Understanding the Digital Economy in Retailing & Its Implications for Output Growth, Household Welfare and Measurement Issues in All Service Sectors*

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September 2019. Version 4.0

* This paper arose from a keynote speech delivered to the annual meeting of the Census Bureau on January 24th 2018 (Econ Revue). Presentations at U. of Miami and Frontiers in Service 2018 led to an earlier version with a slightly different title that benefitted from comments by Emek Basker, Monica Cortiñas, Barbara Robles, Brian Ratchford and Giorgo Sertsios. This version has benefitted from an insightful question on the earlier version by Ariel Pakes as well as from questions and comments at seminars during the first semester of 2019 (UC3M Marketing Department; UPNA Economics and Business Department; and American University Economics Department). A paragraph on GDP measurement implications was added as a result of presentation at SEM's Sixth Conference at Goethe University in Frankfurt, Germany. The author claims responsibility for all remaining obscurities and errors.

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Title: Understanding the Digital Economy in Retailing and Its Implications for Output Growth, Household Welfare and Measurement Issues in All Service Sectors.

Abstract:

This essay characterizes two 'pure' structures in retail sectors, brick and mortar (B&M) and digital economy (DE), in terms of their provision of retailing or distribution services jointly or separately in space and time. The resulting differences generate seven different maximum levels for these distribution services: for four the DE structure dominates the B&M structure; the reverse holds for three. Two important economic implications about the nature of DE retailers follow immediately. First, stores are not necessary for the distribution of goods with associated cost savings; second, there are economic incentives for pure B&M retailers or pure DE retailers becoming mixed mode retailers. These incentives stem from the different maximum services that are feasible to provide by each type of retailer. Important economic implications for output growth, household welfare and measurement in the distribution of goods result from comparing B&M retailers and DE retailers. One of them validates in precise terms the substantial magnitude of productivity increases due to the DE in the retail sector; the other two prevent inaccurate welfare comparisons and correct for measurement biases in statistical agencies measurement of e-commerce, respectively. Three different cases arise with respect to services. Each one has special characteristics that require discussion before analyzing implications for output growth, household welfare and measurement issues in the distribution of services. Finally, understanding the digital economy in retailing yields insights into a new concept: omni channel behavior from an economics perspective.

Key words: distribution services, B&M versus DE retailers, distribution of goods and services, GDP measurement, productivity, and household welfare.

JEL codes: L81; L86; E01; D02; M31; I23.

An objective of this paper is providing an understanding of the essential role of the digital economy in retailing activities. This understanding becomes the basis for appreciating its direct impact

on the brick and mortar economy, including the retail sector and all other service sectors. These impacts can be substantial and affect variables of economic interest in all these sectors, i.e., output growth or productivity, household welfare and measurement issues in various GDP sectors. Understanding the digital economy in retailing generates a wide range of implications for other service sectors because there is a substantial amount of retail activity within each of these sectors. Furthermore, their economic importance stems, among other reasons, from the fact that in 2016 services averaged 69% of GDP in the world and were 79% of GDP in the US (World Bank, WDI Table 4.2).

Departing from a fundamental analytical framework is useful when providing a different perspective. The framework chosen emphasizes the role of space and time in the distribution process. I view the economy as consisting of three primitive economic activities (production, distribution and consumption) that can take place separately or jointly in space and time, which are basic coordinates of human activity. Mechanically, it generates a 25 cells table describing the possible combinations in which these primitive activities as ordered can take place jointly or separately in space and time (Betancourt and Gautschi 2001). For our current purposes we focus on one cell where all three activities (production, distribution and consumption) can take place separately in space and time, namely on the retail sector.

One economic agent embedded in this cell takes the products generated by producers in agriculture and manufacturing and makes them available to consumers without any further transformation **in a number of specific locations during a given time period**, i.e., one can call this economic agent a brick & mortar (B&M) 'pure retailer'. Nevertheless, this cell also embeds another economic agent who takes the products generated by producers in agriculture and manufacturing and makes them available to consumers without any further transformation **from an undefined location during a potentially maximum 24 hours a day/seven days of the week period**, i.e., one can call this economic agent a digital economy (DE) 'pure retailer'. Finally, either pure form can add the other pure form and become another economic agent embedded in this cell, i.e., a mixed B&M and DE 'pure retailer'.

'Pure retailers' are, thus, different molecular or subatomic structures of a cell or an atom, respectively. Whatever analogy one prefers, the DE retailer performs the same function in retailing as the B&M retailer. Nonetheless, it must do so in a different way due to the different role of space and time in the two settings. Can we analyze these different ways relying on our usual tools? The answer is yes because there is a theoretical structure already developed to analyze the function of retailing in a B&M setting (Betancourt and Gautschi 1993) which has been extended recently to capture the function of retailing in a DE setting (Betancourt, et al. 2016). Succinctly put, in both cases the same function is performed but in substantially different ways.

Convenience of exposition suggests starting with a detailed review of the performance of the retailing function in each setting, laying out the basis for understanding their essential differences and two important economic implications that follow directly from these differences. One is the possibility of complete elimination of stores in DE retailing; the other is the existence of economic incentives for either structure to become a mixed mode 'pure retailer'. Afterwards, I discuss the implications of this understanding for the distribution of goods, emphasizing their impact on output growth, household welfare and measurement issues. Three economic implications for the distribution of goods follow directly from these essential differences. First, output increases since the 1990's due to the DE in the retail sector are of impressive magnitude, at least 8% per year. Second, substantial possibilities for cost shifting to consumers in the DE economy can lead to inaccurate comparisons with B&M in evaluations of household welfare and/or underestimation of resulting inequality. Third, confusion about the nature of complementarities in digital economy retailing can lead to substantial measurement errors, which I illustrate with the U.S. Census definition of e-commerce.

Subsequently, I discuss similar implications for the distribution of services by 'impure retailers'. Nevertheless, this case requires first identifying three different contexts generated by different impacts of the digital economy on services to understand these implications. One impact is the DE conversion of a subset of goods into service products through digital distribution. A second one is that for some but not all

distribution services the DE allows for the emergence of new institutional forms, by themselves and/or in combination with other core products or distribution services, in all service sectors. This possibility is due to the separability in production, distribution and consumption of subsets of distribution services across space and time in all service sectors. I illustrate this feature for one distribution service, assurance of product delivery at the desired time, but a similar issue arises with respect to information provision. Finally, for one distribution service (ambiance) the DE economy magnifies its role in purchasing activities while reducing or eliminating its role in consumption activities in a variety of services sectors. I illustrate this feature with an example from the education sector. The last substantive section highlights the importance of complementarities in retailing by illustrating one of them with a recently introduced concept: omni channel behavior. A brief conclusion summarizes and discusses implications for future research.

I. The Retailing Function and Its Performance in B&M and DE Settings.

My view of the retailing function is in terms of the provision of five broad distribution services that accompany retail transactions in which a core product sells at an explicit price. The core product is what consumers pay for in a retail transaction. Several reasons underlie viewing retailing in terms of distribution services. First, these services describe the retailing function in both B&M settings and DE settings. Second, they apply to goods transactions as core products as well as to services transactions as core products. These two features allow a comparison between B&M retailing and DE retailing in terms of the same elementary components for both goods and services. Third, they can be further disaggregated, if necessary or convenient, as illustrated below. Perhaps most important they are easily related to basic economic tools underlying demand and supply. Hence, they provide a basis for analyzing retail markets and undertaking the comparison of interest in economic terms.

Economics and marketing literatures have identified five broad distribution services as the main component outputs of the aggregate one labels retail output (e.g., Bucklin 1973, Oi 1992). These components are accessibility of location (for acquiring products), information (about product prices, hours

available for purchase and product characteristics), assortment (breadth in terms of product categories and depth in terms of product variety), assurance of product delivery (at the desired time and in the desired form) and ambiance (of the retail environment). They have become widely accepted as accompanying any retail transaction (Kopalle, et al. 2009). Viewed as outputs, they are arguments in a retailer's cost function, C (v, Q, D), which exhibits the usual textbook properties of cost functions. For instance, an increase in any of its arguments, e.g., input prices (v_i), core products (Q_k), or distribution services (D_j), increases costs or at least doesn't decrease them, i.e., $C_i \geq 0$, $C_k \geq 0$, $C_j \geq 0$ (e.g., Betancourt 2004: Ch.4).

Viewed as outputs, distribution services can exhibit economies of scale and scope (Baumol, Panzar and Willig 1982) just as typical core products do. Distribution services can be common to all items or specific to a subset of them. Accessibility of location and assortment are usually common to all items in a store. Distribution services such as information and assurance of product delivery are usually specific to a subset of products or items in a store's assortment, but they can also be common to all products in some cases, e.g., information on store hours. Ambiance can be either common or specific, depending on format and whether the retail environment includes only purchasing activities or both purchasing and consumption ones, e.g., shopping centers and shopping malls.[1]

On the demand side, these distribution services operate as fixed inputs in the household production functions of consumers provided by retailers. Hence, a two stage analysis of the household production model (Deaton and Muellbauer 1980) has been used to derive the Marshallian demand for retail products, $Q_k(p, D, Z_i(p, D, W))$, and its properties (Betancourt and Gautschi 1990,1992).[2] For instance, changes in prices, p_k, of any input generate a production or net effect, given the level of commodities Z_i , and a consumption effect. The gross effect of any price change on the Marshallian

[1] For instance, one study of the latter (Bloch Ridgeway and Dawson 1994) identifies four types of patrons: traditionalist and minimalists who go for multi-purpose or single purpose purchases, respectively; enthusiasts who go for purchases, usage of the mall and experiential consumption and grazers who go for experiential consumption but as a result engage in purchase activities.

[2] The notation implies a single retailer, but extensions to multiple retailers are straightforward and available in the two references cited in the text.

demand for a retail product is the sum of both effects. Similarly, the gross effect of a change in a distribution service is the sum of a production or net effect and a consumption effect. Conceptually, distribution services are quantities dual to the shadow prices the consumer would pay for a unit of the distribution service.

In the case of a change in price, the consumption effect changes the level of expenditures required to attain a given level of the commodities that yield satisfaction directly; in the case of a change in a distribution service, the consumption effect changes the amount of expenditures available to attain a given level of the commodities that yield satisfaction directly. Thus, through the consumption effect increases in an input price increase what you have to spend to attain a given level of the commodities that yield satisfaction whereas increases in a distribution service increase the amount you can spend to attain a given level of these commodities. That is, the latter represents an increase in a fixed input to the household production function provided by a retailer. In general, the consumption effect is always positive for 'normal' commodities.[3] Hence, it is a driving force toward gross complementarity for all the items sold by anyone retailer, and especially so for common distribution services.[4]

Retail markets for goods in a B&M mortar setting have been viewed as having two essential characteristics in terms of bundling distribution services and core products and cost-shifting with respect to distribution services (Betancourt and Gautschi 1993). That is, one essential characteristic is performing the retailing function by supplying given levels of the five distribution services described above to every customer of an establishment together with whatever set of core products those customers demand at explicit prices. Another one is choosing where to operate on their cost functions by choosing the levels of these five distribution services for an establishment, which implies choosing the fixed costs incurred by

[3] This requires no regressive inputs in the production of the commodities that yield satisfaction to the household.
[4] An insightful illustration of this gross complementarity force viewing advertising as a mechanism for providing information is available. For example, promotion of Washington apples through advertising by the Washington Apple Commission leads to an increase in the demand for all apples and several other fruits (Richards 1999).

their customers, e.g., lowering these costs to their customers by absorbing them into their own costs when providing higher levels.

By contrast, retail markets for goods in an online setting have as essential features the ability to unbundle distribution services and core products as well as the shifting of a major cost in providing one distribution service to their customers. That is, in performing the retailing function online retailers can: 1) provide given levels of these distribution services unbundled from each other in space and time; and 2) shift the costs of providing accessibility of location for acquiring core products through shipping fees of one kind or another. The unbundling of distribution services by online retailers differentiates them dramatically from B&M retailers in how they perform the retailing function. Hence, I discuss briefly its two main features (Betancourt et al 2016: Propositions 1 and 3).

Proposition 1 states: A 'typical' online channel allows separation across space and time of production, distribution and consumption for all distribution services, i.e., it exhibits strong type II separability.[5] The difference with B&M channels becomes most clear in tabular form. Underlying Table 1 is the role of distribution services as outputs, i.e., just as core products they require production distribution and consumption. One main feature stands out: with respect to the DE pure retailer production, distribution and consumption of distribution services is separable across space and time for every distribution service. Several other features are worth mentioning. Separability of the primitive economic activities with respect to time is feasible for every distribution service except in store information for the B&M retailer. The production, distribution and consumption of information through advertising was separable in space and time before the advent of the Internet. Jointness in space with respect to distribution and consumption is a constraint for all distribution services provided by a B&M retailer except for information through advertising.

[5] Weak type II separability simply means that separation across space and time of production, distribution and consumption of distribution services is feasible for at least one distribution service but not for all five (see text reference for illustrations).

(INSERT TABLE 1 AROUND HERE)

Proposition 3 states: Online channels provide lower (higher) maximum levels of distribution services than offline ones in the following cases. Assurance of product delivery at the desired time as well as information and assurance of product delivery in the desired form for sensory dependent items[6] (accessibility of location, information and assurance of product delivery in the desire form for non-sensory dependent items as well as assortment). Just as before, the differences with the B&M retailer emerge most clearly in tabular form. One main feature stands out from Table 2: the DE pure retailer is superior to the B&M pure retailer in the maximum levels of four distribution services that it can provide for technological or economic reasons but it is inferior for three distribution services. Incidentally, for ambiance no relative ranking arises because there are too many exceptions due to heterogeneity of products, consumers and consumption opportunities to establish an unequivocal maximum for this service in either setting.[7]

(INSERT TABLE 2 AROUND HERE)

Two important economic implications follow from the differences between the B&M pure retailer and the DE pure retailer brought out by Propositions 1 and 3.

Implication 1: *the ability of DE pure retailers to produce assortment independently of its distribution to consumers in space and time generates enormous cost savings in storage, carrying costs and store location costs by allowing these retailers to eliminate all stores (Betancourt et al. 2016: p. 10).* An obvious real world example is Amazon's emergence and dominance as a distributor of books and music.

[6] This concept (stressing tact, taste and smell) is standard in the marketing literature (e.g., Degeratu, Rangaswamy and Wu 2000).

[7] The definition of ambiance for the DE pure retailer is usually in terms of web page appeal and web page functionality and it usually focuses on purchasing activities (e.g.., Cortiñas, Chocarro and Elorz 2019). In contrast, the definition in the B&M setting usually tries to capture pleasing features of the environment, especially when it involves joint purchasing and consumption activities at a given location, for example, as in shopping malls.

Indeed, it led to driving out of business a primarily B&M retailer providing a subset of the same product lines, i.e., Borders.

Implication 2: *the existence of different maximum levels of distribution services provided by each type of retailer and neither type being superior in all of them suggests the existence of incentives in the form of profitable opportunities for either type of pure retailer to become a pure mixed B&M and DE retailer.* Obvious real world examples are the most iconic B&M pure retailer (Walmart) adding an online channel and the most iconic DE pure retailer (Amazon) opening stores directly or by acquiring existing ones. Both icons have expanded into the non-iconic channel within the last ten years.

II. Implications for the Distribution of Goods and Its Measurement.

For pure retailers of all three types distributing goods, the profit function is

$$\Pi = p_R Q - C_R(v, Q, D) - p_w Q, \quad (3)$$

where Q is a vector of the volume or quantity of goods sold (and effectively demanded by customers). p_R is a conformable vector of retail prices; $C_R(v, Q, D)$ is the retailer's cost function defined in the previous section with respect to its three arguments; and p_w is a vector of wholesale prices at which the retailer acquires these goods from wholesalers or manufacturers. The essential difference among the three types of retailers is the components of the cost functions for each and the maximum levels of distribution services each type can provide, i.e., the second terms. In all three cases, the first term captures sales and competition could lead the prices at which these goods are sold to be the same. The third term represents the costs of goods sold and competition could lead the wholesale prices at which these goods are bought to be the same. What differentiates these retailers at the same levels of outputs for the core products (Q) in this setting would be the costs of retailing, i.e., the second term.[8]

[8] Differences between the three types of pure retailers, e.g., in economies of scale, would lead them to operate at different levels of output under profit maximization. The same Q assumption is made here to highlight the role of the costs of retailing in determining the output of the retail sector through provision of distribution services, D.

Not surprisingly, the retail gross margin ($p_RQ - p_wQ$) is viewed as the best measure of retail output for national income accounting purposes in practice (Yuskavage 2006) and conceptually (Triplett and Bosworth 2004: Chapter 8). If above normal profits are zero, the retail gross margin is a measure of the gross output of the retail sector (Betancourt 2004: Ch.4, Section 1, fn.2). Of course if above normal profits are not zero, the retail gross margin includes not only a measure of the gross output of the retail sector but also its monopoly profits. In the national income accounts, electronic shopping and mail order houses (NAICS 4541) contain most of the DE pure retailers. Hence, I compare the evolution of their retail gross margins as percentage of sales with those of total retail sector using publicly available data from the Annual Retail Trade Survey 2015 (ARTS 2015) over the period 1993-2015. Table 3 summarizes the data.

(INSERT TABLE 3 AROUND HERE)

The first two rows of the table indicate differences in retail gross margins as percentage of sales between mainly B&M and mixed mode pure retailers in the total and mainly DE pure retailers in electronic shopping and mail order houses of about 16% during the first decade of the Internet era.[9] The last two rows measure this difference at the beginning of the third decade of this era, which is about 10%. This table brings out two interesting questions. First, what leads to the diminishing differentials between the first and the third decade of the Internet era?

Mechanically, they average 6% and the decline is due to a decrease in the retail gross margin for the mainly DE economy sector since the difference in the average for the total between the two decades is a trivial percentage (0.02%). Since productivity in this mainly DE retail subsector is unlikely to have been decreasing over the period 1993-2015, a decrease in above normal profits generated by the initial innovation wave is most likely to be responsible for this decrease over time in the retail gross margin of this DE retail subsector. Two sources of increased competition over this period immediately come to mind. New exclusively digital firms entering this retail subsector successfully in a wide variety of niches

[9]Amazon launches as an online book retailer in 1995, moves into CD's and DVD's in 1998, into toys and electronics in 1999, and it launches web hosting services in 2002 (e.g., Quinn 2015).

and B&M retail firms adding online channels that expand rapidly. A US Census Bureau practice captures an unusual feature of the latter source of competition. Namely, it classifies online sales of B&M firms in the electronic shopping and mail order subsector after creation of a formal online division by a B&M retail firm (e.g., Nicholson 2017). Presumably, B&M firms engage in this practice once their online sales reach a substantial magnitude. Finally, a third factor that explains a decrease in the abnormal profits of this sector over the period is the increased payment of sales taxes on Internet transactions. The latter were relatively small during the first decade (Goolsbee 2000).[10]

A second question is –what explains this 10% average difference between the mainly B&M and mixed mode total and the mainly DE electronic shopping and mail order category during the third decade? Is it entirely due to higher output growth in this subsector or does it still include substantial monopoly profits? Mechanically, the retail gross margin as percentage of sales for the mainly DE category seems to stabilize in the third decade when for the first time (2014) it increases to a previously higher value (39.1%) reached in the second decade (2002). Hence, if a 10 % differential is a reasonably stable figure the question of whether this difference is all due to productivity or includes monopoly profits is important. A distinguished economist argues that information technology is a main source of inequality increases and estimates monopoly profits from this source to have increased 20% by 2015 (Kurz 2017). Assuming this increase captures all the remaining monopoly profits in the average retail gross margin for the third decade of the Internet era in Table 3, we have the following result.

Implication 3: A*t least 8% of the retail gross margin differential growth in the mainly DE sector is due to higher output growth than in the mainly B&M and mixed mode total retail sector.*

Incidentally, this implication is robust to whether one uses deflated retail sales or the retail gross margins as the measure of output in the retail trade. Discussion of the pro's and con's of both measures is

[10] For the electronic shopping and mail order sector sales taxes as a percentage of the retail gross margin were 5.03% in 2004 and increased to 6.15% by 2014, according to the ARTS 2015, Table 2. The same source reveals that sales taxes as a percentage of total sector retail gross margins decreased from 12.93% in 2004 to 10.10 % in 2014.

available (Manser 2005; Triplett and Bosworth 2004: Ch.8). A recent contribution highlights as an important issue the lack of a reliable price deflator for the gross margin (Ratchford 2016, p. 59), which is one reason we have done the comparison in terms of differentials between the percentages of the total and the electronic and mail order subsector. Nevertheless, for the sake of completeness we note that long run trends estimated by BLS using real annual output growth yield 3.4% for the total retail trade over the period 1987- 2017 and 14% for the electronic shopping and mail order category, i.e., a differential of 10.6% in the mainly DE sector over the longer period. These rates of growth are reported in BLS news release of July 19, 2018 (Table 2, column 5) https://www.bls.gov/news.release/prin1.nr0.htm (last accessed March 13 2019). If we adjust this different measure as we did the retail gross margin for monopoly profits we obtain a similar differential as a result of digital economy penetration over this longer period, i.e., at least 8.48% of the differential in the electronic shopping and mail order subsector is due to higher output growth.

What underlies the greater output growth of the DE pure retailer, in addition to the obvious costs savings from eliminating stores already mentioned? Economies of scale and scope in retailing at the establishment level are important according to earlier retail literature. One scholar labels them economies of massed reserves (Oi 1992); another reports them as between 5% and 9% of total costs for a representative US B&M supermarket (e.g., Betancourt 2004, p.76). Recent literature relates them to addition of stores and supercenters in a contiguous fashion exemplified by the evolution of Wal-Mart (Holmes 2011) and labels them economies of high density. Similar trends toward broader assortments and greater accessibility of location through more stores are responsible for the rise of big box retail chains in the general merchandise sector of the B&M world exemplified by Wal-Mart (Basker et al. 2012). While none of these results addresses directly DE penetration in the retail sector, the evolution they describe reflects indirectly the adoption of ICT technology that made them possible (Ratchford 2016). Moreover, a recent thorough paper extending Holmes methodology to the digital economy provides a direct link.

This study relies on economies of high density to explain the expansion of Amazon's fulfillment centers between 2006 and 2018 as a digital economy pure retailer (Houde, Newberry and Seim 2018). It estimates Amazon's cost savings from expansion of their fulfillment centers due to economies of high density arising from lower shipping costs to result in "… between $5 and $13.3 billion in savings on shipping costs and an increase in profit margins of up to 14%." These estimates of lower shipping costs imply provision of higher accessibility of location (lowering the average shipping distance from a fulfillment center to consumers by 180 miles) and broader assortments (the raw data implies much broader assortments for Amazon at the end of the period) to Amazon customers. Thus, the higher output growth of the mainly DE pure retailer relative to the mainly B&M and mixed pure retailers is due to the availability of broader assortments at fulfillment centers, the lowering of costs in providing accessibility of location to consumers by lowering shipping distances from fulfillment centers to consumers and the savings from elimination of stores. Presumably, productivity in this subsector sector is much higher than in the total retail trade sector although we will not try to arrive at a particular number here, since it is not necessary for our purposes and perhaps not feasible accurately with currently available public data.[11]

What can we say about the impact on household welfare of this higher rate of output growth or productivity of DE pure retailers relative to B&M and mixed mode pure retailers? The first half of the answer is easy: the possibility of purchasing goods by consumers on a 24/7 basis wherever the consumer happens to be located that a computer, tablet or mobile phone is also available is a great direct benefit for every consumer with such a possibility. The second half of the answer, however, is more complicated even for the consumers with access to this equipment. How much do the ones who benefit actually gain? There are two source of gains in principle: efficiency gains through possible lower prices and increased consumer surplus due to increased product variety. We have nothing new to add with respect to increased

[11] First, there is no widely accepted measure of multifactor productivity for the retail sector. Second, labor productivity, which is a possible substitute in general (e.g., Murray 2016), is difficult to adopt for comparisons between B&M and DE retailing because the former entails substantial reliance on part-time labor whereas the latter does not. For what is worth, the BLS news release of July 2018 mentioned in the text reports estimates of 4% in growth of hours for the mainly DE pure retail subsector for the period 1987-2017 and of 0.5% for the total retail trade sector.

product variety (e.g., Brynjolfsson, Hu and Smith 2003). Nonetheless, we do have something new to add with respect to the measurement of the potential efficiency gains.

Implication 4: *A proper evaluation of the efficiency gains by households from DE pure retailers relative to B&M ones requires incorporating in the comparison two features of DE retailing that are often ignored, i.e., all sources of differences in shipping costs between the two types of retailers and the pricing schemes associated with shipping costs adopted by Internet retailers.*

In both cases the core product needs to be transported from the manufacturer, wholesaler or distribution (fulfillment) center to the consumer's location. A B&M pure retailer bears a substantial part of this cost by providing the core product at stores near the customer's location and the customer bears the rest of the cost through the time and monetary resources spent in travelling to acquire the core product at the store. A DE pure retailer, on the other hand, incurs none of the costs of transporting the product to the household's location when she charges customer a shipping charge reflecting these costs. Alternatively, she incurs part of these costs when choosing other pricing schemes, including some that implicitly subsidize one set of customers at the expense of others such as Amazon Prime. Pricing schemes in the DE that fail to account for the full cost to the consumer in acquiring the product introduce a potential wedge between productivity benefits and household welfare improvements with negative implications for household inequality.

In evaluating welfare gains to consumers from the DE it is necessary to incorporate shipping costs explicitly. While early work on limited products addressed this issue explicitly (e.g., Brynjolfsson and Smith 2000). Recent work extends coverage to many more products and sectors but ignores the issue or addresses it only implicitly. For instance, one study relies on multi-channel retailers and ignores shipping costs for the online retail operation (e.g., Cavallo 2017); another one assumes identical prices and ignores part of shipping costs in evaluating what they label convenience gains (Klenow et al 2019). In the former case, these estimates are inaccurate for evaluating welfare gains to consumers in so far as shipping costs vary across the different stores of a retailer for any particular customer (or with those of a centralized warehouse when multi-channel retailers use them to ship the product to online customers). In

the latter case, the inaccuracies are smaller in magnitude (given the assumption of equal prices for the goods) because the evaluation includes an indirect estimate of the shipping costs from the offline store to the consumer while assuming elimination of the online store for this evaluation. Yet, it still ignores the shipping costs from the warehouses to the stores. The latter would be included in the full price of the online option if it were available.

More generally, the impact of the digital economy on household welfare is likely to be beneficial for many, perhaps most households but it will surely be heterogenous across all households. While the 24/7 availability benefits all with access to the required technology and the same applies to increased assortment through potential product variety, the efficiency benefits of the increased accessibility of location for the DE pure retailers will vary across households. Since consumers are heterogenously located in space, however, the issue of shipping costs impacts heavily what the actual efficiency benefits of DE penetration are for any subset of consumers. Those located away from population centers might not be served or face differentially higher shipping fees. Since consumers are also heterogenous with respect to income levels, those at the lower end of the income scale would benefit less from price discrimination schemes designed to incentivize purchases such as free shipping with Amazon Prime. The annual fee for the latter became $119 for existing members in 2018. Impatient consumers will also benefit less than those who are patient and the same applies to those with a preference for sensory dependent goods. Undoubtedly, the emergence of mixed mode pure retailers diminishes these differential impacts on consumers, e.g., online channel consumers can pay online and use a B&M establishment of the mixed mode retailer to pick -up goods. Thus, it becomes an empirical question for any particular set of consumers at a specific point in time determining how better off or worse off they might be.

To conclude this section, note that there are several implications of understanding the digital economy in retailing for measurement issues that affect the distribution of both goods and services. These implications fall in two very different categories: classification problems that arise due to the application of (or conflicts between) various census ‘principles’ to publically available data which affect their

observability; biases in e-commerce measurement as currently undertaken by the U.S. Census Bureau. For convenience of exposition, I identify the classification principles and discuss their detailed implications in the next section as they apply similarly to both goods and services. Here I discuss the measurement biases in the definition of e-commerce as they apply to the distribution of goods through the retail sector. The biases are measurable with greater precision in this case than in the case of services.

Implication 5: *The U.S. Census Bureau publishes data on e-commerce. Unfortunately, their definition of e-commerce generates measurement biases in the distribution of goods through the retail sector of as much as 196.8 % per year during the period 1998-2014 when using e-commerce data as a measure of output and of at least over 100% per year when using it as a measure of online sales. Unbiased measures of e-commerce require a conceptually sensible and empirically implementable definition of e-commerce usage that currently is non-existent in the literature.*

An explicit calculation of these biases in the electronic shopping and mail order category (ES &MO in Table 3) underlies the above figures and is available in published work *(*Betancourt 2018*)*. Retail gross margin data available for the retail sector allows explicit calculation of these biases. In most service sectors, however, it is not possible to calculate retail gross margins because of the inability to calculate the costs of goods sold in a reasonable manner.[12] The biases still exist but our ability to measure them is subject to an additional source of uncertainty, i.e., it requires an additional assumption as to what the true growth rate of output would be.

Instead, I provide here the actual definition used by the census and the conceptual basis for the bias. In the U.S. Census website for electronic statistics (https://www.census.gov/programs-surveys/e-stats/about/faqs.html, last accessed April 15, 2019), one finds the following definition in the answer to the first of the frequently asked questions. "E-

[12] In addition to the retail sector, the cost of goods sold is usually available for the wholesale sector and the transportation sector but not for other service sectors.

commerce sales/revenues are defined as the sales of goods and services where the buyer places and order, or the price and terms of sales are negotiated over an Internet, mobile device (m-commerce), extranet, EDI network, electronic mail, or other comparable online system. Payment may or may not be made online." The last sentence is the source of the problem in that it introduces double counting by treating B&M sales as e-commerce sales. Incidentally, the same problem applies to the definition of e-commerce used by Eurostat.

Succinctly put, the biases arise because these definitions lead upon empirical implementation to count B&M revenues as DE revenues, e.g., picking up goods at B&M channels while paying through DE channels is e-commerce (alternative 1) but email ordering through DE retail channels while paying through B&M ones is also e-commerce (alternative 2). This definition of e-commerce ignores the distinction between users of a channel and customers of a channel (see Cortiñas, Chocarro and Elorz 2019) as well as the implicit complementarity between online and B&M channels underlying Implication 2. That is, alternative 1 implies that the consumer is only a user of the B&M channel and a customer (and thus also user) of the DE channel. Alternative 2, on the other hand, implies that the consumer is a customer (and thus also a user) of the B&M channel but only a user of the DE one. Construction of an accurate index of e-commerce requires additional information to sales/revenues.

An important feature of Implication 5 is that this measurement error affects all Census Bureau Tables that report e-commerce data. For instance, this includes the Annual Retail Trade Survey and the Annual Survey of Services referred to here but also e-commerce data reported for other sectors (e.g., Betancourt 2018, p.158). Moreover, the mistake is insidious enough to affect the work of other major statistical agencies of the U.S. government. For instance, the Bureau of Economic Analysis uses Census Bureau e-commerce data to construct part of their digital economy satellite accounts (e.g., Strassner 2019, Mandel 2018) and the Bureau of Labor Statistics uses e-commerce data to construct producer prices real margins for retail and wholesale(e.g., Borgie 2014: fn. 2 and 3). Incidentally, BEA is looking seriously into this issue, after I first informed them of the issue in March of 2019 at the CRIW conference in DC. On the other hand, the U.S. Census Bureau has been remiss to consider the problem seriously, or warn

their users about its existence, despite awareness of the issue since January 24 of 2018. At that time, I first mentioned the issue in the keynote address to their annual meeting. I have no information on whether or not BLS is aware of the issue.

III. Implications for the Distribution of Services and Its Measurement.

For economic agents distributing services as core products, an essential difference from those distributing goods is that, due to the lack of type I separability, the profit function has to be written as follows

$$\Pi = p_R Q - C_S(v^*, Q, D), \tag{4}$$

where Q is a vector of the level of services provided and p_R is a conformable vector of their prices. C_S is a cost function of producing and distributing these services, which incorporates the prices of all inputs used in both production and distribution of the services. The reason is that usually the cost of goods sold is not a well-defined concept in the case of services as core products. There are too many transformation activities undertaken even in sectors primarily oriented toward retailing such as restaurants, i.e., service providers are 'impure retailers'.

Lack of accounting separability prevents strong type II separability from holding and the separation of production costs from distribution costs in the retailing of services as core products. Nevertheless, service providers need to undertake the same retailing function as before in their interactions with customers. One consequence is that the distribution of services as core products generates three different type of implications, depending on the type of interactions between customers, distribution services and the core service product that the consumer pays for due to the penetration of the digital economy in service sectors. Once these implications are explicit, the implications for productivity and household welfare follow easily. Those for measurement issues, however, require first a brief review of the main 'rules of thumb' or classification 'principles' employed by statistical agencies.

One important principle (the revenue one) is to classify firms in the sector where they generate most of their revenue. Another important principle (the privacy one) is not allowing publishing of data that identify individual firms. A third one (the similarity one) is to classify activities with similar production processes in the same sector. Finally, in their publically available data the U.S. Census Bureau has a significant size restriction in terms of magnitudes that prevents publication of small magnitudes in any sector (the size significance one). In applying these rules in practice, however, complication arise. One is doing so at the establishment level. Many firms are multi-establishment firms and the procedure is to assign each establishment to a NAICS category based on its own reporting data not on the parent firm (see https://www2.census.gov/econ2007/Reference_materials/htm%20files/ec44mdesc.htm; last accessed 5/27/2019). Similarly, another practical issue is implementing rules of thumb differently over time. For instance, the privacy rule relies on introducing new concepts for implementation (see https://www.census.gov/about/policies/privacy/statistical_safeguards.html; last accessed 5/27/2019).

Application of the revenue principle means, for example, Amazon should be classified in the retail sector as a non-store retailer in the subcategory of electronic shopping and mail order houses (NAICS 4541) as soon as it satisfied the size significance principle in terms of magnitudes of revenues. Until Amazon's revenues from its cloud service activities can surpass its revenues from retailing activities, there is no need for reclassification. If this event happens, however, a conflict would arise between the revenue principle and the privacy principle since identification might not be preventable given the current size of the company. While in terms of revenues AWS is only 11% of the total, in terms of operating income is already 50% of the total (e.g., Enright 2019). This somewhat hypothetical example helps explain why the digital economy shows up visibly as measured in the retail sector data under the distribution of goods over the last 25 years and hardly at all in the service sector data under the information sector category, which is where cloud service activities are normally classified.

Implication 6. *Some goods become services through digital distribution.*

Once you allow for this feature, the implications for productivity, household welfare and measurement issue are easy to draw. When retailing some types of services digitally the core products distributed are a service that substitutes or replaces core products previously distributed as goods. Main examples are print products such as books, magazines and newspapers and recorded music products such as vinyl records, tapes or compact disks. Their implications for productivity and household welfare are quite similar to those for the distribution of goods with two exceptions. One exception is the extent of appropriability by third parties due to technological features of information products such as file sharing (e.g., Smith and Zentner 2016) which increases heterogeneity of outcomes for firms in terms of productivity due to losses from file sharing and for consumers in terms of household welfare due to net gains from this feature.[13]

A second exception is the substantial reduction in the costs of providing the digital product to the consumer at a preferred location. Thus, the impact on welfare comparisons between B&M retailers and DE retailers that ignore this issue, highlighted in implication 4, would be far less important in the case of these special products than it is for goods that remain distributed as goods regardless of digital economy penetration. Digital distribution only requires a master file made available to the distributor who can then distribute the product electronically to customers, which is far less expensive than physical distribution, i.e., zero or close to zero marginal cost for distribution to consumers. Thus, for goods that become services ignoring this cost is less likely to reverse welfare gains by households due to DE penetration taking place through providing these products as services rather than as goods.

Implications for measurement issues of these core products that become services through digital distribution, however, exhibit one major change. They become observable with publically available data within the last three decades. In the case of distribution of goods, we saw that full or partial outsourcing

[13] A novel issue arises due to digital distribution: Are the physical product and the digital one the same? Here we ignore this possibility by treating it as simply adding another source of heterogeneity to household welfare impacts.

of distribution activities due to the DE was observable in the retail sector but not in the information sector. Indeed, lack of observability of the digital economy in the information sector has led some information- oriented researchers to motivate the use of alternatives to GDP, especially for measuring well-being (e.g., Brynjolfsson, Egger and Gannamaneni 2018). With respect to the distribution of goods that become services through digital distribution, however, non-observability becomes a far less relevant issue but with a lag.

Appendix Table 1 compares these products distributed as services in the relevant category for the retail sector (Table 1A) with these products distributed as services in the relevant category for the information sector (Table 1B) by looking at the e-commerce data in both sectors. The most striking feature that emerges from the comparison is that goods that become services become observable by satisfying the size significance principle in 1999 whereas the ones classified in the information sector fail to do so until 2013. Moreover, since the process of digital distribution is the same whether Amazon distributes e-books through the retail sector or a publisher firm does so through the information sector, the table provides an example of a violation of the similarity principle.

Unfortunately, the bias in measuring e-commerce discussed in implication 5 becomes a relevant issue in this setting. It limits the inferences that are feasible to draw from specific figures in the Census data of Appendix Table 1. It is possible, however, to make a couple of inferences with additional assumptions. E-commerce penetration as measured is greater in magnitude for print products than for recorded ones in the information sector. If the trend is vaguely true although precisely wrong because of the biases, these figures suggest faster technological progress in visual transmission than in audio or combined audio and visual transmission through digital mechanisms. E-commerce within the category of electronic shopping and mail order (Appendix Table 1A) is over 90% of the category for the print products by 2014 and for recorded ones by 2013. This suggests dramatic switches to digital distribution over the period in this retail subsector and, consequently, a likely substantial reduction in their e-

commerce measurement bias whatever it may have been in the earlier years. For, if every agent is digital (or B&M) there is no bias.

Implication 7: *Type II weak separability in provision of distribution services affects all service sectors in their interactions with customers through reservation systems. This feature changes the provision of assurance of product delivery at the desired time in fundamental ways in all services due to digital distribution. It leads to substantial improvement in productivity, household welfare and creates novel measurement issues.*

This implication for the retailing of services as core products is quite general, since it follows from type II weak separability in the distribution of service products. The concept is applicable in many settings to more than one distribution service. Strictly speaking, it means that it is feasible to provide **at least one or more but not all** distribution services separately in space and time from each other and from the core product sold at an explicit price. I choose assurance of product delivery at the desired time to illustrate the idea for simplicity of exposition. It provides an example very familiar to readers anywhere. Moreover, the latter is easy to extend to all service sectors and to other distribution services such as various aspects of information provision.

Reservations systems are mechanisms to provide this distribution service in any context where interactions between service providers and customers at a given location and time matter when a transaction takes place. Digital penetration in the economy allows this type of interaction to be coordinated electronically. It often leads either to new institutional forms specializing in the provision of this distribution service as a core product by itself or in a variety of associations with other core products and/or subsets of distribution services. For instance, in the case of restaurants (or hotels) a new institutional form for providing assurance of product delivery at the desired time entirely online is the emergence of Open Table (Booking.com). While there are examples from other sectors, such as Quest Diagnostics (QD) in the health sector, we will focus on Open Table due to expositional convenience. It

highlights an institutional form that specializes in the distribution of a single distribution service, assurance of product delivery at the desired time.[14]

Open Table is a two-sided platform. On one side, it provides assurance of product delivery at the desired time to customers wherever they are located whenever they demand the service. It does so separately in space and time from the production of this distribution service on the other side, which actually takes place at the restaurant through whatever mechanism it uses to allocate tables. Furthermore, Open Table distributes this distribution service to the two sides, consumers and restaurants, from yet another location: namely, from wherever its own computers are located. The implications for productivity and household welfare generated by these stand- alone institutions are similar to digital provision of all distribution services jointly in the case of goods. That is, they increase productivity for restaurants due to lower costs of having more households reach them digitally (since there is no need for part of the B&M facility near the household location open for business at any particular time for this purpose). Similarly, they increase household welfare due to their 24/7 availability and less waiting at restaurants. Household welfare also improves due to Open Table's practice of charging the restaurant rather than the customer for the distribution service (as long as meal prices remain the same).

An interesting feature of this phenomenon is that both in the case of restaurants and in the case of hotels, one finds that the economic agent providing the core service product also takes reservations directly.[15] A clear implication for measurement follows when the distribution service is available through Open Table. On the other hand, if the reservation is available only through the restaurant, it is impossible to measure independently of the core service, just as in the case where goods become services through

[14] The QD example is more complicated because it involves two distribution services, assurance of product delivery at the desired time (through their appointment process) and accessibility of location (through their ability to be more conveniently located for patients than doctor's offices) as well as the need for physical interaction between the patient and a phlebotomist to generate the core service. The latter is information through laboratory tests that patients and doctors use in the production of health outcomes.

[15] Incidentally, some restaurants refuse to take reservations. This suggests that there are sufficient costs in providing the service that it is not worthwhile to incur them at some range of expected levels of demand for restaurant meals.

distribution. When the reservation is available through Open Table, measurement takes place in the NAICS four digit category Personal Assistants and Laundry Services (8129).

Of course, Open Table is not the only exclusively online reservation system and not all of them belong to the same NAICS category as Open Table. For instance, there is a service sector category called Travel Arrangements and Reservations Services (NAICS 5615). Both Travelocity, an exclusively online reservation service for travel, and Booking.com belong to this category. Both of these travel and hotel reservation systems as well as Open Table appear in the publically available US Census data as part of e-commerce in the annual services survey, which I illustrate in Table 2 of the Appendix. Just as in the case of goods that become services upon digital distribution, however, it is difficult to speak confidently about the specific figures for e-commerce due to the previously mentioned biases discussed in Implication 5.

Without qualification, Table 2 reveals that these exclusively online new institutional forms made feasible by the digital economy have surpassed the size significance principle at least since 2004. With the qualification that the bias in e-commerce measurement has not increased dramatically over the period, online sales of firms providing personal services such as Open Table have grown at the double- digit rate of 12.09 % over the period although they remain a small fraction of the category (2.85% in 2015). With a similar qualification, we can note that the penetration of the digital economy in the travel arrangements sector as measured by e-commerce is higher than for personal services (36.5% in 2015) although its rate of growth is lower (8.65%).

Similar possibilities and issues arise in all other service sectors that provide core services as products to consumers, since they need to provide distribution services together with the core services. One particular sector that may be worth investigating in detail from our perspective due to its recent success is the Fin Tech sector. Over 1,420 companies reside in this sector covering a variety of finance subsectors. They are listed by Fin Tech Weekly (https://www.fintechweekly.com/fintech-companies, last accessed April 14 2019).

Implication 8: *Ambiance's role in purchasing activities as a distribution service tends towards magnification and its role in consumption activities tends towards elimination in all services sectors that engage in mainly digital distribution.*

One direct implication for the retailing of services as core products arises due to the role of ambiance. When this role affects primarily purchasing activities for some aspects or dimensions of the core service products, these aspects become available and suitable for digital distribution. When this role affects both purchasing and/or primarily consumption activities, exclusive digital distribution becomes far more difficult if not impossible. Educational services are useful for our purposes by providing an extreme example with most features already documented in the literature. Post- secondary educational services have been characterized into two basic models as nonselective, NSPE, and highly selective, HSPE, (Hoxby 2014). An important aspect of the characterization employed is that the former type lacks two forms of human interactions in the consumption of the service, student-student and student- instructor[16], which can be described in our terminology as essential aspects of joint production of the core product and of ambiance in the second type of educational services provision, i.e., in HSPE. Hoxby also identifies certificates as a main core service product for NSPE and bachelor's degrees for HSPE. Presumably, master's degrees would also qualify as a main core service product for HSPE.

The first point to note is that Hoxby's classification ignores the possibility of mixed mode retailing by educational institutions. In Spain, for example, a highly prestigious institution (UC3M) provides Master's degrees through digital distribution in various areas but requires campus attendance without exceptions for at least one activity, i.e., final exams. This is clear from the answer to frequently asked questions # 16 in their website description of these degrees (https://www.uc3m.es/master/libraries-archives/faqs, last accessed April 14, 2019). The implications for productivity and household welfare are similar to those in the distribution of goods. The number of

[16] One might add student-alumni interactions also as a relevant though often ignored (by academics but not by administrators) aspect of joint production of ambiance and the core product in HPSE.

customers (students) available for instruction through digital distribution is much larger than on campus since digital distribution eliminates the need to concentrate the students in a particular space at a particular time. From the point of view of customers (students) household welfare improves substantially due to the cost savings in transportation costs and the flexibility in the timing of when most learning activities take place.

The implications for measurement issues are more complicated as they would depend on whether or not the individual HSPE educational institution reports these revenues from digital distribution separately from other revenues. In the case of NSPE, some information would be available directly from Census data through the US Census Bureau Annual Survey of Services. The 2015 survey provides information on total revenues and revenues from e-commerce for the NSPE educational services sector in general and the digital NSPE educational services sector (Table 9) through e-commerce. In Table 3 of the Appendix we provide the total and e-commerce series for this segment of the educational sector, which starts in 2009. The definitional footnotes show NAICS sectors included (6114-6117) are only NSPE institutions and the ones excluded (6111-6113) contain the main HSPE institution, i.e., higher education, in which one expects e-commerce activity to be minor despite the existence of MOOC courses and a few specialized online degrees. The latter usually require these HSPE to operate as mixed mode impure retailers and provide some services on campus to digital students.

Once again the specific figures in the survey are difficult to discuss meaningfully due to the over estimating biases measuring e-commerce in census data stressed in Implication 5. Between 2009 and 2015 NSPE education services, measured as e-commerce, grew by 8.86% whereas the total NSPE sector grew by 5.52%. If the bias discussed in implication 5 remains the same, the digital economy grew over 3 % faster than the total in this subsector. In higher education, e-commerce data for HSPE (e.g., through revenues from MOOC) is not available. Whatever digital provision of MOOC courses or online degrees might amount to in terms of revenues, this digital provision is impossible to identify separately with publically available census data. More generally, when ambiance is relevant only for purchasing

(investment) activities, as in the NSPE sector, the digital economy impact is easy to find, at least in principle. On the other hand, when ambiance is relevant for both investment (purchasing) and consumption activities jointly, as in the HSPE sector, it is difficult if not impossible to identify its impact on a GDP sector separately. To conclude, the educational example provides a useful guide on how digital distribution affects other service sectors with respect to the role of ambiance.

IV. Omni Channel Behavior in Economics: Within Firm Complements, Between Firms Substitutes.

A recent contribution relying on the concept of distribution services online and offline provides a useful definition of the concept of omni behavior from a consumer perspective. It differentiates between customers and users of a company's channels (Cortiñas, Chocarro and Elorz 2019). A customer of a company's channel is anyone who purchases a product in that channel; a user of a company's channel is anyone who takes advantage of any of the distribution services provided by a channel, including purchasing products. These definitions lead to a segmentation of the customer base of a fast fashion company into three categories. Mono-channel customers, who purchase and use the services of only one channel (offline or online). Partial omni- channel customers, who purchase in one channel and use any distribution services of the other one without purchasing. Complete omni- channel customers, who use and purchase in both channels. From a consumer perspective, implicit in this segmentation is a definition of omni-channel behavior as "being a user and/or a customer of more than one channel over the period of analysis"

Omni-channel retailing has become a popular term in marketing. For instance, a special issue of the **Journal of Retailing** (Verhoef, Kannan and Inman 2015) is devoted to the issue. Interestingly enough, there is no definition of the term omni-channel from a consumer perspective in this volume although there is one from a management perspective. i.e., "We define omni-channel management as the synergetic management of the numerous available channels and customer touch points in such a way that the customer experience across channels and the performance over channels is optimized." (p.175). One

difficulty with this literature is that the word channel can refer to communications channels or to distribution channels. This creates potential for confusion. More substantively, it provides a different perspective on issues. Here, we restrict attention to omni channel behavior where channels refer strictly to distribution channels.

Several insights follow from the definition introduced here. First, it suggests one possible solution to the creation of an index of e-commerce without bias through the differentiation between users and customers of a channel at a point in time (e.g., Betancourt 2018). Second, it provides an alternative to the management definition capable of increasing company profits by exploiting the complementarities that exist between B&M and DE channels within a firm stressed in Implication 2. Third, it provides a connection to earlier literature on free riding in the context of B&M customers by simply extending the application of the concept across firms.

For instance, prior to the Internet a consumer could go to a B&M store, ask for a tennis racket as a loaner for a couple of days, try it out and return it, and purchase the racket via mail order. A consumer who engages in this behavior was a user of the B&M store, who acquired information and assurance of product delivery in the desired form from the firm owning the store, but became a customer of the mail order firm. In old parlance, this consumer was a 'free rider' of the B&M store and a customer of the mail order firm. The Internet magnifies the possibility of free riding with respect to distribution services that provide information and assurance of product delivery in the desired form. More generally, note in this context that omni channel behavior within a firm normally exhibits complementarity whereas across firms it normally exhibits substitutability as the 'free riding' label suggests.

V. Concluding Remarks

In this essay I summarize a way of thinking about retailing that allows a comparison of its role in the B&M economy with its role in the DE economy in terms of performing the same distribution function by providing the same outputs in a different manner, i.e., by providing the same set of distribution services in

a different manner. The difference in the use of space and time by the two types of economic structures, however, generates differences in the maximum levels of services that are feasible to provide for technical or economic reasons. These differences generate important economic implications in general and for the distribution of goods and services.

I have drawn the implications for the distribution of goods in terms of its impacts on output growth or productivity, household welfare and measurement issues. Doing so with respect to the distribution of services, however, required the development of three prior impacts of the digital economy on services before discussing the same three outcomes as in the case of goods. This approach in the case of the implications of weak separability for distribution services and the role of ambiance in the retail activities of service sectors opens up a wide variety of potential opportunities for future research for the interested reader to pursue. Finally, I have also drawn insights from a new concept developed using distribution services, omni channel behavior from a consumer's perspective. These insights clarify the meaning of omni channel behavior from an economics perspective and differentiate it from the management perspective in the marketing literature.

Last and not least, analysis of the biases introduced by the U.S. Census Bureau definition of e-commerce throughout their data on the services sector render this concept to be closer to a public bad than a public good. Indeed, the economics profession and the public at large would benefit if the Bureau simply published online revenues instead of e-commerce revenues as currently measured wherever the latter appears in a website. Meanwhile a research project to develop an unbiased index of e-commerce usage would be a worthwhile undertaking. No amount of big or small data research would solve this problem. It is a conceptualization problem.

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Table 1. Summary of Separation across Pure Retailers

	B&M		**DE**	
Services	Space	Time	Space	Time
1. Accesibility of Location	{P,D,C}	P/D/C	P/D/C	P/D/C
2. Information*	{P,D,C}	{P,D,C}	P/D/C	P/D/C
3. Assortment	P/{D,C}	P/D/C	P/D/C	P/D/C
4. Assurance of product delivery	P/{D,C}	P/D/C	P/D/C	P/D/C
5. Ambience	P/{D,C}	P/D/C	P/D/C	P/D/C
6. Advertising	P/D/C	P/D/C	P/D/C	P/D/C

* Excluding advertising; {,} implies jointness of primitive activities; / implies separation of primitive activities

Table 2. Potential Levels of DS in Different Pure Retailers: B&M/DE

	B&M	**DE**
1. Accessibility of location	Low	**High
2. Information		
2.1. Sensory items	High	*Low
2.2. Non-sensory items	Low	**High
3. Assortment:	Low	**High
4. Assurance of product delivery:		
4.1. At the desired time	High	*Low
4.2. In desired form sensory	High	*Low
4.3. In desired form non-sensory	Low	**High
5. Ambiance (´normal´ setting)	High	Low

*indicates that online channel attains substantially lower maximum level of this distribution service relative to offline channel.

**indicates that online channel attains substantially higher maximum level of this distribution service relative to offline channel

Table 3. Retail Gross Margins: 1993-2015 (Percentage of Sales)

Year	**1993**	**1994**	**1995**	**1996**	**1997**
Ret. GM/S (total)	27.9	28.0	28.0	27.7	27.6
Ret. GM/S (E-Sh.&MO)	44.7	44.6	43.7	44.0	42.7

Year	**1998**	**2000**	**2002**	**2004**	**2006**
Ret. GM/S (total)	27.7	27.5	27.7	28.5	27.8
Ret. GM/S (E-Sh.&MO)	40.9	38.6	39.1	38.9	38.6

Year	**2008**	**2010**	**2012**	**2014**	**2015**
Ret. GM/S (total)	26.8	28.3	27.6	27.7	28.7
Ret. GM/S (E-Sh.&MO)	37.1	36.7	37.2	39.1	39.0

Source: US Bureau of the Census: Annual Retail Trade Survey – 2015.

Data Appendix.

Table 1: Books and Music in Retail and Information Sector, Total and E-Commerce

Table 1A. Books, Music through Retail Sector: 1999-2014 (Total & E-commerce, millions of $)

Year	**1999**	**2004**	**2009**	**2012**	**2013**	**2014**
B&Ma. Tot.	3434	4930	7569	10991	11444	11579
B&Ma. E-cm	1439	2270	6000	9778	10249	10828
Mu&Vi Tot.	4250	3591	6107	9914	11263	S
Mu&Vi E-cm	762	1480	5064	8964	10325	S

Electronic Shopping & Mail Order Houses (NAICS 4541), Sales by Merchandise Line. (S means that the estimate does not meet publication standards). E-commerce (E-cm).

Source: US Bureau of the Census, Annual Survey of Retail Trade- 2015.

Table 1B. Books, Music through Information Sector: 2012 - 2015 (Total & E-cm, millions of $)

Year	**2012**	**2013**	**2014**	**2015**
Books, etc., 519: Tot	94,027	103,331	115,882	132,740
Books, etc., 519: E-cm	NA	28,537	33,211	40,495
Video & Sound 512: Tot	91,974	95,084	94,475	98,982
Video & Sound 512: E-cm	NA	4,509	4,646	5,836

Other Information Services (NAICS 519) & Motion Picture & Sound Recording Industries (NAICS 512). NA means that the data was not available for electronic commerce until after this year. E-commerce (E-cm).

Source: US Bureau of the Census, Annual Survey of Services, Employer Firms: 1998-2015 (Table 9).

Table 2. Assurance of Product delivery at Desired Time in Two Service Sectors: (millions of $).

Year	**2004**	**2008**	**2012**	**2015**
NAICS 8129: Tot	75,043	82,833	87,030	101,406
NAICS 8129: E-cm.	825	1,382	2,151	2,894
NAICS 5615: Tot	27,822	32,697	34,346	40,786
NAICS 5615: E-cm	5,980	8,311	10,661	14,893

Personal & Laundry Services, NAICS 8129 (Open Table); Travel Arrangements and Reservation Services, NAICS 5615. E-commerce (E-cm).

Source: US Bureau of the Census, Annual Survey of Services: Employer Firms, 1998 - 2015 (Table 9).

Table 3. Revenues from Educational Services (NAICS 61) in NSPE Subsectors: 2009-2015 (millions of $)

Year	**2009**	**2011**	**2013**	**2015**
Total*	45,635	51,971	55,188	61,934
E-Commerce*	3,150	3,838	4,723	5,242

*Excludes primary, secondary and higher education (NAICS 6111-13); includes business and computer and management training, technical and trade schools, other schools and instructions and educational support services (NAICS 6114-17).

Source: US Bureau of the Census, Annual Survey of Services: Employer Firms, 1998-2015 (Table 9).