Exogenous data are external to the organizational structure of the firm and are able to describe the characteristics of the market in the sense of the demand side but also to shed lights on institutional, political and cultural variables that have an impact on the production processes. The sum of endogenous and exogenous data defines the data environment. Data is the main source to development knowledge management (Kasemsap, 2015). The role of knowledge management has increased due to the possibility to interconnect the internal production process of the firm with the external world of the firm using tools such as *Internet of Things-IoT* (Botta, et al., 2016) and *Big Data Analytics-BDA* (Sivarajah, et al., 2017) in a *Business Analytics-BA* and *Business Intelligence-BI* framework.

The possibility to use large amount of data remove some of the main limitations of the supply side in the short run. In effect in the context of basic micro-economics assumption, there is the idea that the firm has no chances to change the supply in the short run. The impossibility is due to rigidity in the investment of assets: plants, raw materials, mechanical machines and even workforce are fixed in the short. The fixity of the supply in the short run has been a crucial limitation of the production processes in the *Fordism-Taylorism* (Lander & Liker, 2007), where firms have no possibilities neither to control the supply in the short run, neither to prevent changes in the evolution of demand side, that is in the development of consumer buying behavior. But the fixity of the supply side in the short run has survived also in lean production where firms can control the supply in the middle-long period without any possibility to include immediately consumer buying behavior in the production program. Only in smart production (Kang, et al., 2016), with the usage of huge amount of data, there is the possibility to remove the limit of the rigidity of the supply in the short run generating a more flexible supply in the short run. The flexibilization of the supply in the short run is feasible thanks to the application of tools for data management. Data give the firm the possibility to control not only its own production and supply chain, but also to analyze and predict consumer buying behavior (Erevelles, et al., 2016). By this means managers can apply shortermist tools to program the production process, the warehouse

management, workforce organization, having an impact on the entire supply chain. The firm can not only produce the exact quantity required by the market but also can practice prices that consumer can pay in the form of dynamic pricing. Data offers the possibility for the firm to realize the flexibilization of the supply in the short run internalizing the consumer buying behavior in the context of production programming. The barriers between consumer buying behavior and the production programming are destroyed by the means of data analysed and interpreted in the context of business intelligence and its connections with data management, knowledge management, *Enterprise Resource Planning-ERP* (Saade & Nijher, 2016) and their application with *Artificial Intelligence* (Kolbjørnsrud, et al., 2016) and *Machine Learning* (Singh & Singh, 2013). The process of automatization of production and its ability to generate gains can also have an impact in the reduction of the role of management, especially middle management, in the organization of firms and business units.

### *2. Supply and demand in the context of industry 4.0*

In particular, the flexibilization of the supply in the short run is realized with the interiorization of the consumer behavior expectations as in the sequent formulas:

$$\boldsymbol{Supply_{Equilibrium_{it}} = a_1 + b_1(FactorsOfProduction)_{it} - b_2(Demand)_{it}}$$

$$\boldsymbol{Demand_{it} = a_1 + b_1(RealDemand)_{it} + b_2(PotentialDemand)_{it}}$$

$$\boldsymbol{RealDemand_{it} = a_1 + b_1(PlannedConsumption)_{it} + b_2(ImpulsiveBuyingBehavior)_{it}}$$

$$\boldsymbol{PotentialDemand_{it} = a_1 + b_1(ExpectactionsOfIncome)_{it} - b_2(ExpectactionsOfSaving)_{it}}$$

$$\boldsymbol{Demand_{it} = a_1 + b_1(PlannedConsumption)_{it} + b_2(ImpulsiveBuyingBehavior)_{it} + b_3(ExpectactionsOfIncome)_{it} - b_4(ExpectactionsOfSaving)_{it}}$$

$$\boldsymbol{Supply_{Equilibrium_{it}} = a_1 + b_1(FactorsOfProduction)_{it} - b_2(PlannedConsumption)_{it} - b_3(ImpulsiveBuyingBehavior)_{it} - b_4(ExpectactionsOfIncome)_{it} + b_5(ExpectactionsOfSavings)_{it}}$$

The possibility for the firm to realize a profit is based on the sequent equation:

$$\boldsymbol{Profit_{it} : b_1(FactorsOfProduction)_{it}}$$
$$\boldsymbol{< b_2(PlannedConsumption)_{it} + b_3(ImpulsiveBuyingBehavior)_{it}}$$
$$\boldsymbol{+ b_4(ExpectactionsOfIncome)_{it} - b_5(ExpectactionsOfSavings)_{it} - a_1}$$

In mainstream economics there is no possibility to immediately adjust the level of production factors to demand. In the short run there are rigidities that make impracticable the marginal adjustments. This rigidity has been empirically verified during the period of *Fordism-Taylorism*. During the period of lean production innovation was introduced in the way in which firms adjust factors of productions in respect to changes in the demand side. But lean production was based on a strong limitation that was: the impossibility to control consumer buying behavior in the short run for the absence of data able to describe consumption. At this point the new innovation of smart production seems to be one of the main improvements in the process of flexibilization of the supply in the short run, for the fact that smart production has the possibility not only to control the production in the middle-long period as in the lean production, but also smart firms are able to control consumer buying behavior by collecting data immediately and adjusting the supply side consequently (Cheng, et al., 2018) . Smart production, by the possibility of internalizing immediately consumption in the production processes, has removed the mainstream assumption, of the fixity of the supply in the short run.

The development of smart firms and production has the possibility to destroy representative prices. In reality the idea of representative prices has been introduced in the mainstream economics to justify perfect market equilibrium (Fama, 1972). Prices are able to realize an identity between supply and demand. This identity is represented by an information-the price- that every actor in the market knows perfectly without asymmetric information (Kline, 2015). The absence of asymmetric information, that is the absence of obstacle to the development of information, create a system in which every change in price is based on real modification of demand and supply. But the question of price representativeness and perfect market competition has been challenged in theoretical and applied economics (Tirole, 2015). The question of representative prices means that in a certain time there is only one price for all the customers and the economic agents. Our critique is different since it is not based on the theoretical fallacies or empirical analysis, but it is based on a technological question: innovations in the context of digitalization and informatization can generate individual non-representative prices. Technology has changed the way in which prices are realized: in the same time there are different prices for different economic agents based on historical purchase behavior.

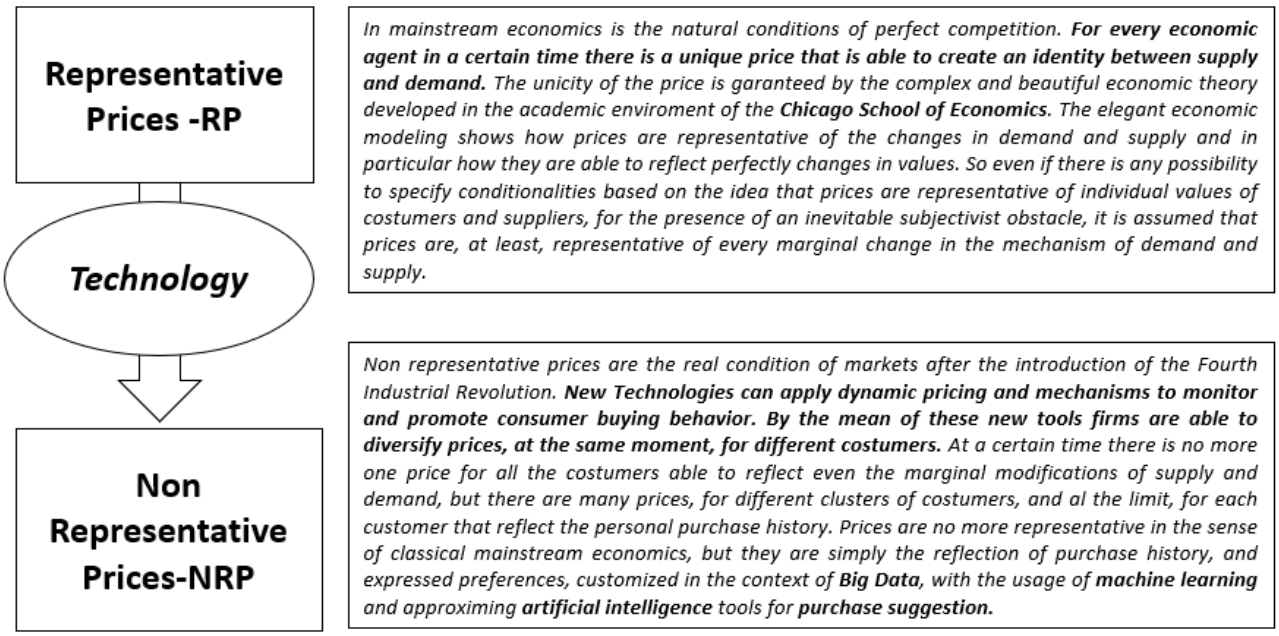


*Figure 1. The change between representative prices and non-representative prices*

Non representative prices are the normal state of the real and virtual economy since the advent of the *Fourth Industrial Revolution*. Every innovation in the information technology, either in the sense of connection among devices and machines, even in the sense of consumer buying behavior analysis, can extract data to use for pricing. In this context pricing is no more determined as the identity between marginal costs and marginal revenues as in classical micro-economics assumptions but is determined by estimating the purchase attitude of individual customers based on data mining. Prices are no more representative. Prices do not represent changes in demand and supply and don't represent a unique information feasible for every economic actor in a certain moment. But at the contrary, prices are determined unidirectionally using consumer data by firms in their attempt to maximize profits.

Sequently we analyze the role of nudge in the context of price determination (Thaler & Sunstein, 2009). The theory of nudges has been developed in the cultural and cognitive enviroment of behavioralism (Thaler, 2017). Behavioralism has increased its importance especially in finance (Thaler, 2005) and decision-making theory. The fail of mainstream economics in the prediction of financial crisis and in the analysis of cognitive bias has created an incentive to generate new theories and explanations. In this context the development of behavioural economics has offered many opportunities to better understand the complexity of financial crisis and decision-making failures. The theory of nudges has been developed by Richard Thaler (Barberis & Thaler, s.d.). In nudge theory consumer behavior or decision making behavior can be changed with external influence. For example, in the case of a consumer in a shopping mall, there are a lot of nudges that can change the purchase planning of the costumer such as for example: advertisements, hostess, music, lights, shelf

management, prices, quantity, discounts. This information can change the planned consumption. The question of nudge is particularly important in the context of e-commerce (Djurica & Figl, 2017). In effect even in e-commerce there is the possibility to change the planned consumption with offers, advertisement, and suggestion of purchases (Mirsch, et al., 2018). Nudge changed the way in which firms generate prices. In effect one of the main assumptions of demand, is the fact that costumers have an idea of the goods and services they need and formulate an accurate reservation price for that purchase. But in the context of behaviouralist economic framework, every decision of the customer, is not only generated in connection with individual preferences but is determined also in connection to external influences that is either auto-determined and etero-determined. Symbolically we can say that:

$$\boldsymbol{IndividualDemand = a_1 + b_1(IndividualPreferences) + b_2(Nudges)}$$

Individual preferences are based on financial constraints and on the basic needs of customers, while nudges are completely unplanned, and they are based on the emotional response that the customer shows in connection with external influences. Nudges not only affect the consumer buying behavior but also have an impact on the price determination. In effect firms in the pricing of goods and services determined in connection with nudges does not apply mechanism of identity between demand and supply, prices do not reflect effectively changes in the level of production or needs of the population. Nudges based prices are simply based on the activation on an emotional response in consumption and try to trigger impulsive and compulsive buying behaviors (Billieux, et al., 2008) . In this sense nudges can destroy any correspondence between demand and supply for a certain good or services and introduce distortions that reduce price-representativeness. The increasing in the efficiency of nudges, the activation of impulsive and compulsive buying behavior destroy the assumption of the presence of rational individuals able to make choices that correspond to personal interests. In reality nudges in their ability to generate impulsive buying behavior, either in real or in virtual consumption, generate *etero-direction* in the process of decision making.

| **The Role of Nudge in Destroying Basic Economic Assumptions** | |
|---|---|
| **Neoclassical Assumptions** | **Nudge Consequences on Neoclassical Assumptions** |

| | |
|---|---|
| *Prices can reflect changes in demand and supply. Every change in demand and supply can reflect a change in needs of customers or a in the production processes of the firm.* | Prices are determined to activate impulsive and compulsive buying behavior with a weak relation with the mechanism of demand and supply. Consumers have no "*real needs*" since their buying behavior are inducted by marketing and merchandising either in the real or in the virtual environment. |
| *Individual agents are rational and able to program and execute purchasing plans* | Individual agents are not rational. They change purchase programming frequently based on specific offers. Prices, suggestion algorithms, music, lights, and advertisements can change the planned consumption reducing the rational behavior. Individuals change their status from being rational to being emotional. Behavioral decision making can describe and predict the role of choices in the change from rational individuals to emotional individuals. The advent of emotional individuals, that substitute the rational based choices with emotional based choices, justify the large usage of behavioralism in contemporary economics. |
| *Prices are representative: they reflect the value of goods and services.* | Prices are no more representative of the value of goods and services. Prices are based on emotions of the customers. Consumers have limited abilities to compute the complex amount of costs and revenues associated to the purchasing activity. |
| *In perfect market hypothesis the relation price/quantity is common knowledge for every economic agent.* | The relation between price and quantity is obscure. Prices are not related at the quantity that a firm produce, or at the quantity a consumer buy. Prices of products and services are based on their ability to activate an emotional response of the customers. The greater the emotional response, the higher the price. It is necessary to introduce a new measure to evaluate revenue that is the Emotional Marginal Revenue. In particular if marginal revenues are equal to MR and marginal costs is equal to MC, and if ER is the value attributed by the consumer at the emotional stimulation than the Emotional Marginal Revenue is based on: |

| | |
|---|---|
| | $\boldsymbol{EMR = MR + ER \geq MC}$ |

Another tool developed in connection with the evolution of industry 4.0 is the dynamic pricing (den Boer, 2015) . In particular the dynamic pricing is strictly connected to e-commerce even if in its development has shaped the mind and the strategic programs of managers (Lei, et al., 2018). The idea of dynamic pricing consists in the immediate adjustments of pricing based on the complex mechanism of supply and demand and on the ability of the firm to analyze Big Data able to describe the detailed behavior of customers. Dynamic pricing can be used as a tool to change prices based on the estimation of the demand for single consumers, goods or services. In this way dynamic pricing destroys the idea that there is only one price for all economic agents, but instead creates a situation in which at the same time there are multiple prices for multiple agents. A condition applies when dynamic pricing is associated with nudges. In this case pricing is neither based on the relation between demand and supply, neither based on the rational ability of the consumer to choose the best quantity/price relations, but it is only based on the sequent elements: purchasing history and emotional response to nudges.

E-commerce has helped to develop new tools for pricing and gain profits from controlling consumer buying behavior (Huang & Kuo, 2012). E-commerce makes large amount of Big Data, customization, suggestion algorithms (Akter & Wamba, 2016). All these tools can be used to practice prices that are completely independent from the mechanism of demand and supply, and that can destroy the idea of rational behavior of the costumer (Li, et al., 2017). In particular there is the ability of e-commerce to create prices for individual or clusterized customers that are able to generate purchasing acts and realize new forms of consumption (Wu & Chou, 2011). E-commerce works without considering the price as the resultant of the identity between demand and supply. Prices in e-commerce are determined to activate consumer buying behaviors, emotional responses to external stimulus, increasing the level of loyalty of consumers and the profit of the platform (Jiang & Yang, 2016).

We also present a model for the application of Internet of thing to smart manufacturing (Manyika, et al., 2016). In this case there is an elevate probability of the firm to create a more flexible supply in the short run. Manufacturing firms can create an interconnected system based on the development of networks in the context of data environment creating synergies between endogenous data and exogenous data. Manufacturing firms are able to implement forms of Business Intelligence, Business Analytics, ERP, and DSS and create a system in which there is a connection between the external condition of the market, the situation of the supply chain, and the inner situation of the production process of the firm.

The development of informatics has changed the way in which prices are determined. Prices are information. Industry 4.0 has changed the way in which prices are determined and interpreted. Prices can be manipulated with the technique of dynamic pricing. Firms consider the possibility to introduce in their optimization process information regarding consumer behavior, generated using large amount of data. But, the impact of the *Fourth Industrial Revolution* does not only apply in the price determination mechanism, it is also relevant for the supply side, in the sense of organization of the production processes. In fact, thanks to the application of tools of *Business Intelligence*, firms have the ability to predict the quasi-exact amount of products and services that optimize the profit considering, not only the role of factor of production, but analysing also the role of nudge and dynamic pricing in the increasing of sales in the short run (Chen, 2017). Using this set of tools firms can generate a more flexible supply in the short run.

In particular the sequent axioms of the mainstream economics that are destroyed such as for example: the idea of price representativeness, the idea of rationality, the definition of price as the equilibrium between supply and demand, the idea of the rigidity of the supply in the short run. Mainstream economics main assumptions are under the axes of the science of information. The development of the application of the *Fourth Industrial Revolution* destroys either the idea of rigidity of the supply in the short run, either the idea of the existence of representative prices. The industrial system has shifted from *Fordism-Taylorism* to lean production. But the possibility to interconnect machines and robots in the context of *Internet of Things- IoT* can effectively increase the level of efficiency of suppliers (Hwang, et al., 2017). One of the most important results of the industry 4.0 consists in the interconnection of real and virtual machine using sensors. These interconnections generate data. Data are used to predict consumer behaviour, competition and the structure of markets in the short run. In this sense it is possible to divide data in two different categories: exogenous data and endogenous data. Exogenous data are generated by the firms during the exercise of the production process. Endogenous data are based on the market. Some barriers divide exogenous from endogenous data. But the development of the internet of things in the context of data management and governance can change the relation between endogenous an exogenous data. But the complex processes of data management generate new questions that are relevant also in a legal framework (Massaro, et al., 2019).

Firms, organizations and individuals operate in a data environment. Data can be divided in two different sets: exogenous data and endogenous data.

$$\boldsymbol{DataEnvironemnt = a_1 + b_1(ExogenousData) + b_2(EndogenousData)}$$

Exogenous data are external to the economic organization able to describe phenomena such as consumer behaviour, sales, macro-economic scenario etc. Exogenous data can describe how the economic organization interacts with the external reality considering e.g. political, social, institutional and financial features. Exogenous data are crucial to define the way in which the firm can act to improve its market share, affecting consumer behaviour, challenging for competition and acquiring a hegemonic role in accordance with cultural values of a nation or population.


*Figure 2. The Composition of Data Environment.*

Endogenous data are generated in the production process by the firm and are data on workers, material, resources, employed in the production process. Endogenous data are generally extracted from the production processes by using tool such as Enterprise Resource Planning-ERP, Business Intelligence-BI (Massaro, et al., 2019) and Business Analytics-BA (Nofal & Yusof, 2016). The development of industry 4.0 has created a system in which endogenous data and exogenous data are mixed in a managerial structural tool able to make prediction and to take decisions about production, warehouse, investment, workforce organization. The development of industry 4.0 creates the possibility for a complex informative environment based both on endogenous and exogenous data offering new opportunities for firms and economic organizations.

**Data environment and the supply side.** Industry 4.0 can reshape the data environment of the firm creating an informative infrastructure able to generate more data-based decision (Mourtzis, et al., 2016). The complex system of informative infrastructure can connect exogenous and endogenous data and the automatization process to decide how to produce, and how to manage warehouse, workforce and other production inputs. The possibility to generate an interactive process of data interpretation coming out from a data environment associated with the autonomous machine-based decision making can improve production reducing costs of warehouse, stock of materials and goods. Due to this large amount of information the supply side can change the offer of good and service in short time automatically, reducing the costs of organization and increasing the level of profit. The reduction of the rigidity of the supply side in the short run is an innovation generated in connection

with the introduction of smart production and industry 4.0 and ultimately based on the destruction of the barriers between endogenous data and exogenous data.

We can consider the role of internet of things in the sequent financial conditions:

- *Production:* are data generated in connection with production processes. These are data based on the interconnections of devices with sensors. The production system based on IoT can be managed by automatic algorithms (Dumitru-Alexandru, 2016 ).
- *Warehouse:* warehouse can be automatized (Atieh, et al., 2016). The automatization of warehouse can be considered as a tool to improve technologies of lean production. The passage from lean production to smart production is generated also in the context of the automatization of warehouse creating a more efficient supply chain.
- *Marketing:* marketing department make large usage of data generated to verify the characteristics of consumer buying behavior. Marketing managers use data either endogenous and exogenous to determine which products and services can have more success in the markets, and which prices can create loyal customers.
- *Finance:* Financial planning is a crucial part of the entire process of profit optimization. But the possibility for the firm to apply forms of financial planning is based not only on the analysis of balance sheets but also is related on the analysis of non-structured data e.g. data from production process and data from external environment, both interpreted as financial data.
- *Governance and Administration:* governance and administration processes require the development and interpretation of data either exogenous or endogenous. Governance and administration processes afford the question of sustainability of the production processes (Espinosa & Armour, 2016 ). Managers must choose among different typologies of governance. The choice between shareholder maximization and stakeholder management has a relevant impact either on the performance of the firm either on the macroeconomic sustainability (Ferri & Leogrande, 2015). Governance of data should be inspired to a multiple set of values to preserve the interests of stakeholders (Ferri & Leogrande, s.d.).
- *Competition Analysis:* competition analysis is a tool to verify and quantify the presence of firms able to reduce profits or the market share. In particular competition analysis should be connected with the complex activities of mergers and acquisitions devoted to shed light on the future situation of the markets (Bourreau, et al., 2017).

To describe the level of data environment in the context of supply side we can use the sequent formula:

$$\boldsymbol{SupplySideDataEnvironment_{it}} = \boldsymbol{a_1} + \boldsymbol{b_1}(\boldsymbol{Production})_{it} + \boldsymbol{b_2}(\boldsymbol{Warehouse})_{it} + \boldsymbol{b_3}(\boldsymbol{Marketing})_{it} + \boldsymbol{b_4}(\boldsymbol{Finance})_{it} + \boldsymbol{b_5}(\boldsymbol{GovenrnaceAdministration})_{it} + \boldsymbol{b_6}(\boldsymbol{CompetitionAnalysis})_{it}$$

For the firm $i$ in the time $t$.

Every process presents in the context of supply side is based on a complex analysis of data that are crucial to reduce losses and increase profits in the context on Internet of Things (IoT). The possibility for the firm to improve its position in the market, to reduce systemic risks, and micro-variation of the market able to generate losses, is based on the complex system of relations present in the interconnection of the main production function with the large usage of data. To analyze data, information and knowledge it is necessary to use tools such as for example DSS, ERP, Business Intelligence and Business Analytics.

**Data Environment and the demand side.** The data environment has an impact on the demand side. Data can be used to shape the consumer behaviour. Firms and productive organizations have the possibility to know behaviours, desires and the reaction of consumers to nudges (Bigne, 2018). By the means of this information firms can make individual offers to single consumers creating idiosyncrasies in the function of prices. There are more different prices based on the customization process for a single good in a single e-market. In this way the price is no more representative of the tension between offer and demand for a whole market. Instead prices are based on consumer buying behaviour and are individually based on their purchase history (Al-Salamin & Al-Hassan, 2016). This means that there is no unique solution to the problem of the encounter of the price in the context of the demand and supply, but there are multiple solutions that are multiple prices able to solve the identity between demand and supply, not for the market as a whole but for the single individual consumer.

**Data environment and the price.** The possibility of the firm to know the consumer buying behaviour and to administer to each consumer the reserve price defines a new phase in the process of value determination in the market. In the classical theory prices are generated in connection to the encounter of supply and demand. In mainstream economics prices have some of the characteristics of the public good. The price is in effect characterized by absence of rivalry and positive externalities. Every consumer has the possibility to verify in each moment the amount of the price. The idea of a price as a public good, or the idea of price representativeness, has important implications especially for the social and political acceptance of market economy. The idea that the price is one for all the consumers in a single market has been considered as an inner justification for stipulating the social contract

underlining capitalism. But, digital economy, has changed the way in which prices interact with transactions. Prices are no more "*public*" or "*representative*". Prices are based on single consumer purchase history (Gavious & Segev, 2017).

As we can see the possibility to destroy the barriers between endogenous and exogenous data can improve the possibility of the firm to control better either the production process either the consumer buying behaviour. The quantitative and interconnecting tools of industry 4.0 can revolutionize some of the basic assumptions of the mainstream economics that are: the rigidity of supply in the short run, the presence of a price based as a unique solution founded in the encounter between supply and demand side.

The complex data-environment realized with the interconnection between endogenous data and exogenous data, and the technology used to extract information is able to change the classical assumptions of mainstream economics such as for example: rationality of economic agents, prices as representative of demand-supply adjustments, rigidity of the supply in the short run.

### *3. Different definitions of Industry 4.0*

But preliminarily we must address a terminological question that is if the digitalization of firms and society is a Third, a Fourth or even a Fifth Industrial Revolution. The difference in the denomination of technologies is not based on the semantic meaning of tools used seems more related in respect to two elements:

- *The definition of the First Industrial Revolution:* generally, authors that consider the digitalization of the firm as a Third Industrial Revolution (Dosi, et al., 2013), consider that the first industrial revolution has been realized in the XVIII century in England (Rifkin, 2012). At the contrary authors that consider the digitalization of the firms as the Fourth Industrial Revolution consider the agricultural revolution as the First Revolution and the Industrial Revolution realized in England during the XVIII century as the Second Industrial Revolution (Schwab, 2016).
- *The consideration of the digitalization of firms as a unitarian or a differentiated process:* some authors (Schwab, 2016) consider the fourth industrial revolution as a unitarian process. While under another point of view the Fourth Industrial Revolution is considered as a process of informatization of society while the Fifth Industrial Revolution is the particular development of production processes based on artificial intelligence and machine learning (Skobelev & Borovik, 2017) .

In our analysis, we consider the definition of Schwab (Schwab, 2016) in which the process of digitalization of the firm is considered as "*The Fourth Industrial Revolution*" even if this is considered as a passage to a new kind of society that is the "*Society 5.0*" (UNESCO, 2019 ).

### *4. From Fordism-Taylorism to the digitalization of the firm: a comparative analysis*

The digitalization of the firm has introduced many innovations in respect to the production processes. In particular the digitalization of the firms as increased the knowledge (Bouncken, et al., 2019) that firms have with respect to market and consumer behavior, and vendors. The increasing level of information has helped the firm to plan the production level in the short run. Firms have the possibility to collect orders from customers, and to analyze continuosly the variations of prices in the market of productive factors such as semi-finished products and raw materials, and by this way change the production in the short period. This change of the production process in the short run based on data collected from customers, vendors and markets, is the "*flexibilization of the supply in the short period*". During the period of Fordism-Taylorism flexibilization was not possible. In fact, firms should plan a certain production and in the case of positive changes in demand, should had account a reduction in profits earned, while in the case of negative changes in the demand, should had account an increase in unsold products that reduces the level of sales and increases the stock of finished goods in the warehouse. The passage from Fordism-Taylorism to the Fourth Industrial Revolution is characterized by the increasing informative power that is embedded in the data and that firm can use through business intelligence and artificial intelligence.

The increasing level of data and knowledge can augment the possibility for the firm to control the production processes based on the characteristics of the demand, of the market, of the costumers, and vendors. In this sense it is important to consider that the development of new tools of management that are the complex systems of business intelligence, and business analytics, and artificial intelligence, increases the possibility of the firm to escape from financial crisis, production crisis or reduction in the level of demand. The main result is the flexibilization of the supply in the short run that gives the possibility for managers to overcome the limitation of the fixed assets and fixed plants to realize a productive system that is based on micro-fluctuation of the demand, macroeconomic context and vendors conditions (Fan, et al., 2015). In the previous industrial context, based on Fordism-Taylorism there were no possibility to realize a dynamic adjustment of the production in the short term, due to the fact that the knowledge about customers, markets and vendors were not feasible in the short run, and firms should realize plans with the risk of a reduction in the level of demand for a certain good and the risk of internalize losses either in the sense of missing profits either in the sense of reduction of effective sales. The industrial system of the Fordism-Taylorism was more exposed to

crisis from the demand side, that are changing in the income of workers or in their ability to buy a certain product due to a recession, a depression, or the change in technological improvements. The passage from Fordism-Taylorism to the Fourth Industrial Revolution has reduced the probability for a firm to afford a crisis based on demand, due to the fact that the consumer availability to acquire goods and services is a component of the production function in the form of data. In this sense we can better explain the difference in the production function in the passage from Fordism-Taylorism to the Fourth Industrial Revolution as in the sequent equations:

$$\boldsymbol{ProductionFunction_{FordismTaylorism_{it}}} = \boldsymbol{f(HumanCapital_{it}; Technology_{it}; FinancialCapital_{it})}$$

Where $\boldsymbol{i = Number\ Of\ Firms}$ , $\boldsymbol{t = Period\ Of\ Production}$

$$\begin{cases} \boldsymbol{ProductionFunction_{FourthIndustrialRevolution_{it}} = f(HumanCapital_{it}; Technology_{it}; FinancialCapital_{it}; Data_{it})} \\ \boldsymbol{Data = a_1 + b_1(ConsumerBehavior)_{it} + b_2(SupplyChain)_{it} + b_3(InstitutionalChange)_{it} + b_4(MacroeconomicScenario)_{it}} \end{cases}$$

Where $\boldsymbol{i = Number\ Of\ Firms, t = Period\ Of\ Production}$

As we have described the production function, we can also isolate the effect of the flexibilization of the supply in the short run. The flexibilization effect is produced by the sum of Technology and Data. In synthesis we can say that

$$\boldsymbol{FlexibilizationEffect_{it} = f(Technology_{it}; Data_{it})}$$

in which

$$\boldsymbol{Technology = a_1 + b_1(CloudComputing)_{it} + b_2(BigData) + b_3(MachineLearning)_{it} + b_4(ArtificialIntelligence)_{it} + b_5(InternetOfThings)_{it}}$$

and

$$\boldsymbol{Data = a_1 + b_1(ConsumerBehavior)_{it} + b_2(SupplyChain)_{it} + b_3(InstitutionalChange)_{it} + b_4(MacroeconomicScenario)_{it}}$$

The flexibilization of the supply in the short run is based on the interiorization in the production function of the firm of a series of data and information that are able to reflect the behavior of customers, the supply chain, the institutional change and the macro-economic scenario. In this sense we have that the flexibilization effect acts as a force able to reduce the sequent risk of the firm:

- ***Overproduction:*** the flexibilization effect can solve the question of overproduction. Overproduction is costly for the firm since it reduces the level of profit and the sales. Over production can be generated by an increase in the offer of a certain typology of goods and services, and by a change in the customer behavior. Over production creates an increasing

cost in warehouse management, due to the presence of unselled finished product, and the presence of raw materials. The value of the products that are in the warehouse can be depreciated at a high rate, creating losses for the firm. Overproduction was common in the Fordism-Taylorism. The flexibilization effect saves firms from overproduction crisis.

- ***Underproduction:*** is the condition of the firm that has produced few products and services in respect of the demand of the market. Underproduction is a cost for the firm, in terms of missing profits. In effect if the firm had increased production it would also increase profits and sales. Underproduction can be costly for a firm for example in a phase of market expansion. In a phase of boom of products and services, firms can increase their market share, the number of their customers, and also can increase profits and sales. But, in the presence of scarce information, firm couldn't be able to realize the investment necessary to increase the production of plants. Underproduction was a problem in the context of Fordism-Taylorism. But due to the presence of the flexibilization effect generated as a mix of technology and data, firms are better able to predict booms in the markets, adjusting, in the short time, the production function.
- ***Technological change:*** can be a factor of survivor or can also destroy a firm. Economic organizations try to anticipate technological change. During Fordism-Taylorism the probability to realize prediction about the future of technology was very low and inefficient. The tools of Fourth Industrial Revolution are better able to predict the development of technologies in the future, even if there is no certainty, and the prediction of the future, in the long term, remains imperfect. But the flexibilization effect, that is the combination of technologies and data, has some chance to predict technological change especially in the short run. The prediction of the technological change in the short run can increase the ability of the firm to invest, to improve market share and increase customers.

In synthesis we can say that in the passage from Fordism-Taylorism to the Fourth Industrial Revolution there are two essential innovations: technologies and data. We have analyzed the difference in the production functions either for the case of Fordism-Taylorism either for the case of the Fourth Industrial Revolution isolating the "*Flexibilization effect*" that is the complex set of tools that are able to create the flexibilization of the supply in the short run. The flexibilization of the supply in the short run is essentially due to technologies and data.

## *5. Toward an Infinite Flexible Supply in the Short Run*

Smart production is the ability of a firm to organize its process using data. Data-driven firms in the context of digitalization are the evolution of a lean production. In fact, lean production has reduced the level of raw materials in firm's warehouse. But smart production gives firms deeper possibilities to reduce risks and gain profitability by controlling and in part governing the demand side through the permanent analysis of consumer buying behavior.

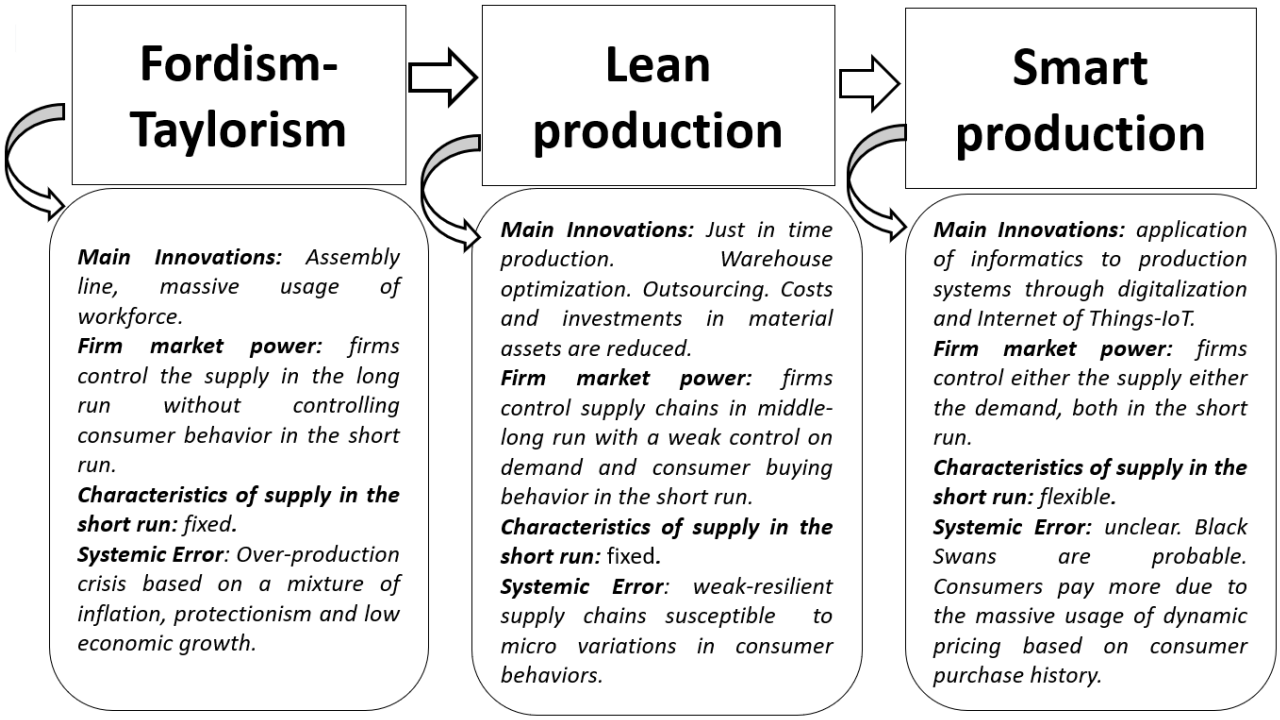


*Figure 3. From Fordism-Taylorism to Smart Production Through Lean Production.*

One of the main propositions in micro-economics and industrial textbook is the rigidity of supply in the short run. But the development of internet of things has created tools to change and manage the rigidity of the supply. The rigidity of the supply is based on the fact that the cycle of production, and the organization of factors of production, can't be easily modified. But the development of new technologies can generate data that interiorized in the production function of the firm creating a modification of material assets in the short run such as for example in the case of raw materials. In effect firms can follow the development of customer behaviour especially in the context of e-commerce. Firms can individualize the price for single consumers based on the purchase history. This condition relates to the question of dynamic pricing (Feng, et al., 2018).

The large abundance of data used to control even the production and the consumer behaviour change the economic organization of industries generating a more flexible supply in the short run. Data collected from real and online stores can be incorporated in production programs modifying the quantitative production. At the same time e-commerce websites have consumer behaviour information and can create specific offer to consumer clusters. In this context there is a double effect

on the main definition of markets demand and supply. Supply can change in the short run and demand can be created using dynamic prices for individual and clustered customers.

What is new in this kind of organization based on prices is the ability to creating a flexible offer and a more controlled demand in the short run. In conclusion if data-based internet of things and applications are able to reduce costs of production optimizing warehouse and the resources used to generate goods and services, at the same time there are negative effects for the determination of consumer prices for the fact that e-commerce knows information about the consumer behaviour.

This organization can generate an economic improvement in terms of profits for industries while at the same time can reduce the consumer ability to choose prices and offers. But technology can give also new instruments to defend the ability of consumer to discern prices among different.

One of the main ideas of the mainstream economics is that in the short run the supply is characterized by rigidity. But the rigidity of the supply can be reduced using a complex system of *Business Intelligence*, *Machine Learning*, *Data Mining* and *Automatization Processes*. Using Industry 4.0 tools such as for example *DSS* and *Business Analytics* there are more probabilities for the firm to apply models able to predict consumption in the short run organizing subsequently either the production processes either the supply chain. The complex informative system able to overcome the barriers between endogenous data and exogenous data generate knowledge that can be used to drive corporations in a management of supply with an efficient time to market based on data. This can have a rule in the process of flexibilization of the supply.

To increase the level of supply flexibilization it is necessary to have the sequent set of tools:

- *Smart supply chain:* the difference between a smart supply chain and a classical supply chain is in the presence of a deeper interconnection that reduce the probability of mis-allineament and congestion in the distribution and logistics process (Wu, et al., 2016);
- *Data warehouse automatic decision system;* automatic data warehouse are able to reduce the costs of raw materials creating the conditions to a more sustainable production processes (Yangui, et al., 2016);
- *Business intelligence:* business intelligence is generated in connection to the development of a series of tools and instruments that can analyze and interpreting data. Business intelligence tools can increase the information content of decision-making processes (Olszak, 2016);
- *Machine learning:* machine learning is complex system of algorithms that are used to create automatic decision-making mechanism able to learn either from errors or from new data. Machine learning can increase substantially the level of knowledge of economic organization, creating new procedures and a better evaluation of financial, economic and productive risks affecting the market (Delen, et al., 2013);

- *Big Data Mining:* big data mining allows the company to obtain information through the relational, interpretative and predictive analysis of large databases (Massaro, et al., 2019). The activity of big data mining does not really have to be considered in relation to a specific area, but rather should be considered as a dimension that must penetrate the company as a whole, or accompany decision-making processes (Massaro, et al., 2019). Especially for market analysis, or in context based on large variability, competition, and changing in consumer buying behavior is extremely important for the firm to accompany and found every decision with a process of big data mining.

Some tools that in the context of Internet of Things can conduce the productive processes towards a more flexible supply in the short run are indicated in the sequent formula:

$$\boldsymbol{SupplyFlexibilization_{it}} = \boldsymbol{a_1} + \boldsymbol{b_1}(\boldsymbol{SmartSupplyChain})_{it} + \boldsymbol{b_2}(\boldsymbol{AutomaticDataWarehouse})_{it} + \boldsymbol{b_3}(\boldsymbol{BusinessIntelligence})_{it} + \boldsymbol{b_4}(\boldsymbol{MachineLearning})_{it} + \boldsymbol{b_5}(\boldsymbol{BigDataMining})_{it}$$

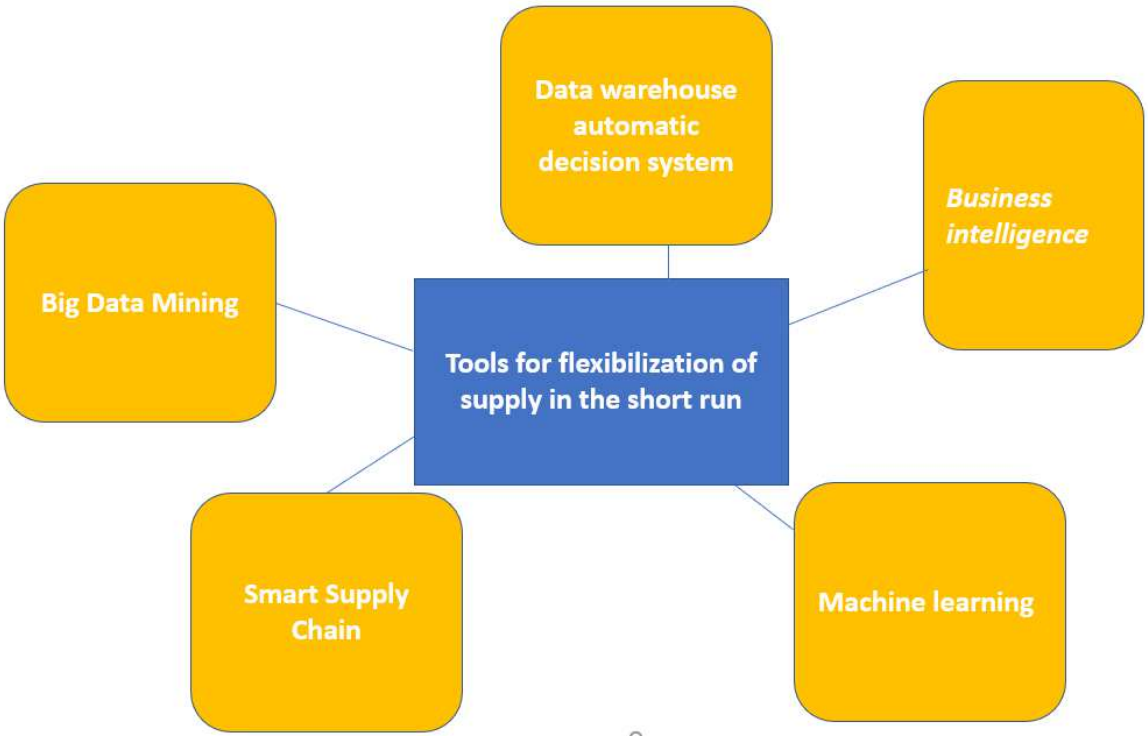


*Figure 4. Tools of flexibilization of the supply in the short run.*

The flexibilization of supply can increase the level of profit by reducing costs. In particultar firms can reduce the level of raw materials and semi-finished reducing the cost of warehouse. Firms have

the objective to perform the flexibilization to reduce the level of resources in the data warehouse, to generate products and services that are more in the interest and desire of customers, and to reduce costs and increase profits. The flexibilization of the supply in the short run has changed completely the level of sustainability of the industrial processes creating the conditions for reducing the probability of crisis from over-production.

**Advantages of the flexibilization of supply.** The advantages of the flexibilization of supply consists in the fact that the firms have the ability to reduce costs of data-warehouse, to reduce the level of investments in raw material, and to produce quantity that the market can effectively absorb. In a macro-economic sense, the flexibilization of the supply increases the sustainability of the production systems, due to the elimination of financial and industrial crisis derived from over-production. The flexibilization of supply can be positive for the sustainability of supply chain, the resilience of distribution system and the anti-fragility of logistics methodology.

**Disadvantages of the flexibilization of supply.** The flexibilization of the supply side can have some negative impact for the fact that is associated to a productive system able to attack impulsive and compulsive buying behavior through the development of tools to process information such as *Business Intelligence* and *Business Analytics*. The question of impulsive and compulsive behavior is relevant for the fact that people can reduce its saving rate (Hirsh, 2015) in association with emotional consumption. Impulsive and compulsive buying behavior are negatively associated with income and social status. In effect people with more self-control have better financial behaviors (Strömbäck, et al., 2017). This means that the development of a system able to induce people to impulsive and compulsive buying behavior can structurally reduce the level of saving, creating the condition of starvation, poverty and financial fragility ending in a reduction of GDP growth and creating the condition for stagnation and economic inequality.

## *6. The Destruction of the Representative Prices*

The question of individual reserve prices can change with the development of the digital economy. One of the main propositions of the neo-classical theory is the fact that at a certain time there is one price for a certain good for all the economic agents. But the development of individual profiles in the context of e-commerce and especially in the mixture between e-commerce and real economy, can change the way in which prices are builded, and the meaning of what they represent. For example, in real store the development of tools such as visual merchandising has increased the probability of an increased in the consumer buying behavior (Galiano, et al., 2019).

Prices can change for single consumers. Each consumer receives prices that are based on its individual purchase history. Data on individual purchase history can also be used to predict the consumer buying behavior (Qiu, et al., 2015).

The idea of price representativeness is based on the fact that the price is the unique solution of the equilibrium between demand and supply. Every change in the determination of demand and supply has a reverberation on the price. At a certain time, there is only one price that can verify the identity between supply and demand, and this price is common and clear for all the economic agents. The idea of the existence of a single price defined in the precise connection between demand and supply is an important element of the social acceptability of the market. But this definition of the price of equilibrium is no more applied in the context of industry 4.0.

In the context of internet of things there is the possibility for a firm to practice at the same time a different price for different individual customers and different clusters of individuals. In this scenario prices are no more representative. Prices are not common anymore but instead they are based on discrimination among groups and individuals and are also able to perpetuate inequalities. The idea of unicity of the price is destroyed and substituted by an infinite number of equilibrium prices that are the result of single negotiations between the firm and individual consumers or clusters of consumers. Prices are no more representatives of the value. In fact, the utility function of the consumers has been completely distorted. Consumers have increasing inducted needs activated by the mean of impulsive and compulsive buying behavior. These behaviors have changed the idea of economic value. Economic value is no more an intrinsic value of the individual preferences of the costumers, neither is a characteristic of the good or services. But economic value of the purchase is interiorized in the same act of purchasing the goods and services. Consumers are no more value makers in the market, as they were in the past by interiorizing and systematizing their needs, but costumers are value takers in the market, due to presence of complex tools that activate their impulsive buying behavior (Vonkeman, et al., 2017).

The act of purchasing, in the context of internet of things and in the *Fourth Industrial Revolution* is no more an act in the feasibility of the consumer. Consumers have been expropriated of the purchasing acts and inducted to impulsive-compulsive behavior.

## *7. The Rule of e-Nudge in Price Determination*

Nudge theory has been developed by Richard Thaler and Cass Sunstein to afford the question of the role of external influence on economic behaviors. The authors argue that the behaviour of economic agents can be changed significantly by micro influences. Nudge theory has been proposed at a government level to promote healthy and ethical behaviour among the population. But nudge theory can used also for-profit purposes (Hansen, 2016).

For example, the idea of suggestion algorithms (Wu, et al., 2019) can be considered as an application of nudge theory in the context of e-commerce. In this sense nudge theory not only does not operate as a new form of paternalism i.e. in the supposed interest of the costumers, but certainly works as a form of customer exploitation, for the fact that consumer are no more able to distinguish between goods that rationally increase their own welfare and goods that increase the firm's welfare. The ability of the customer to choose responsibly can be significantly reduced once the customer has interiorized the suggestion proposed by the algorithms based on individual data. If the web-platform is efficient the possibility for the customers to escape from the individual offer is exceptionally low. The widespread usage of data for the process of customization significantly increase the probability of the firm to perform prices at the right level for the revealed preferences of the customers. At that time, the suggestion algorithm can formulate a purchase offer that can fit perfectly the individual preferences of the customer based on data.

The possibility for the firm to realize an increase profit through suggestion algorithms motivate the widespread usage of nudge in the context of e-commerce (Mirsch, et al., 2017). Nudges creates a distortion in the mechanism of price determination. Prices are no more determinated by the encounter of demand and supply. Prices are determined based on the purchase history of the consumer and on the probability that the customer will acquire the suggested offer. As in the sequent formula:

$$\begin{aligned}\boldsymbol{NudgeBasedPrices} \\ &= \boldsymbol{a_1} + \boldsymbol{b_1}(\boldsymbol{PurchasingHistoryOfTheCustomer}) \\ &+ \boldsymbol{b_2}(\boldsymbol{ProbabilityOfSuccessOfSuggestionAlgorithms})\end{aligned}$$

Evidently there is a positive relation between *Purchasing History* of the and the *Probability of Success* of the suggestion algorithms. In effect the greater the data able to describe the *Purchasing History* of the customer, the greater the *Probability of Success* of the suggestion algorithms. Data, even in the case of nudge-based prices, change the mechanism of price determination. Prices are no more produced by the intersection of demand and supply, but prices are determined in connection with the expressed preferences of the costumer manifested in the *Purchasing History* of the customer and on the annexed *Probability of Success* of the suggestion algorithms. The *Probability of Success* of

suggestion algorithms in never equal to zero due to the fact that data managers can attribute a certain positive probability to the customer using clusterization processes. On the other side even when the *Probability of Success* of suggestion algorithms is equal to 1, that is the maximum amount feasible, the firm can increase the knowledge about the consumer behavior.

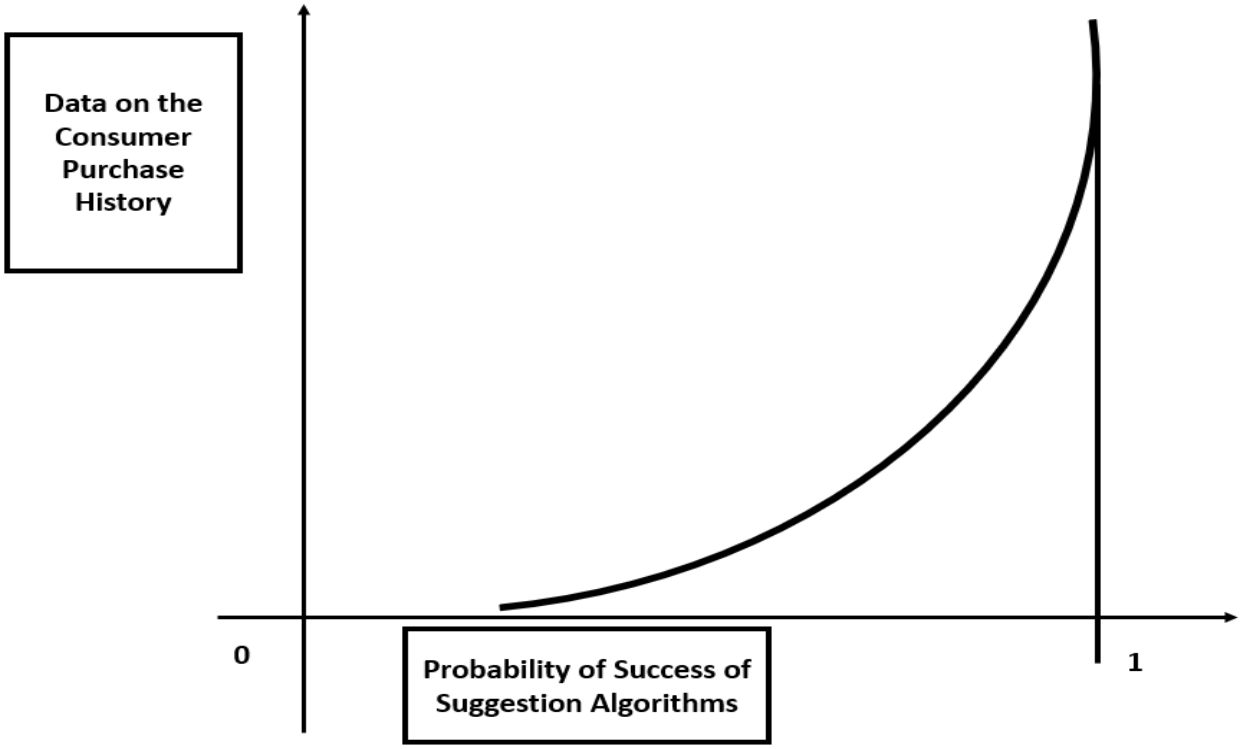


*Figure 5. The relationship between Data on the Consumer Purchase History and the Probability of Success of Suggestion Algorithms.*

Even if nudges have been introduced in the context of behavioral economics as a tool to describe how micro-influences can affect the consumer decision making processes, and are at least considered as a way to improve more healthy behavior in the sense of paternalistic government (Sunstein, 2014), there are also dark and obscure sides in nudging, especially when nudges are applied to e-commerce and associated to large dataset able to describe the consumer buying behavior. In this case nudges, expressed in the form of suggestion algorithms, can reduce the "*rationality*" of the customers, increasing the median expenditure for purchase and the dependence for an "*assisted purchase procedure*" that reduce the level of the ability of the customer to choose consciously. The marketing application of the nudges change the way in which prices are considered either theoretically or practically. In the classical theory for each market and each product there was only one price for all the customer. In the contemporary condition of the market that is based on the sectorialization and clusterization of individual customer due to the presence of big data, prices are relative to single products and single costumers. At a certain point, for a single product or service there are so many

prices such as the number of customers interested in the purchase process, and for each of them the price changes in respect to historical data and suggestion algorithms. Suggestion algorithms are considered as nudge but with an un-ethical and anti-paternalistic characteristic. Infact while in classical nudge theory, every micro-influence can be disposed in the interest of the customer, in the context of nudge thoery applied to commercial purposes the perpetuation of nudges is in the exclusive interest of the firm.

Nudges, in the form of suggestion algorithms (Weiss & Mehrotra, 2001), are able to induce customers to one of the worst behavior: impulsive and compulsive buying able to destroy saving, income and even reducing the ability to make "*rational choices*" based on "*self-evaluation*". By this massive application of algorithm to extract income from costumers, nudges are transformed from a form of paternalism to a form of exploitation and alienation of the customers. The aggregate effect of the increased perpetuation of impulsive and compulsive buying behavior can reduce the functionality of national and global economy by reducing saving, increasing private debt and creating the condition for the diffusion of regressive economic phenomena such as poverty, financial fragility and individual financial failures.

## *8. Dynamic Pricing and Price Individualization*

Dynamic pricing is another tool to destroy price representativeness, the idea of the price as determined in the connection between supply side and demand side, and the presence of rationality in the consumer buying behavior. Dynamic pricing is a technique used especially in the context of e-commerce. But, due to the extreme success and profitability of the procedure, it has overcomed the limits of e-commerce to enter in the strategic planning of pricing in marketing department in real firms. Dynamic pricing has a hegemonic impact either in e-commerce either in traditional commercial firms.

The idea of dynamic pricing in its simplicity has some revolutionary effect. Dynamic pricing works with asymmetric information. Dynamic pricing contrasts with two concepts:

- **Price unicity:** the fact that at a certain time there is only one price for goods and services in a certain market for all the economic agents;
- **Price representativeness:** the fact that price represents the encounter of demand and supply.

Both these principles do not hold in the context of dynamic pricing. Dynamic pricing changes the price for goods and services at a certain moment for different typologies of individual or clusters of consumers. The idea of the unicity of the price does not apply anymore. But the development of the

dynamic pricing has also changed the idea of price representativeness for the fact that prices do not represents changes in demand-supply, but simply are realized using data mining tools.

## *9. Case Studies 1: e-Commerce*

E-commerce makes a huge application of dynamic pricing and nudges as in the case of suggestion algorithm. The main tool to determine how consumers makes their choices consists in the usage of big data analysis tools that are instruments to implement business intelligence and business analytics. The diffusion of such tool is so great that every platform offers e-commerce tools for big data analysis. For example, Amazon (AWS, 2019) offers a lot of tools to analyze the consumer buying behavior such as:

- *Amazon Athena;*
- *Amazon EMR:*
- *Amazon Redshift:*
- *Aws Glue:*
- *Amazon Cloud Search:*
- *Amazon Kinesis:*
- *Amazon QuickSight:*
- *AWS Lake Formation:*
- *Amazon ElastichSearchServices:*
- *AWS Data Pipeline:*

These kinds of services can create tools to mine information able to describe the level of financial investments. Data mining has changed completely the process of customization, profilation and pricing. Prices are not determined by the encounter between supply and demand. Prices are generated by big data. Big data are used to extract information about consumer buying behavior.

The application of big data, machine learning, blockchain, is feasible for the single seller on e-commerce platform. Due to this new technology there is no chance to create prices that are characterized by unicity and representativeness. The consequence is that costumers are not rational anymore, but they are emotional. The rising and the adfirmation of emotional customer as a new antropological class of customers requires a change in the economic paradigm that the behavioral economics has only partially anticipated. The massive application of big data analysis has changed definitely the mechanism of price determination, that is no more related to rationality of the customer,

neither to the encounter between supply and demand, but is grafted in the human emotional structure manifested in consumer buying behavior, especially in its impulsive and compulsive attitude.

The emotional based price determination can be controlled with the widespread usage of big data in e-commerce, and help to create methodologies and tools, to extract consumption from users. Emotions fuels consumption, and big data can extract information, able to create the condition to realize offers able to have an impact on the economic conditions.

The AWS Amazon System has developed tools for machine learning, that can create new enterpreneurs that are able to use the new tools of industry 4.0 in the orientation of artificial intelligence. The fact that feasible platforms, such as Amazon can develop similar projects at low prices, means that in the reality, the mechanism of dynamic pricing and the process of collecting data to induce impulsive and compulsive behavior are commonly entered in the context of e-commerce business. And since the percentage of the costumers that acquire products and services from internet is increasing, there is an effective impact on the level of impulsive and compulsive buying behavior. E-commerce works as a tool that create a greater diffusion of dynamic pricing, and reduce the price representativeness, the idea of price unicity. Technology applied to e-commerce creates conditions for the destruction of the application of mainstream application affecting demand and prices.

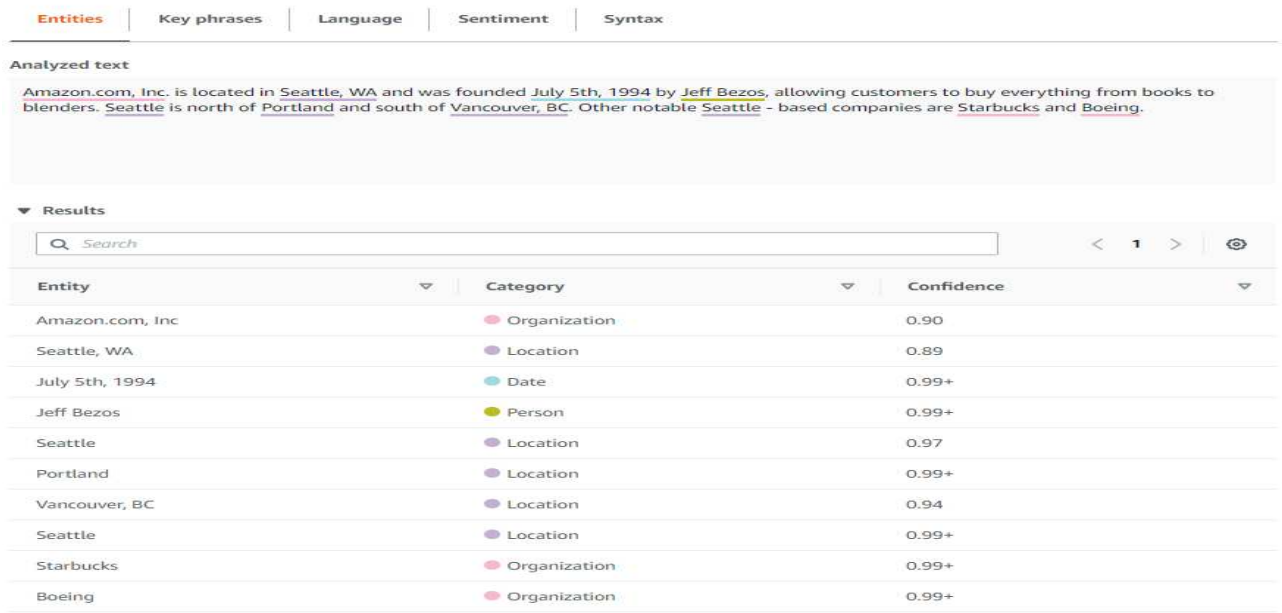


*Figure 6. Amazon Natural processing language tool in the context of Machine Learning instruments.*

## *10. Case Study 2: Manufacturing*

Also, manufacturing has been changed by the massive usage of informatics in the production processes. In particular the creation of Internet of Things I.o.T. has developed tools and mechanism to change the role of the supply (Zhang, et al., 2015). I.o.T. mechanism have the possibility to change

the role of the warehouse organization and the mechanism of workforce, and material asset management. The change in manufacturing is based on the idea of connecting endogenous and exogenous data through the development of business intelligence tools. Business intelligence can develop analysis and decisions based either on endogenous either on exogenous data. The coordination of endogenous and exogenous data generates more conscious decisions able to connect either data from the demand side, either data from the production processes. By this mean there is the possibility for the firm to better organize the productive processes reducing the fixity of the supply in the short run. The flexibilization of the supply is based on the business intelligence analytical decision making process that can be considered either to consider, at the same time, and with a unique tool, changes in the demand side, even on a micro-base, and connecting them with the organization of the production processes in the context of supply flexibilization.

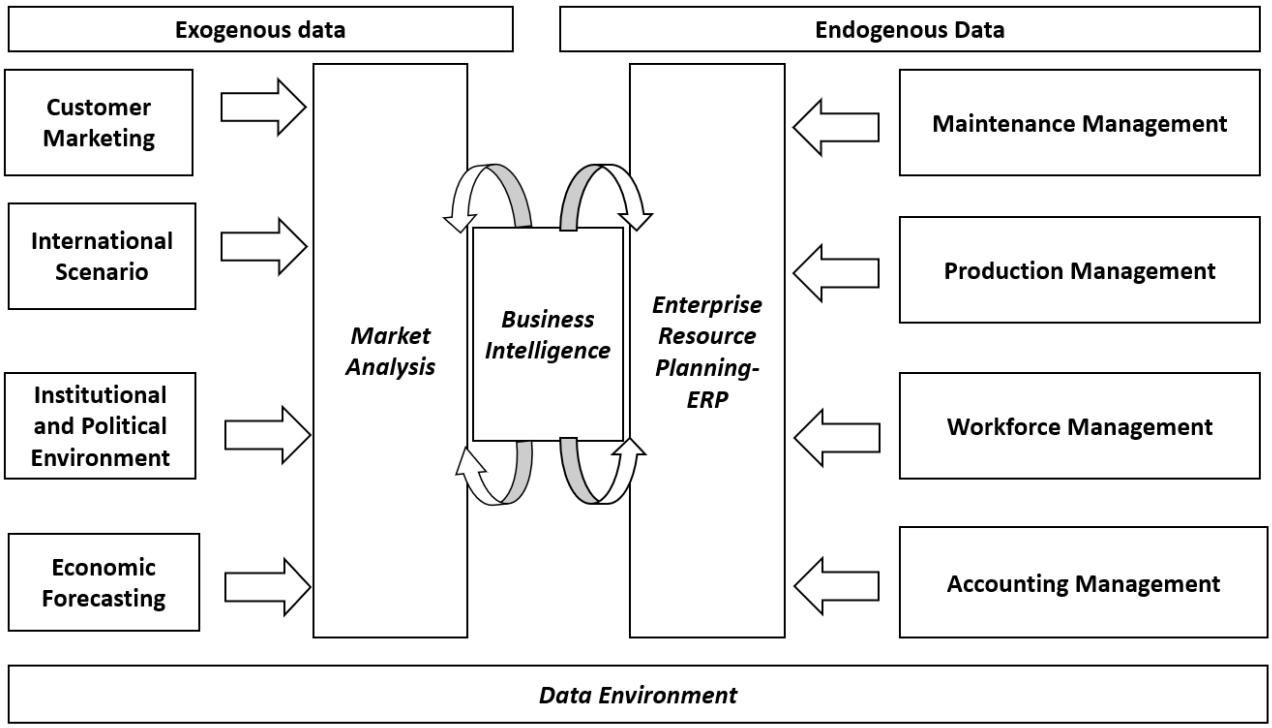


*Figure 7. The connection between endogenous data and exogenous data through the execution of Business Intelligence able apply Enterprise Resource Planning-ERP and Market Analysis.*

Business intelligence considers either endogenous either exogenous data. On the endogenous side there are data affecting production, warehouse, accounting, workforce, maintenance. Endogenous data are flow in Enterprise Resource Planning-ERP tools. ERP tools develop methodologies to better organize production factors in the context of supply programming either in the short period. Data and decision elaborated from Enterprise Resource Plannig-ERP constitute an input for Business Intelligence tools.

On the other side, there are exogenous data, that are data external to the firm environment. Exogenous data can represent customer marketing, international scenario, institutional and political enviroment, economic forecasting. Exogenous data and decisions flow in the context of market analysis tools. Market analysis tools confer data to business intelligence box.
The entire process can be automated to generate better decision affecting either the ERP processes i.e. the quantity to produce and quality to produce, either the market analysis processes i.e. the price to practice for individual and clusterized customers.

## *11. Conclusions*

In conclusion we can say that the development of the industry 4.0 can change some crucial propositions of the classical mainstream economics in particular: the idea of fixed supply in the short run, and the question of price representativeness. Fixed supply in the short run has been always a limit for firms in their attempt to improve profits. Even the possibility of a price representativeness is destroyed by the development of individual price for single consumer based on their purchase history. New models are required to analyze the role of supply, demand, and price representativeness in the context of industry 4.0. Firms have new tools to increase their profits: flexibilization of the supply in the short run and the application of individual prices for each consumer based on the purchase history. The massive application of machine learning, automation decision processes, and artificial intelligence, either in manufacturing either in e-commerce, creates new conditions to describe the development of supply and demand in the new data environment. Data can be transformed in decisions able to flexibilize the supply in the short run and at the same time to reduce the price representativeness through the practice of individual and clusterized price on the demand side.
Due to the widespread usage of informatics in the context of production and in e-commerce there is a necessity to rebuild a new economic theory that based on the idea of the destruction of price representativeness is able to generate tools to analyze the functional mechanism of demand and supply. Industry 4.0 has destroyed the idea of price representativeness and has reduced the applicability of the assumption of the rigidity of the in the short run.

## *Aknowledgment*

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# *12. Index of figures*



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