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Bartering for 'Free' Information: Implications for Measured GDP and Productivity

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Abstract

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'Free' information from the Internet is ubiquitous. While some of this information is supported by advertising revenue, and thus covered in our earlier research (Valuing 'Free' Media in GDP: An Experimental Approach," Nakamura, Samuels and Soloveichik 2016), the majority of this content is supported by marketing. In this paper, we introduce an experimental GDP methodology which includes marketing-supported information in both final expenditures and business inputs. For example, Kelley Blue Book would be final expenditures when it is used by a consumer to research used car prices. On the other hand, the same website would be a business input when it is used by a construction company to research used small truck prices.

Our method for accounting for 'free' information is production based. We measure the resource input into the information (or other content) of the medium, rather than a measure of the consumer surplus arising from the content. BEA uses a similar production oriented approach when measuring other components of GDP. In contrast, other researchers used broader approaches to measure value above production costs. Brynjolfsson and Oh (2012) attempt to capture some of consumer surplus by measuring the time expended on the Internet. Varian (2009) argues that much of the value of the Internet is in time saving, an additional metric for capturing consumer surplus. The McKinsey Institute (Bughin et. al 2011) attempts to measure the productivity gain from search directly.

We find that including 'free' information in the production account has little impact on either GDP or total factor productivity (TFP). Between 2006 and 2015, measured nominal GDP growth rises by 0.02% per year, real GDP growth rises 0.07% per year and TFP growth rises 0.03% per year. Before 2006, nominal GDP growth rises by only 0.005% per year, real GDP growth rises by only 0.003% per year and TFP growth rises by 0.012% per year. Accordingly, including 'free' information in the input-output accounts slightly ameliorates the recent slowdown in growth, but it is not nearly enough to reverse the slowdown.

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Introduction

Stiglitz, Sen, and Fitoussi (2009) argued that measured GDP is not a perfect proxy for welfare. One frequently discussed discrepancy between welfare and GDP is 'free' information. 'Free' online information like Kelley Blue Book or 'free' apps like Candy Crush contribute directly to consumer welfare, but that contribution is not currently captured in the final expenditure part of GDP. We outline an experimental methodology to capture the contribution of 'free' information to consumer welfare while staying within the framework established by the official guideline for national accounting, the System of National Accounts 2008 (SNA 2008). As with owner-occupied housing, we impute production and consumption even though no money changes hands.

We impute a barter transaction between users and marketers: users receive 'free' information in return for accepting exposure to marketing. Our experimental methodology has at its heart two balancing components. On the expenditure side, we impute information purchases equal to the cost of providing information services. These costs are paid by marketers, so 'free' information is actually marketing-supported information. On the output side, we impute information production equal to the cost of providing the information services. Information could have been supplied through non marketing-supported alternatives, and, indeed, they can be thought of as having been bid away from alternatives. For example, auto purchases can be researched at marketing-supported websites like Kelley Blue Book or subscriber-supported magazines like Consumer Reports.

Conceptually, this imputed barter transaction is nearly identical to the imputed barter transaction developed in earlier work for advertising-supported media (Nakamura, Samuels and Soloveichik 2016). The main difference is that advertising-supported media is a three way transaction involving media companies, viewers and advertisers. Media companies barter 'free' media for ad viewership and then resell the ad viewership to advertisers. In contrast, marketing-supported information is generally a two way transaction involving only viewers and marketers. Marketers barter 'free' information for marketing viewership and then use the marketing viewership in-house. Because the marketing viewership is not sold in an arms-length transaction, we require different data sources and methodologies to value it than we used for advertising-supported media.

At first glance, marketing-supported information appears to be rare and not worth studying. In fact, the majority of Internet content is actually marketing-supported information. It is true that marketers rely on advertising-supported social media platforms like Twitter to host their content and advertising-supported search engines like Google to direct viewers to their content. But the actual tweets and websites are generally written by marketers promoting their own company's goods and services. Similarly, marketing-supported television commercials account for approximately one third of total viewing time. These commercials may not be as entertaining as the media programs surrounding them – but they generally contain useful information like pricing or product attributes. Businesses also use marketing-supported information frequently. Many professional, scientific and business journals run articles written by companies promoting their own products. Trade shows are frequently subsidized by corporate marketing. Later in the paper, we will show that marketers spent $357 billion on marketing-supported information in 2012. This is a large enough category to be worth study.

We find that including marketing-supported information in the input-output accounts raises recent growth rates. Since 1960, marketing-supported information has been larger than advertising-supported media and it has been growing faster than advertising-supported media. Therefore, the impact on the GDP growth rates is larger. Between 2006 and 2015, marketing-supported information raised measured nominal GDP growth by 0.02% per year and measured real GDP growth by 0.07% per year. Over the same time period, advertising-supported media had virtually no effect on nominal GDP growth and increased real GDP growth by only 0.02% per year. Almost all of the increased GDP growth from marketing-supported information is due to the explosion in online content such as corporate websites, smartphone apps, etc.

This paper recalculates productivity growth when 'free' information is included as both final expenditures and business inputs. We estimate the contribution of 'free' information from the supply side by measuring the marketing expenditures that support them. That is, we do not directly capture the value of Kelley Blue Book, but only measure the cost of providing it. This can be interpreted as a lower bound on the contribution of this 'free' information to output and productivity – but it is consistent with the standard methodologies for estimating an industry's contribution to output and productivity. Therefore, our supply side numbers will be comparable to other productivity research.

We analyze four separate sub-categories of marketing-supported information: a) In-person information at trade shows; b) Print information such as customer magazines, newspaper inserts or research papers; c) Audio-visual information such as television commercials, webinars or podcasts; d) Digital information such as company websites, Tweets, downloadable apps, online commercials and other digital information. In our experimental methodology, all of these sub-categories have the same general impact on measured nominal GDP. Nevertheless we split the sub-categories because each component has its own price index and because many researchers and policy-makers are especially interested in particular sub-categories and would like information on that sub-category alone. Unwanted marketing like telemarketing or junk mail are excluded from our research.[1] In addition, we exclude advertising-supported newspapers, magazines, radio, television and online software because those products were already studied in a previous paper "Valuing 'Free' Media in GDP: An Experimental Approach" (Nakamura, Samuels and Soloveichik 2016, subsequently referred to as NSS).[2] Finally, we exclude 'free' shopping experiences like in-store makeovers because our research on that topic is still very preliminary and not ready for publication. We hope to study 'free' shopping experiences in a future paper.

Our paper will be divided into three parts. Section 1 provides background information on the current BEA official methodology for handling marketing-supported information in GDP. We then describe our experimental methodology in more detail and review the previous literature on marketing-supported information. Section 2 collects data on marketing expenditures and estimates the value of marketing-supported information in the United States. We then use that data to recalculate nominal output and nominal GDP from 1929 to 2015. Section 3

[1] In practice, the line between marketing-supported information and unwanted marketing is fuzzy. Some individuals read their junk mail and learn useful information about products and services being offered. Other individuals consider television commercials to be a pure waste of time and learn nothing from them. As a robustness check, we collected data on various categories of unwanted marketing. We will provide alternative estimates of marketing-supported information upon request.

[2] The line between marketing-supported information and advertising-supported media is also fuzzy. Before 1960, it was common for advertising agencies to produce radio programs or television programs directly and embed marketing content in the show. We classified those advertising agencies as a type of media company and included their programs with 'free' media rather than marketing-supported information. Conversely, telephone companies earn significant revenue by publishing yellow page directories. We classified those directories in marketing-supported information because telephone companies are not traditional media companies.
It is important to note that our classification does not depend on whether something is enjoyable. Marketers often bundle their information with humor and other soft sells. Conversely, advertising-supported media sometimes contains product information, financial advice and other less enjoyable topics.

introduces our price indexes for 'free' information and marketing viewership from 1929 to 2015. The section then goes on to recalculate real GDP and TFP by industry. Finally, we include two Appendixes with more detailed information for interested readers. Appendix A shows how our methodology changes the input-output accounts and other industry statistics. Appendix B describes the data used.

Section 1. Conceptual Discussion of Marketing-Supported Information

In the SNA 2008 and the U.S. Bureau of Economic Analysis (BEA) National Income and Product Accounts, marketing-supported information expenses are treated simply as an intermediate input to the production of other goods and services. If we think of cruises as being the marketed good, then a trade show presentation produced to explain the advantages of cruises is considered an expense of the cruise line. The current methodology treats the costs of the trade show presentation just like the costs of direct inputs like restaurant meals or on-board entertainment. In this treatment, there is no consumption benefit or related PCE spending on the information provided, except to the extent that the consumer pays for costs associated with receiving the information, such as driving to the trade show. The difficulty with that treatment is marketing-supported information provides a much greater value to consumers than the cost of driving to the trade show. Because marketing-supported information provides a flow of information that is a very close substitute to direct spending on information that is included in PCE, it is inconsistent to not count this as consumption in final expenditures. In this paper, we will not take any firm stance on whether marketing-supported information is a close substitute for PCE and whether it should be included in GDP. Instead, we construct an upper bound on the possible value of marketing-supported information and show that measured GDP would not change significantly even if marketing-supported information was included in GDP at its maximum possible value.

This difficulty is highlighted when the Internet bids consumer content providers, such as Betty Crocker[3] away from the paid information sector into marketing-supported information. Under the current treatment, Betty Crocker would cease to be providing consumer information services and becomes marketing instead. Another way to think about the impact of information is to consider how the value of flour to the consumer is affected by an increase in the number of marketing-supported recipes available. The increased recipe variety increases consumer choice and therefore welfare. One may consider that the increase in the recipe variety should be captured in the quality-adjusted price for flour. Holding nominal output fixed, this decline in quality-adjusted prices for flour would result in a measured real output increase for the flour milling industry. In turn, this real output increase would result in an increase in measured TFP of flour production, even if there is no change in the direct product or process of the flour milling industry. Our method avoids the problem of trying to capture the value of free information in quality-adjusted prices of existing goods by treating the production and use of 'free' information as a new economic transaction.

It is useful to clarify the conundrum with the following highly stylized model. We consider a cruise line, a vacation planner, and households.[4] The cruise line must market to sell the cruises. Initially, the cruise line spends $60,000 to run the cruises, spends $20,000 on marketing with no information value, and sells 100 cruise packages for $800 each. The vacation planner sells 100 tickets to her class on planning vacation itineraries for $200 each. One hundred households each spend $800 for cruise packages and $200 for information on vacation itineraries. Now, suppose the cruise line hires the teacher for $20,000 and reduces their other marketing costs by $20,000. The teacher provides her class for free but includes a pitch for that cruise line brand. The 100 households receive the cruise package and the information but pay only the $800 per household for cruise packages (and listen to a pitch for the cruise line). For simplicity, we assume that the demand for information is unaffected by this switch. In other words, households act as if they were paying $200 for the information, but instead, they are

[3] Betty Crocker is not a real person. She was created in the 1920's as a human face for the chefs and customer service representatives employed at General Mills. A variety of actresses have portrayed Betty Crocker in public.
[4] For simplicity, we assume that the cruise line hires the teacher itself and then hosts the class in their own office. In a more realistic model, the cruise line might outsource the teaching to a specialty company which focuses on trade show presentations and then pays an outside hotel chain to host the class. The imputed barter transaction of marketing viewership in return for content is the same and measured GDP is the same.

viewing the marketing and they appear to perceive that viewing the marketing costs them $200 each. Roughly speaking, the households consume the same amount but pay less out of pocket.

In the current national income accounts treatment, output drops. The consumer information is no longer measured as part of personal consumption, only the cruise line is. In the initial case, $100,000 in economic resources was used to produce $100,000 in consumption output. With marketing-supported consumer information, $80,000 is used to produce $80,000 in consumption output. Effectively, $20,000 has disappeared from real output. However, this appears to be a misrepresentation in that the households are still consuming the same real amount of information, but it has disappeared from measured output.

One possible treatment would be to view the information with marketing included as having the same real value but falling in price to zero. That is, nominal output is $80,000, but real output is $100,000. While we do not actually observe the market value to the consumer of the information in most cases, we can impute the market value based on the production cost. But standard economic formulas do not work well when analyzing goods and services with zero prices. For example, it is difficult to explain why consumers sometimes pay to avoid marketing if the price for marketing-supported information is zero. Furthermore, if the situation should reverse and a price be paid, the rate of inflation for that item cannot be calculated.

A more satisfactory treatment was explored in "Valuing 'Free' Media: An Experimental Approach" (Nakamura, Samuels and Soloveichik 2016). That paper treated advertising-supported media as a barter trade of entertainment received by the consumer in exchange for which the consumer agrees to view the advertisement. We propose doing the same for marketing-supported information. We would record a dollar as paid by the consumer to the cruise line company for the information, and the cruise line company would pay it back to the consumer for viewing the marketing. In this treatment, marketing-supported information is reflected in the real income and consumption of the consumer.[5] The amount mirrors the true value of information to modern society and in a way which finds parallels with the treatment of

[5] The paper also explores treating advertising-supported media as a 'gift' from media companies to consumers. This 'gift' treatment has the same effect on measured GDP and gross industry output as the barter transaction. But it is unclear how to attribute output gains when businesses receive inputs as gifts from other businesses.

similar products with no out-of-pocket price, such as residential services of owner occupied dwellings and financial services of checking accounts.

The value of information (not the total nominal spending by marketers) is the pertinent value for the barter transaction. However, it is difficult to estimate the production costs for marketing-supported information directly. Instead, we will start by estimating total spending by marketers and then extract the value of marketing-supported information from total spending. This approach follows the data available. Conceptually, the costs of producing unwanted marketing are not relevant to the barter transaction and should be disregarded.

Our experimental methodology does not require any major conceptual changes to SNA. In this paper, we treat marketing-supported information as a payment in-kind for services produced by households. SNA 2008 already counts other noncash payments as labor income (Section 7.51). SNA also imputes cash values for barter transactions (Section 3.75), owner-occupied housing (Section 6.34), and financial services indirectly measured (Section 6.163). Just as with those transactions, we impute a value for marketing-supported information based on estimated costs. However, since the household is not 'employed' by the information producer, we treat the household production of the service of providing access to marketing as a form of production by an unincorporated household enterprise. To minimize the deviation from BEA's official accounts, we do not consider the production process for marketing viewership. We intentionally avoid this due to the plethora of issues involved in measuring household production.

Consumers use marketing-supported information for both household production and pure leisure. For example, some people watch cooking videos to learn specific techniques and then use those techniques when making dinner. Other people watch cooking videos because they enjoy the sight of elegant dinners and beautiful desserts. SNA 2008 currently excludes almost all non-market production from GDP, and therefore combines consumer purchases for household production with consumer purchases for direct consumption in PCE. Consistent with this treatment, our experimental methodology does not distinguish between marketing-supported information used for household production and marketing-supported information used for pure leisure. If future editions of the international guidelines for national accounts choose to include

household production in either measured GDP or a recognized satellite account, then our experimental methodology could be revised to match the new treatment.

Comparing Marketing-Supported Information with Advertising-Supported Media

Conceptually, this imputed barter transaction described earlier is nearly identical to the imputed barter transaction developed in advertising-supported media (Nakamura, Samuels and Soloveichik 2016). The main difference is that the previous paper focused on advertising viewership, and this paper studies non-advertising marketing exposure. Advertising viewership is almost exclusively 'purchased' by media companies from the general public and then resold to outside companies. In contrast, marketing exposure is generally 'purchased' by non-media companies from potential customers and used in-house. Because marketing is produced by so many industries, it is more difficult to track than advertising. Later in this paper, we will describe the multiple datasets necessary to track marketing-supported information.

At first glance, it might seem that television commercials are double-counted in our experimental methodology. In our previous paper, we valued advertising-supported television programs based on the revenue that media companies earn from selling advertising slots. In this paper, we value marketing-supported television commercials based on the cost of producing those commercials. Under our experimental methodology, television viewers are genuinely paid twice for viewing commercials: first they receive advertising-supported programs as an incentive to be in the room when commercials are aired, and then they received marketing-supported information as an incentive to actually watch the commercials.[8] Our experimental methodology is careful to count each payment exactly once so that total output of 'free' media/information is equal to the total expenditures by advertisers/marketers. This type of two-part payment occurs in other industries as well. For example, cell phone providers frequently charge a base rate for activating service and then levy additional charges for international calls, downloaded games, etc. When measuring industry output, BEA tracks total sales without differentiating between base charges and additional charges. We will follow this general treatment when tracking marketing-supported information.

[8] Like other complimentary goods, the price and quality of television commercials affects the demand for media programs and vice versa. This may create issues for researchers seeking to measure consumer welfare.

It is important to note that marketing-supported information has more ethical issues than advertising-supported media. Media companies are generally careful to distinguish between their media content and advertising content. Because of this separation, the main cost of advertising content is wasted time. In contrast, non-media companies frequently blend information with marketing. This blending creates the potential that users may be given false information or not be given important warnings. Because misinformation can be very costly, there is a long history of government laws and professional organization guidelines regulating the types of marketing allowed and the disclosure required by marketers. Regulations tend to be stricter for sensitive areas like health care or financial advice. It might seem that these ethical and legal issues require different treatment for marketing-supported information in GDP. In fact, many other goods and services which are already included in GDP have ethical issues and are highly regulated. The standard GDP methodology values those goods and services at their market price or production cost without considering the ethical issues explicitly. For example, brokerage services are valued based on their marketing price without consideration of whether the broker was acting ethically when recommending investments to their clients. We will follow this methodology for marketing-supported information.

Other Research on Advertising, Brand Equity and Education Capital

Our research on marketing-supported information is distinct from the rich literature on advertising and marketing. Previous researchers have studied why marketing exists and calculated how much firms should optimally spend on marketing (Dorfman and Steiner 1954; Nerlove and Arrow 1962). Other papers have argued that marketing increases sales over the long run, and therefore, they should be considered an investment in brand equity (Nakamura 2005; Corrado, Hulten, and Sichel 2009). All of this research is focused on the companies which produce marketing-supported information and then use it to sell products and build brand equity.[9] In contrast, our research is focused on the households or businesses who barter marketing viewership in return for marketing-supported information. None of the results in this paper depend on whether companies use their bartered marketing viewership for short-term sales

[9] In addition, the marketing expenditures studied in those papers include more than marketing associated with 'free' information or 'free' media. For example, companies can increase sales with telemarketing calls, junk mail and other channels that aren't generally bundled with information or useful products.

campaigns or long-term brand building. The only thing that matters is that companies want marketing viewership and consumers want information. These two groups are able to exchange 'free' information for marketing viewership via a barter transaction.

Marketing-supported information is also distinct from education capital. Education capital is a long-lived intangible asset that is a major component of human capital. Like all other human capital, education capital is owned by the individual who receives the education (Christian 2016). It is true that marketing-supported information is sometimes used to produce education capital. For example, many students use 'free' YouTube videos to teach themselves long-lived skills like programming or accounting. However, the categories are not identical. Marketing-supported information includes short-lived education like a YouTube video which teaches people how to decorate for their quinceanera. Because the quinceanera is a once in a lifetime event, the training does not have any long-term value and it is not considered part of human capital stock.[10] Conversely, most students learn their long-lived skills in the formal education sector. The operating expenses of those schools are already captured in government output and personal consumption expenditures.

Section 2. Marketing-Supported Information Production: Consumer Information and Business Information

We estimate total spending in two steps. First, we use the Economic Census to estimate the purchases of selected inputs to marketing-supported information from 2002 until 2012. Next, we use the Occupational Employment Survey (OES) to estimate the cost of in-house marketing. Our conceptual framework makes no distinction between marketing-supported information purchased from outside companies and marketing-supported information produced in-house. Accordingly, we will combine both production methods in all of our figures and discussion. This treatment is consistent with our previous research on advertising-supported media. In that

[10] Many researchers studying human capital are focused on market earnings rather than household production. These researchers might exclude even a paid cooking class with long-term value from education investment.

paper, we tracked the aggregate value of 'free' media content without distinguishing between media programs licensed from specialty producers and media programs produced in-house.

Our primary data on purchased marketing is taken from the Economic Census. The Economic Census reports product line sales across all businesses with employees in 2012, 2007 and 2002.[11] We identified ten product lines of interest: 1) Media representation services in NAICS 5418; 2) Public relations services in NAICS 5418; 3) TV/radio advertising planning, creation and placement services in NAICS 5418; 4) Digital/Print advertising planning, creation and placement services in NAICS 5418; 5) Remaining marketing-supported information in NAICS 5418; 6) website development in NAICS 5415; 7) website hosting in NAICS 518; 8) commercial photography in NAICS 5419; 9) yellow pages and other directory advertising from NAICS 511; and 10) event planning and management from NAICS 561.[12] In total, these ten product lines accounted for $127 billion worth of sales in 2012. Only a small portion of the $127 billion in product line sales is for completed marketing campaigns that are ready for public consumption immediately. Instead, most companies combine purchased marketing inputs with in-house marketing production before rolling out a completed marketing campaign.

Our primary data on in-house marketing is taken from the Occupational Employment Survey (OES). That survey reports employment and earnings for selected industry/occupation combinations. The OES does not track individuals who are employed producing in-house marketing directly, but we have identified a list of occupations which are likely to be involved with marketing production. We use that data to estimate total expenditures on in-house marketing using a two-step procedure. First, we calculate total earnings for marketing professionals who are employed outside the marketing sector. Next, we multiply those earnings by an adjustment ratio to estimate total expenditures on in-house marketing. Our expenditure estimates are an attempt to measure total costs, and therefore include labor costs for marketing professionals, labor costs for support staff, non-labor intermediate expenses and a return on

[11]The Economic Census does not require businesses without employees to report product line detail. In addition, some businesses may underreport or misreport revenue to the Economic Census. When calculating GDP, BEA adjusts for all of these issues. We use BEA's pre-existing adjustments for 2007 to calculate total sales.

[12] These product lines are not an exhaustive list of all inputs to marketing-supported information. However, these product lines are likely to be the largest purchased inputs and the inputs most unique to marketing-supported information. We welcome suggestions for alternative product lines to include.

capital. Appendix B contains more details on the calculations. In 2012, we calculate that the US private business sector produced $230 billion of marketing-supported information in-house.

In total, we calculate that U.S. businesses spent $357 billion on marketing-supported information in 2012. This number appears very large - but it is consistent with the industry literature. The research firm 'Outsell' publishes an annual report which tracks spending by category. They report that U.S. businesses spent $241 billion on marketing in 2012.[13] We also experimented with using corporate filing data from Compustat to estimate marketing-supported information. Based on the Compustat data, we calculate that U.S. businesses spent approximately $4.5 trillion on sales, general and administrative (SG&A) in 2012. The industry literature suggests that total marketing accounts for approximately 30% of total SG&A, or $1.35 trillion. We then subtracted expenditures on advertising-supported media, expenditures on unwanted marketing and compensation for salespeople to calculate a residual value for marketing-supported information. Based on that residual methodology, we estimate that marketing-supported information accounted for approximately 16% of that 1.35 trillion, or $210 billion. So, our estimate of $357 billion is a little higher than some of the industry literature but not completely different.

Conceptually, our approach is similar to the paper 'Brands as Productive Assets: Concepts, Measurement and Global Trends' (Corrado and Hao 2013). Furthermore, our estimate of $357 billion in 'free' information and $156 billion in 'free' media is quite similar to their estimate of $569 billion in brand investment[14]. However, the similar levels are mostly a coincidence. Corrado and Hao explicitly include telemarketing produced by NAICS 561, market research services produced by NAICS 5416 and other product lines that we exclude from marketing-supported information. Conversely, our paper's estimate of in-house marketing includes an estimate of non-labor costs and indirect labor costs that Corrado and Hao chose to exclude. As a result of these different methodologies, it is not meaningful to compare the level of expenditures reported in our paper with their paper. However, the similar growth rates found in both papers is more meaningful and provides strong support for our results.

[13] Outsell combines advertising and marketing to get $397 billion of total spending. In our previous paper, we estimate that companies spent $156 billion on advertising, leaving $241 billion for marketing.
[14] Taken from Table 7, average rate between 2007 and 2011.

Historical Expenditures on Marketing-Supported Information

The OES survey goes back to the late 1980's, but many of the occupation codes and classification methodologies changed around 1998. Furthermore, the OES only covered a rotating sample of industries from 1988 until 1995. As a result of all these changes, it is difficult to use the same datasets to measure marketing-supported information before 1998. In this paper, we will use the decennial population Census, historical Economic Censuses and other datasets to estimate expenditures on marketing-supported information for selected years. Like the OES, we use earnings for individuals employed in marketing-related occupations as a proxy for overall marketing expenditures.[16] Between years with data, we use purchased advertising agency services as an interpolator. Appendix B contains more details on the data.

Figure 1 shows expenditures on marketing-supported information relative to GDP over time. We find that marketing-supported information is currently larger than advertising-supported media and it has grown faster over time. In 1929, businesses spent only $1 billion on marketing-supported information, approximately 1.0% of aggregate GDP. In 2015, businesses spent $433 billion on marketing-supported information, approximately 2.4% of aggregate GDP. Over the same time period, expenditures on advertising-supported media have hovered around 1% of nominal GDP. Yet advertising-supported media receives the vast majority of policy-maker and researcher attention. This paper aims to highlight the imbalance by focusing on marketing-supported information alone. For reference, we also show expenditures on telemarketing, junk mail and other unwanted marketing. This category is relatively small and has been declining over the past decade. At the present time, marketing-supported information is clearly the dominant form of communication between companies and customers.

In Figure 1, it is interesting to decompose the nominal growth into its components. By construction, nominal growth is explained by three factors: a) price change for marketing-supported information; b) quantities of marketing viewership; c) ratio of marketing-supported

[16] Unlike the OES, the Census relies on self-reported occupation and industry, which may not match the occupation or industry reported by an individual's employer (Fisher 2012). In addition, the Census uses coarser occupation codes than the OES. As a result, the Census data may not be a reliable dataset to estimate the **level** of marketing-supported information at any given time. Nevertheless, the Census data can be used to track growth rates.

information quantities to marketing viewership quantities. Later in the paper, we will show that media production costs have roughly tracked overall GDP prices (Figure 8) and quantities of marketing viewership have risen only slightly faster than overall GDP quantities (Figure 10). This implies that, the main contributor to the dramatic growth shown in Figure 1 is an increase in marketing-supported information per unit of marketing viewership. This suggests that users of marketing-supported information may have enjoyed significant welfare growth that is not captured in the published GDP or TFP statistics. By introducing price indexes for the barter transactions (discussed below), our experimental methodology captures the increased 'consumption' of marketing-supported information.

Marketing-Supported Expenditures by Sub-category

Neither the product line information provided by the Economic Census nor the occupation codes provided by the OES specify precisely what type of marketing-supported information is being produced. For example, a 'writer' might write a column for a print newsletter, contribute to a corporate blog or write dialogue for a filmed ad. Many 'writers' do all three simultaneously. As a result, it is extremely hard to split total expenditures on marketing-supported information between possible sub-categories.

In our analysis, we decided to split marketing-supported information into four sub-categories: a) trade shows and other in-person demonstrations; b) recipe books, white papers and other print marketing; c) infomercials, and other audio-visual marketing; and d) websites, apps and other digital marketing. These sub-categories were chosen because each has a different production process and each may be affected differently by technological innovations like the Internet or air travel. In addition, previous researchers and policy-makers have focused on digital marketing – so it is useful to provide numbers for digital marketing alone. Unfortunately, we were unable to find any government data splitting marketing expenditures between these four sub-categories. Instead, we purchased reports from the research firm Outsell which covered the

time period 2007 to 2015. Before then, we use a variety of sources to estimate spending by subcategory. Appendix B contains details on the datasets used and the imputation techniques.[18]

Figure 2 shows our best estimate of marketing-supported information by category. We find that that marketing-supported information grew dramatically over the past decade, and this growth is entirely driven by digital marketing. Websites account for the largest portion of this digital marketing, but companies are also spending heavily on social media outreach like Facebook pages and Twitter feeds. In recent years, companies have also started developing smartphone apps and other mobile marketing. Despite the recent explosion in online marketing, the overall growth rate for total marketing-supported information in the past decade is not exceptional. Rather, marketing-supported information has steadily increased its nominal GDP share by 0.03% per year from after 1975, but was relatively steady before 1975. We have not yet identified a reason for the trend break in 1975, but online marketing was very rare before 1995 and cannot possibly explain the growth from 1975 until 1995.

Opportunity Costs of In-House Marketing

Both the Economic Census and the OES data focus on out-of-pocket **expenditures** and ignore the opportunity cost of in-house marketing. Freemium games like Candy Crush are the best known category of opportunity cost marketing. These games are free to download and play, but they offer extra lives and other bonuses for purchase. In other words, the 'free' game is basically marketing for the premium products that make money. The vast majority of these ad slots are created and used within the company, so the ad slots represent an opportunity cost of forgone ad sales rather than out-of-pocket expenditures which would be recorded in the Economic Census.[19] Similarly, cable networks devote a large share of advertising slots to their own shows, movie theaters spend significant amounts of time showing trailers for upcoming films and newspapers run ads encouraging readers to renew their subscription.

[18] Note that the precise split between marketing categories has no effect on aggregate marketing expenditures. However, each information category has its own physical production costs and its own consumer share. As a result, the adjustment to measured nominal GDP is influenced by the split. Furthermore, each information category has its own price index – so the rate of real GDP growth is also influenced by the split.

[19] Some freemium games also earn money from collecting personal data and reselling it to interested parties.

Figure 3 shows the opportunity cost for in-house marketing over time. The most important result is that the opportunity cost of in-house marketing is very small relative to out-of-pocket marketing expenditures. Americans may be spending enormous amounts of time playing freemium games like Candy Crush – but they rarely buy expensive items while playing those games. When measuring GDP using our experimental methodology, we account for 'free' information based on the resource input rather than the time used or happiness created. As a result, we assign a very low value to Candy Crush despite the possibility it creates enormous consumer surplus. Because opportunity cost marketing is so small, we will not track it separately in the remainder of this paper. Instead, we will combine it with the marketing expenditures shown in Figure 2.

Content Creation Costs for Marketing-Supported Information

Not all of the expenditures shown in Figures 2 and 3 are of value to the information users. Companies spend significant resources printing the marketing material which is bundled together with marketing-supported in-person and print information; clearly the users do not value the printing component in and of itself. Fewer resources are necessary to distribute audiovisual and online marketing, but there are still costs for distribution. We have not been able to find any data directly measuring the costs of printing and distributing marketing. However, there is a vast marketing literature comparing viewership of media content with marketing content like television commercials. The general result is that marketing viewership is only slightly lower than media content viewership (Danaher 1995), (Rose, Generali and Coleman 2006), (Nielsen 2015), (Schweidel, Mosely and Kent 2016). New technologies like the remote control or DVR have increased commercial skipping somewhat, but the effect is relatively small. The most plausible explanation for the equal viewership is that users value a minute of marketing-supported information almost as much as they value a minute of advertising-supported media. Furthermore, the expenditure numbers in Figure 2 suggest that per minute costs are similar for marketing-supported information and advertising-supported media. Taken together, these two facts suggest that the ratio of user value to creation costs are similar for marketing-supported information and advertising-supported media. Based on that result, we can use our pre-existing research on non-media costs (Nakamura, Samuels and Soloveichik 2016) as a proxy for non-

information costs. In particular, we set non-information costs equal to 57% of print marketing costs, 25% of audio-visual marketing costs and 25% of online marketing costs.For in-person information, we assume that marketing without informational content accounts for 50% of in-person costs. We assume that these marketing cost shares are fixed over time and across customer categories.

Note that the marketing distribution costs estimated above can be thought of as a lower bound on the true (non-information) costs of marketing. For example, marketers generally frame the information presented so that their product is placed in the best possible light. This framing provides little value to users – and so the costs of framing should be subtracted from overall marketing expenditures. Take the case of a car company that spends enormous resources designing road tests which favor their brands. These design costs are not included in the marketing distribution costs given above, but may be included in our estimate of spending on marketing.[22] Unfortunately, we were not able to find any data on these framing costs, and so we do not subtract them in this draft. As a result, the estimated values for marketing-supported information shown later in the value should be seen as an upper bound. As we will show later, even with this upper bound, the estimates of 'free' information are not large enough to impact the slowdown in measured GDP growth that motivated this exercise.

Figure 4 shows the estimated share of marketing devoted to information content. From 1929 to 2015, the information content share of marketing grew from 43% to 66%. This steady increase is caused by a composition shift. Figures 2 and 3 show that print marketing and in-person marketing have been steadily declining relative to other media categories. Those same categories also spend a much larger share of expenditures on non-information, so they have less money available to subsidize useful information. As a result, marketing-supported information has grown faster than overall marketing expenditures.

[22]The cost of framing information is not necessarily positive. For a variety of reasons, corporate cultures generally encourage workers to be loyal to their company's products and report good news whenever possible. This type of corporate culture lowers the cost of framing information to be favorable, but it has other organizational costs. In the extreme, managers may be forced to hire outsiders to get an unbiased assessment.

Marketing-Supported Information Usage by Consumers vs. Businesses

The identity of the user determines both the terminology used and also the impact on measured GDP. When consumers use 'free' information, we call the media "consumer information" and add the value of that consumer information to personal consumption expenditures (PCE) and GDP. Balancing that additional PCE, we impute income to viewers that are, in effect, paid to view marketing, with those payments being equal to the cost of providing education programs. This additional income precisely equals the additional PCE, so there is no change in household savings. When businesses use 'free' information, we call the information "business information" and add the value of that training to intermediate inputs. Balancing that additional intermediate input, we impute business output for marketing viewership. This additional business output precisely cancels out the additional expenditures on intermediate inputs, so measured value-added and GDP do not change when businesses use 'free' information. However, measured productivity may change because outputs and inputs have different prices.

Historically, marketing-supported consumer information has focused on relatively boring topics like product attributes or household production tips. For these topics, the description of marketing-supported content as information appears uncontroversial. In recent years, marketers have started to use the digital communications to reach consumers directly. For example, a movie star might use Twitter to share exciting projects with fans or just to build buzz. In many cases, these direct communications are styled in an informal manner and therefore do not feel like marketing. However, the economic theory behind this type of entertainment is similar to the rest of marketing-supported consumer information. Our paper will use the same terminology to describe the two marketing approaches.

It is difficult to split marketing-supported consumer information from marketing-supported business information. As we discussed earlier, our primary data on marketing expenditures is taken from the Economic Census and the OES. Neither of these datasets have any data on whether marketing is used by businesses or consumers. In a few cases, the products advertised provide some clue about the likely industry of the user. For example, hospitals are the main purchasers of MRI machines – so websites with information on MRI machines are probably targeting hospital executives. But many companies target a general audience and use

the same marketing for both businesses and consumers. The purchased dataset Outsell splits their market report between business to business (B2B) and business to consumer (B2C) companies – but their sample sizes are small and we are reluctant to rely on their methodology for splitting respondents between B2B and B2C.

This paper uses a variety of data sources to split information usage between consumers and businesses. To start out, we split media representation services, public relations, and commercials bundled together with advertising-supported media using the same business/consumer split developed earlier in our paper on advertising-supported media (Nakamura, Samuels and Soloveichik 2016).[23] We also use our earlier research to split opportunity cost marketing like theatrical movie trailers. The only exception is that freemium games like Candy Crush are allocated almost entirely to the consumer sector. For in-person demonstrations, we rely on the Center for Exhibition Industry Research (CEIR), which reports that 85% of trade shows were business-to-business (Stevens 2005).[24] Finally, we assume that the remaining marketing is split in proportion to the customer population. For example, an industry that sells 30% of its output to consumers is assumed to target 30% of its marketing-supported information to consumers and the rest to businesses.[25] Across the entire economy, we calculate that consumers account for 39% of purchases, 27% of print marketing and 21% of online marketing.[26] In other words, industries targeting consumers typically devote a slightly smaller share of their revenues to marketing-supported information than industries targeting businesses.[27]

Figure 5 shows the estimated consumer share of marketing-supported information. We find that the consumer share has hovered around 50% throughout the entire time period. There is

[23] We allocate TV/radio marketing to the audio-visual marketing sector and split public relations and digital/print marketing between print media and online media in proportion to their share of advertising. Similarly, we split the smaller categories media representation services and remaining marketing based on advertising shares. Once they are split, we use the NSS business/consumer splits for each category.

[24] This split is not weighted by expenditures. In addition, the CEIR does not follow BEA's treatment of owner-occupied housing or the non-profits. We believe that adjusting for these factors is unlikely to change results much.

[25] It is definitely possible to produce plausible counterexamples to this assumption. For example, firms in a collusive industry might target most of their marketing towards signaling competitors with consumers a distant afterthought. Conversely, industries selling intermediate goods sometimes market to consumers with the goal of increasing demand for their direct customers. Intel has pursued this strategy in recent years.

[26] When calculating purchases, we exclude imputed spending like owner-occupied housing. We allocate health care and other non-cash benefits to the consumer sector.

[27] The consumer share is taken from previous research on productivity (Jorgenson, Ho and Samuels 2014). For simplicity, we assume a fixed business/consumer split over time. Results are similar if we allow the split to vary. Note that these splits are spending shares and may not track time allocations or customer counts.

a little variation caused by shifting marketing categories, but this variation is small and does not appear to be associated with obvious economic or social changes. Measured GDP and other summary statistics would not change significantly if we fixed the consumer share at exactly 50% throughout the entire time period.

Figure 6 shows the increase in nominal GDP from including marketing-supported consumer information. Consistent with Brynjolfsson's research, online consumer information has grown enormously in the past decade and now accounts for 0.36% of nominal GDP. However, some of this increase is offset by decreases in other types of marketing-supported consumer entertainment. Accordingly, nominal GDP growth over the past decade increases by 0.02% per year when we include 'free' information in final expenditures. This is not a trivial change – but it is not nearly enough to reverse the recent slowdown in GDP growth. Like all intermediate inputs, the cost of marketing-supported business information is already captured in the purchase of the final expenditures and the value added of the industries that produced the intermediate inputs. However, some researchers may be interested in it nevertheless. For reference, Figure 7 shows marketing-supported business information over time. We find results similar to Figure 6.

Comparing Our Results to the Industry Literature

In 2015, we estimate that marketing-supported online entertainment added $65 billion to the United States GDP. This is more than twice the $24 billion in value we attribute to advertising-supported online entertainment (Nakamura, Samuels and Soloveichik 2016). In total, we estimate that the 'free' Internet content added $89 billion to the United States GDP. This is not a trivial amount, but it is far lower than alternative estimates. For 2011, Brynjolfsson and Oh (2012) estimated a value of $376 billion based on time use data.[30] The Boston Consulting Group (Dean, Digrande, Field, Lundmark, O'Day, Pineda, and Zwillenberg 2012) estimated a value of $500 billion in 2011, based on consumer surveys and an economic model. The much higher numbers in these studies are a consequence of different methodologies and different (but

[30] Brynjolfsson and Oh's paper (2012) values free websites, which is broader than either marketing-supported online information and advertising-supported online media. But that only explains a portion of the difference.

related) research questions. Both studies use indirect methods to estimate the consumer utility gained from leisure time spent online. However, this paper is trying to estimate only the cost of producing online information. There are many areas of the economy in which consumer spending on an activity is much lower than total utility for that same activity. For example, sleeping occupies about one-third of total time and provides enormous utility. Yet, beds represent a very small fraction of consumer spending.

On the other hand, our estimates are similar to pre-existing estimates of the consumer value for high-speed Internet. In 2006, Greenstein and McDevitt (2010) estimated that U.S. households received $20 billion to $22 billion of value from broadband Internet. In comparison, we estimated that U.S. households enjoyed $19 billion of marketing-supported online information and $7 billion of advertising-supported online media in 2006. In other words, we estimate that the total value of 'free' websites was slightly larger than the value of broadband Internet. This suggests that dial-up Internet may have generated $4-$6 billion of value in 2006.

Section 3: Price Indexes for Information and Marketing Viewership

Information is a very difficult service to deflate properly. One issue is that users generally expect up-to-date content – so we cannot track the cost of producing the exact same lesson over time. In addition, information is a non-rival good with poorly defined units of output. For example, a website might switch from offering a few long instructional videos to many short clips. Is this change an increase or decrease in total output? Finally, information quality generally depends on its accuracy – yet accuracy is extremely hard to measure.

For now, we will use pre-existing price indexes to value marketing-supported information. For in-person demonstrations, we use BEA's published price index for commercial and vocational schools (Table 2.4.4U, line 291). For the remaining categories, we use the price indexes developed in our previous paper on advertising-supported media (Nakamura, Samuels and Soloveichik 2016): for print information, we use the newspaper and magazine price index. For audio-visual information, we use a weighted average of the price index for broadcast radio,

broadcast television and cable television.[31] For digital information, we use the price index for online media. The construction of these price indexes is discussed in that paper. Figure 8 shows the prices for marketing-supported information from 1929 until 2015.

It is important to note that the price indexes in Figure 8 do not account for network effects, positive externalities from information or other information-specific factors. We believe that those factors probably raise online information quality over time and therefore lower quality-adjusted prices. As a result, the price indexes shown in Figure 8 should be seen as being on the upper end of the true inflation rate for online information. On the other hand, the size and direction of the bias for other information categories is harder to measure. In addition, the experimental methodology developed in this paper may have secondary implications for price measures for information which is partially marketing-supported and partially paid by users. These implications are a topic for future research. For now, we hold all other price indexes in the industry-level production account fixed.

Figure 9 recalculates our GDP quantity indexes using the prices in Figure 8. We find that real GDP growth increases faster than the nominal GDP growth increase shown in Figure 6. Intuitively, the plummeting price for online information reinforces the explosive nominal growth of online information. Between 2006 and 2015, real marketing-supported online information grew 21% per year. This is enough to raise overall real GDP growth by 0.06% per year. Over the same time period, the other categories of marketing-supported information contributed an additional 0.01% of real GDP growth per year. However, even this increase is not enough to reverse the recent slowdown in real GDP growth.

Quantity Indexes for Marketing Viewership

Figure 9 presents results to fully measure the impact of 'free' marketing on aggregate GDP. However, most policy-makers and researchers are interested in decomposing real GDP growth into the component parts of TFP growth for individual industries, quantity growth of

[31] In particular, we assume that television commercials, public relations and other audio-visual marketing which is consumed together with advertising-supported television and radio is split between broadcast radio, broadcast television and cable television in proportion to the split for advertising. Audio-visual marketing which is consumed separately from media is assumed to have the same price index as cable television.

capital, quantity growth of labor and quantity growth of other inputs. Holding real information output fixed, our experimental methodology treats more Internet surfing time as an increase in inputs and therefore a reduction in TFP for the industries bartering marketing-supported information for online viewership. Conversely, more Internet surfing is considered an increase in output and therefore an increase in TFP for industries using online information. The intuition for this is that some companies use marketing-supported information as an input. Marketing viewership is the implicit payment for 'free' business information, so it is counted as an output.

A large portion of marketing viewership is consumed together with advertising viewership. For example, an Internet surfer might use an advertising-supported search engine to locate a marketing-supported website. Similarly, a television viewer might watch advertising-supported programs together with marketing-supported commercials. Accordingly, our quantity indexes for print, audio-visual and online marketing viewership are based on the same time use data we used earlier to calculate advertising viewership in NSS. We then adjust that time use data for the portion of marketing content which is consumed separately from advertising viewership. For in-person marketing, we use attendance data from the Center for Exhibition Industry Research as a proxy for marketing viewership. All four of these price indexes require strong assumptions and may not account for special features of the marketing industry.[32] We welcome suggestions for more data on time use or better proxies for the quantity and quality of marketing viewership between 1929 and 2014. Appendix B contains much more detail on how we measure time use for each information category.

Figure 10 shows quantity indexes for marketing viewership from 1929 to 2014. We find that marketing viewership has risen approximately 3% per year since 2000. The vast majority of this increase is due to the explosion in time spent online during the 2000's. However, the increase in marketing viewership shown in Figure 10 explains only a small portion of the real GDP increase shown in Figure 9. In other words, the vast majority of the real GDP increase shown in Figure 9 represents an aggregate productivity increase rather than an increase in measured inputs. We combine the quantity indexes in Figure 10 with the nominal advertising expenditure data from NSS and the nominal marketing expenditure data from Figures 1 and 2 to

[32] A particular concern is that the main cost of marketing-supported information is often bias rather than time spent. Unfortunately, we have not been able to find any data tracking the amount or severity of marketing bias over time.

calculate price indexes for marketing viewership.[33] We will use those price indexes in the next section to calculate total factor productivity.

Recalculating TFP Using Our Experimental Treatment of 'Free' Information.

This section calculates industry-level statistics for each of the 63 business sector industry categories tracked in the paper 'Long-term Estimates of U.S. Productivity and Growth' (Jorgenson, Ho and Samuels 2014). Except for the marketing-supported information component, all of our data on labor and non-labor inputs by industry is based on that paper's data. Our data tracking output of marketing-supported information is based on OES's reported earnings for marketing professionals in each of the 63 business sector industry categories. By construction, nominal output of marketing-supported information is equal to nominal input of marketing viewership for every industry and subcategory – so we do not need a separate dataset to measure inputs of marketing viewership. Our data tracking usage of marketing-supported information is based on the industry splits previously developed in NSS. Appendix B contains more information on our precise methodologies. Because there are so many industries, it is not feasible to show each one separately. Instead, we will combine all industries together to show the aggregate TFP impact of each marketing category. Results for individual industries are available upon request.[34]

Figure 11 shows the summary results. We find that 'free' online marketing raises measured TFP growth by 0.04% per year between 2006 and 2014. This is a substantial increase in measured productivity growth, but it is still not nearly enough to reverse the recent slowdown in aggregate TFP growth. We also find that 'free' audio-visual marketing raises measured TFP growth over the past few decades slightly, but this increase is more than offset by a slight decrease in measured TFP growth from in-person marketing and print marketing. On the other

[33] In particular, our formula for marketing viewership prices in Year t is:
$(\text{Advertising Spending}_t + \text{Marketing Spending}_t)/(\text{Advertising Viewership Time}_t + \text{Marketing Viewership Time}_t)$
Our previous paper on advertising-supported media only focused on advertising viewership and did not incorporate marketing expenditures. As a result, the TFP calculations in NSS are not consistent with this paper.

[34] In order to make our TFP numbers more comparable to the existing literature, we treat the household viewership sector as an entirely new industry. That new industry is not included in the 63 industry categories tracked in our calculation. We also exclude the government sector. Because of this focus, our TFP numbers only track private sector business and are not representative of the entire economy.

hand, the impact on measured TFP for specific industries is often much larger. For example, online stores like Amazon have developed incredible websites which provide product reviews and other useful online information. Their measured TFP would increase significantly if the value of those websites was included in industry output.

Concluding Remarks

The information sector poses a number of difficult questions for the national income accounts and the measurement of productivity. In this paper we have addressed one narrow question: how to account for 'free' information subsidized by marketing. We show that online information is not the first information category subsidized by marketing and many of the measurement issues can be addressed by a simple tweak to the current GDP measurement methodology. We then used our experimental methodology to recalculate GDP and GDP growth

We found that the experimental method raises recent GDP growth and TFP growth. Between 2006 and 2015, nominal GDP growth rises 0.02% per year, real GDP growth rises 0.07% per year and TFP growth increases 0.03% per year. Many previous researchers studying the Internet have focused on advertising-supported online media companies like Google or Facebook. These companies are easier to study because advertising revenue is tracked in the Economic Census and in other government surveys. Yet those companies only account for a quarter of expenditures on 'free' online content. Researchers who want to measure the full value of the Internet may want to go beyond Internet publishing companies to the universe of companies with webpages or twitter accounts.

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Figure 1: Total Marketing Expenditures

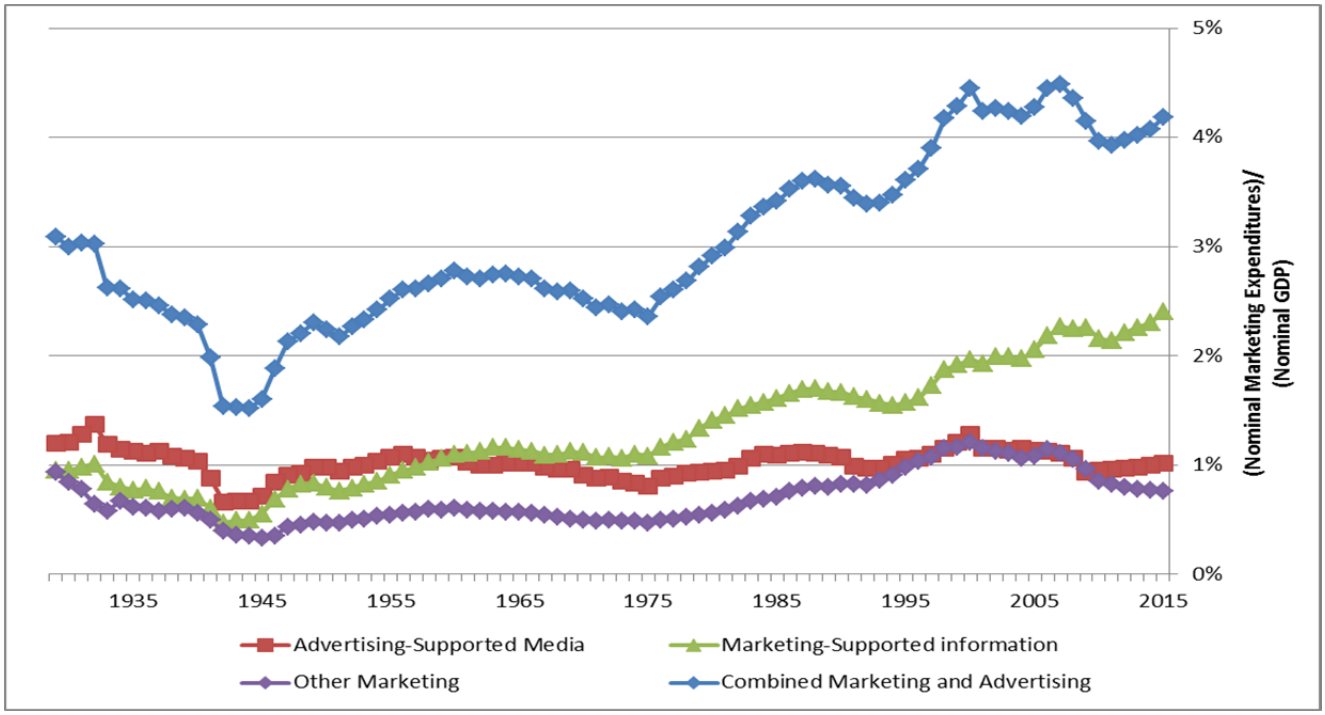


Figure 2: Expenditures on Marketing-Supported Information

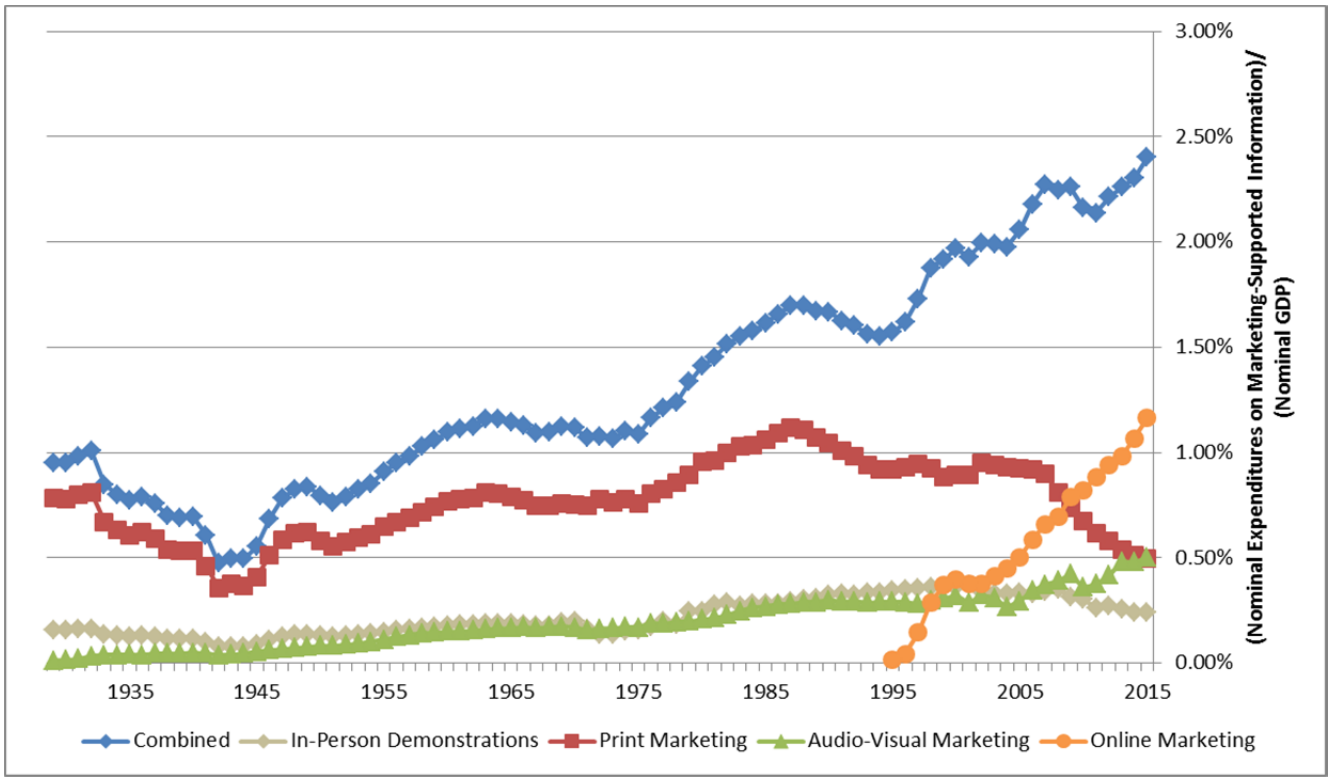


Figure 3: Opportunity Cost of Marketing Information

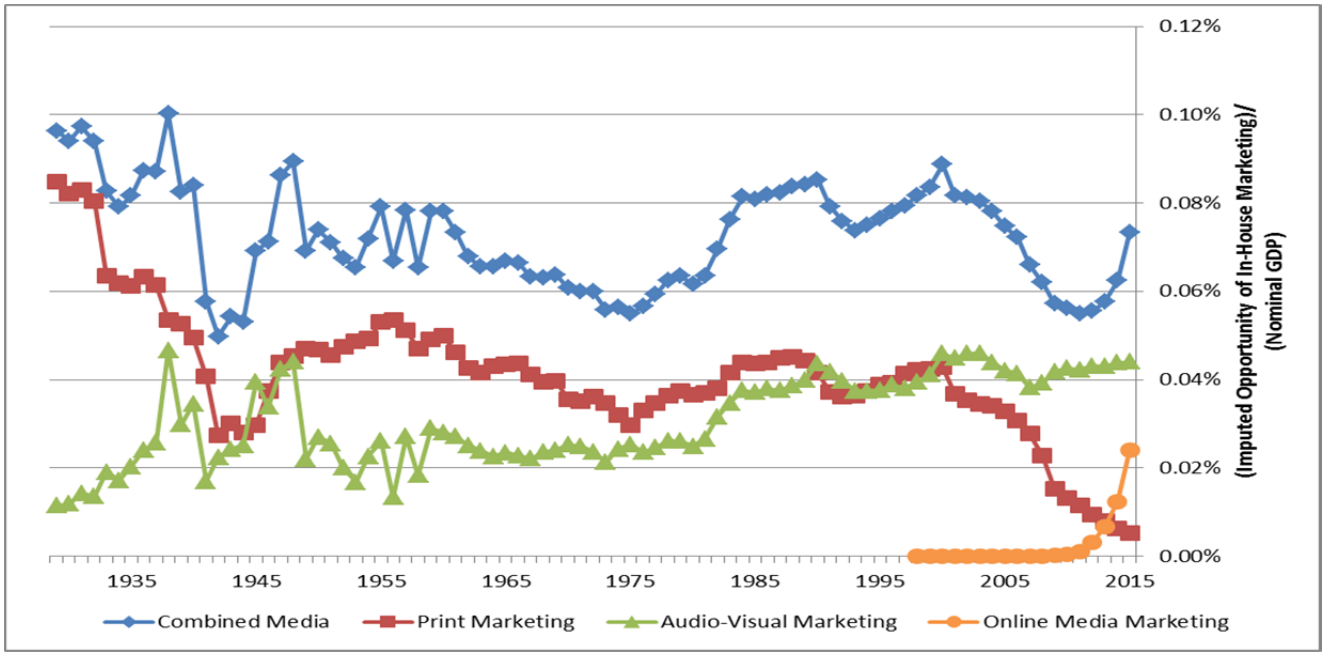


Figure 4: Share of Marketing Devoted to Content Creation

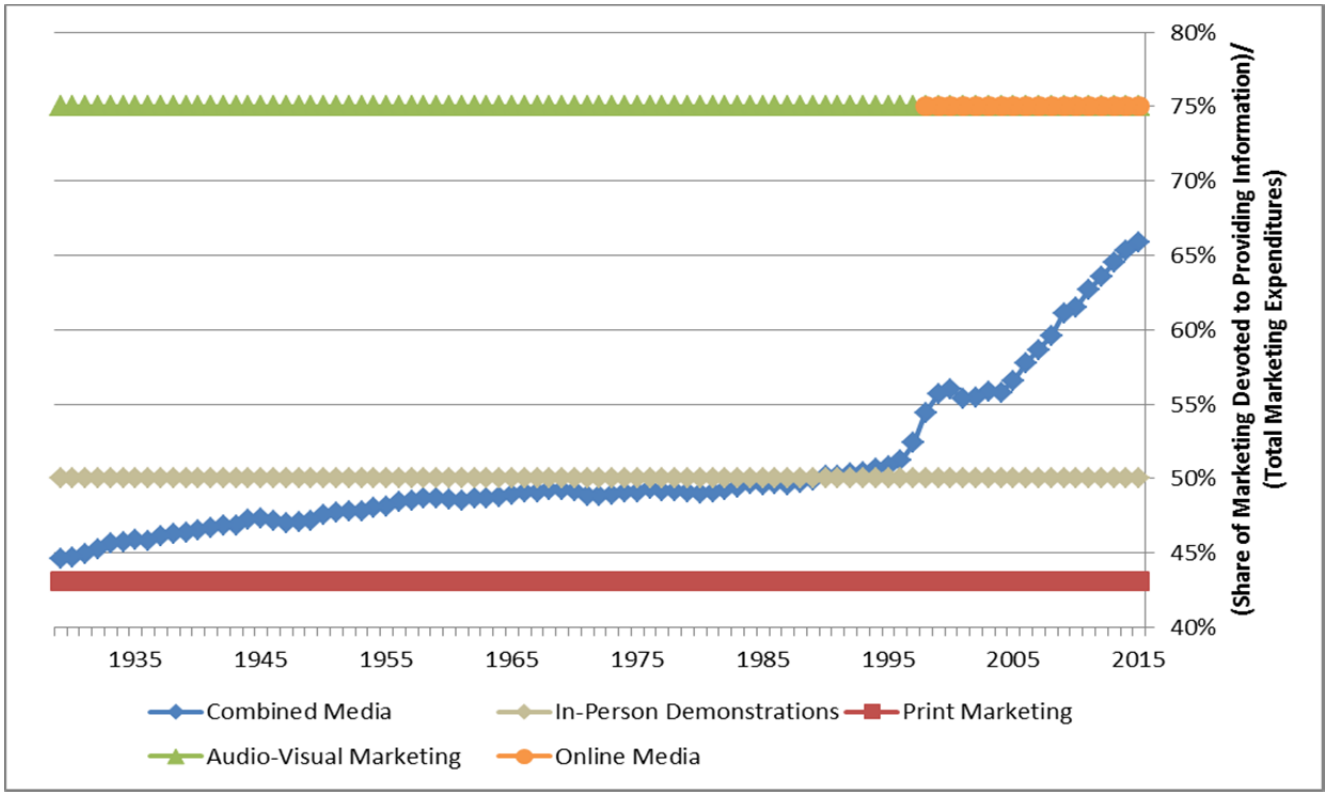


Figure 5: Consumer Share of Marketing-Supported Info.

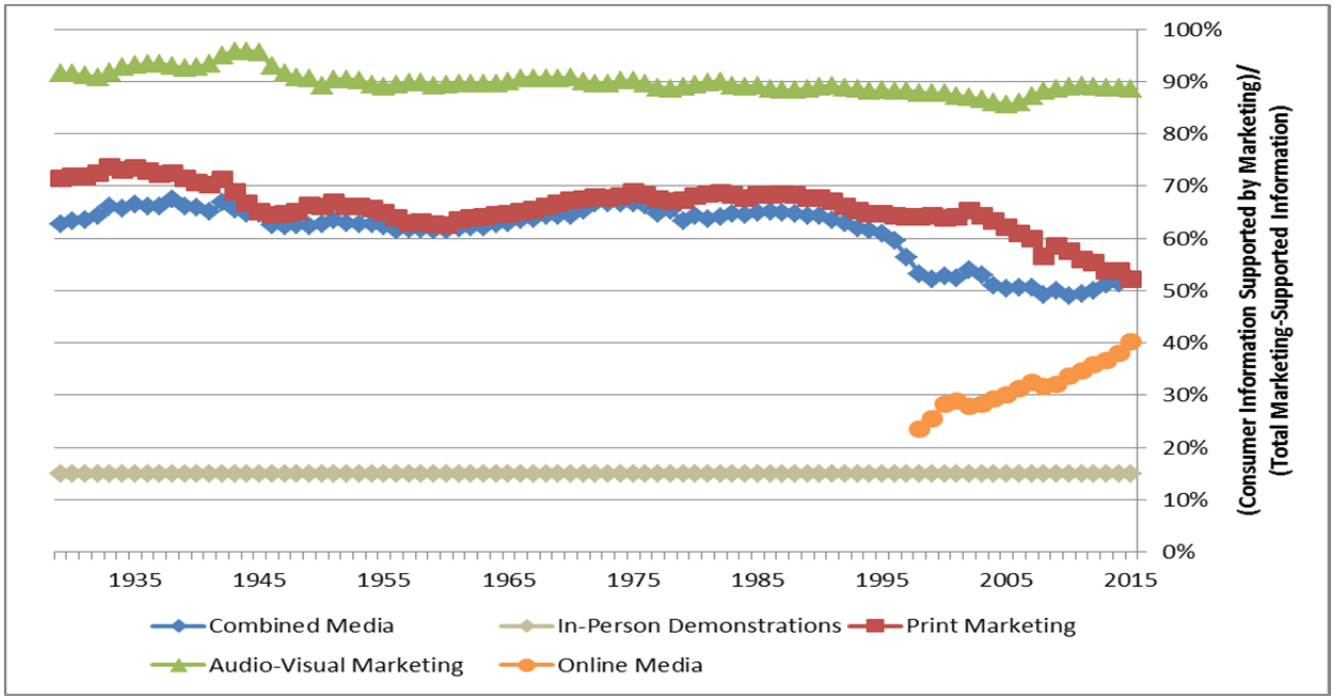


Figure 6: Marketing-Supported Consumer Information

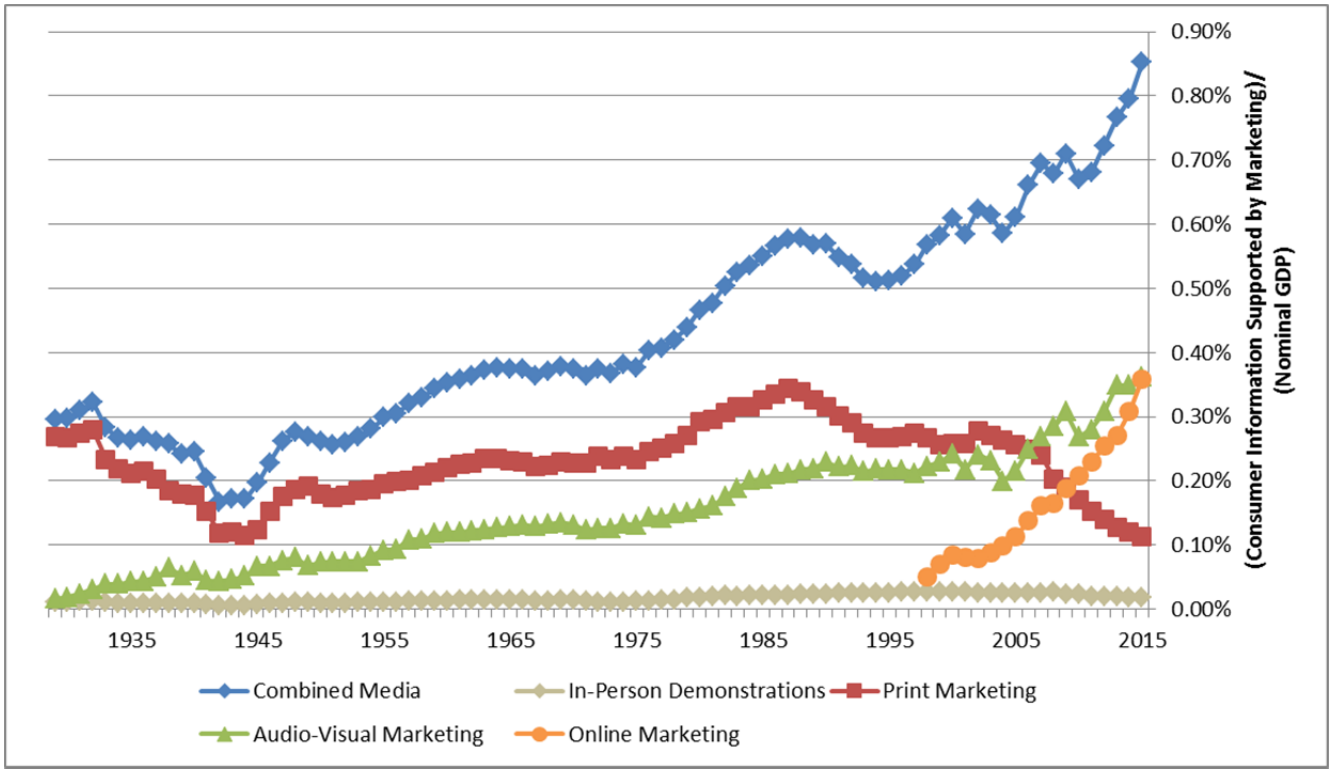


Figure 7: Marketing-Supported Business Information

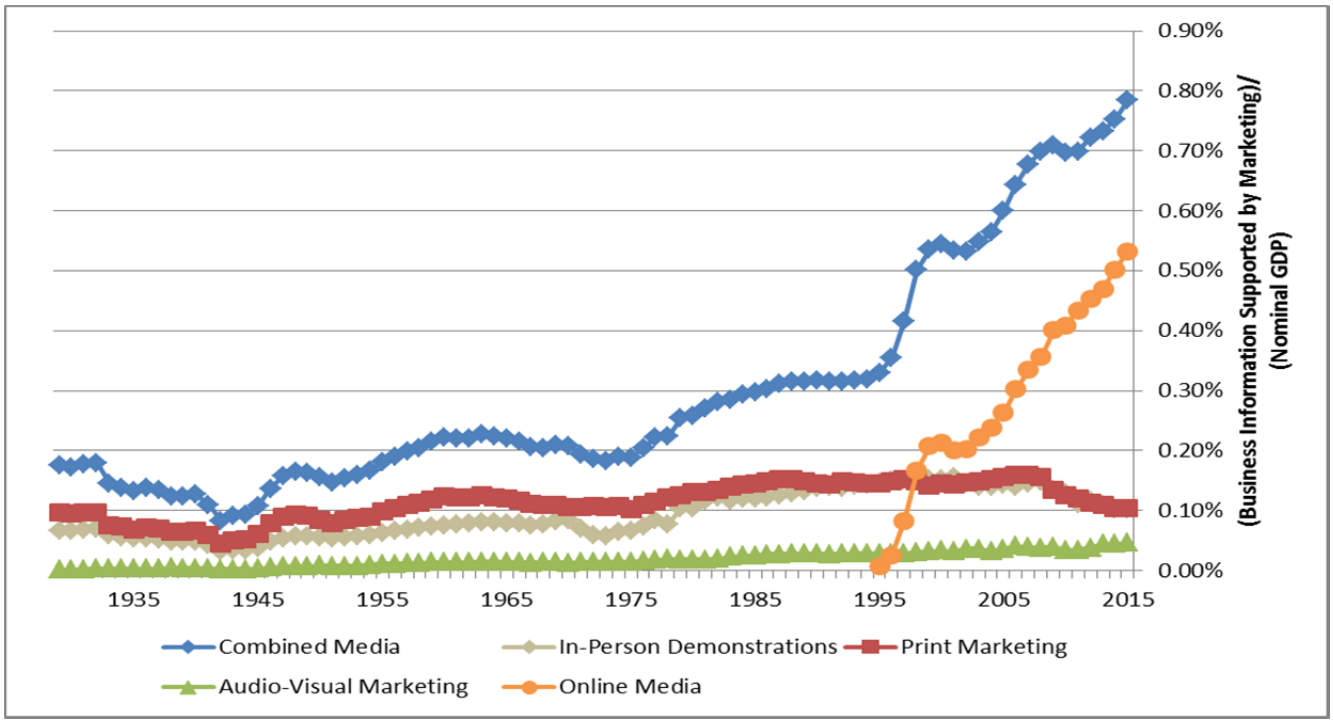


Figure 8: Prices for Marketing-Supported Information

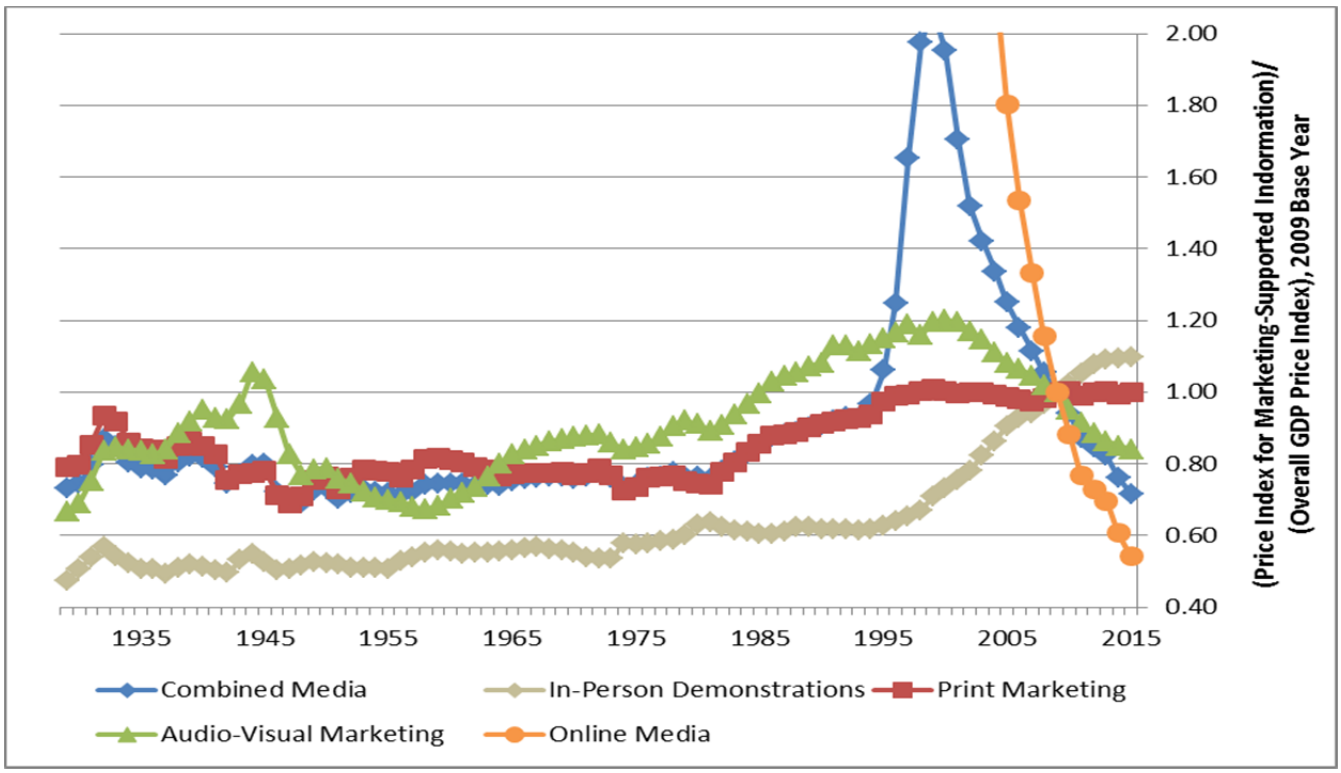


Figure 9: Change in GDP Quantities from 'Free' Information

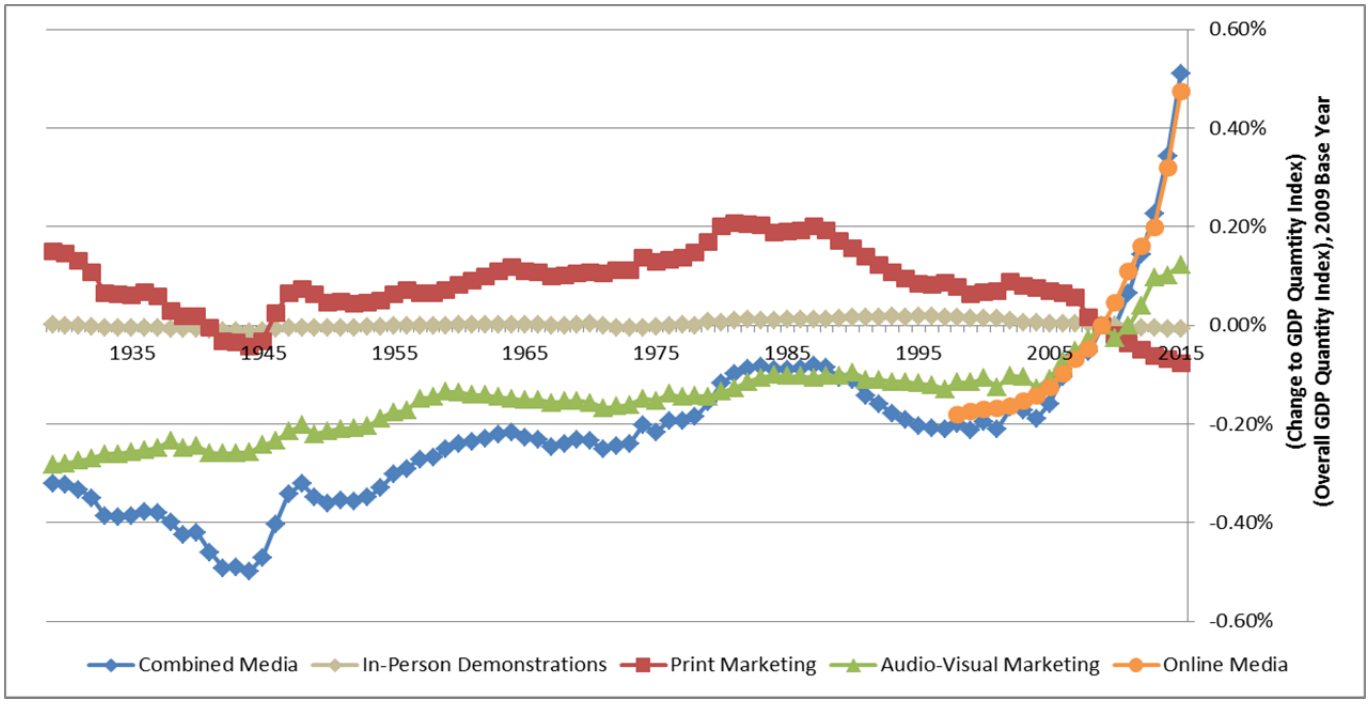


Figure 10: Quantity Indexes for Marketing Viewership

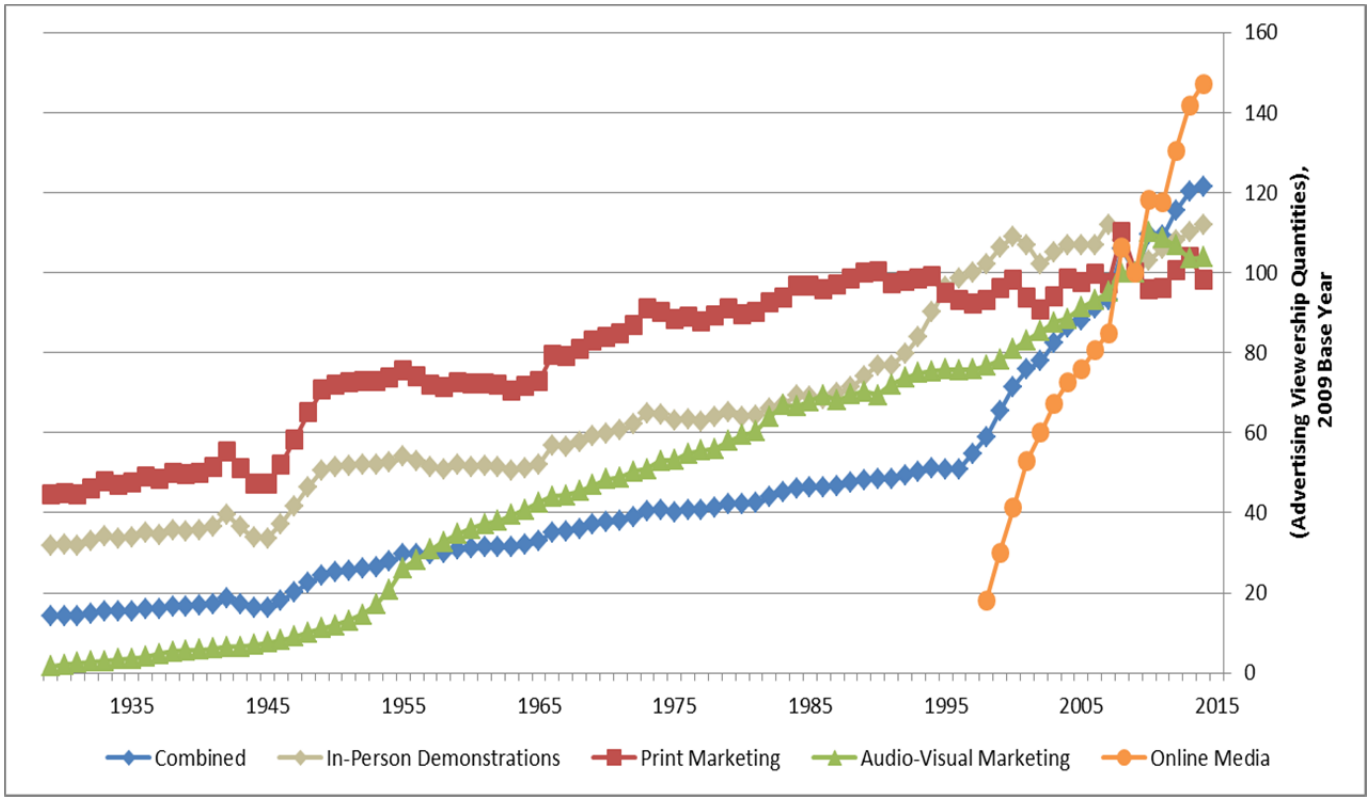
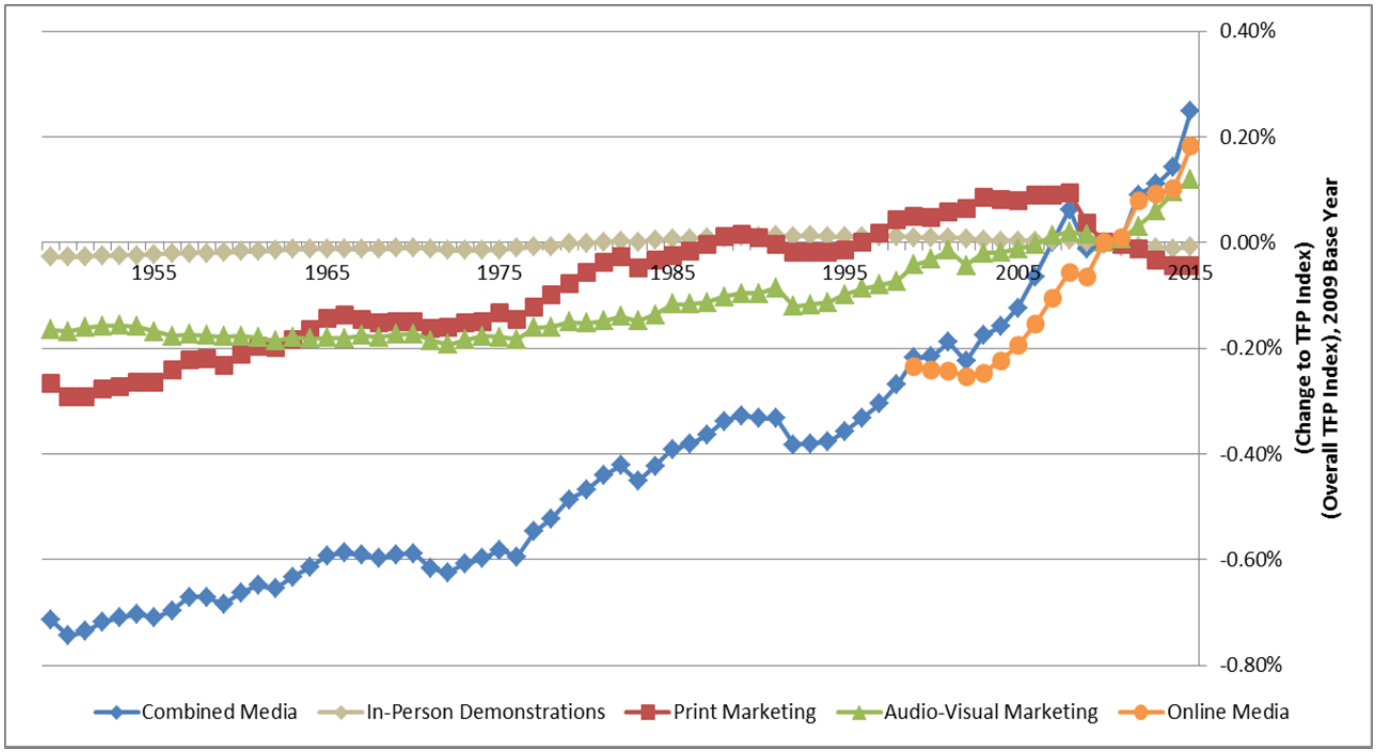


Figure 11: TFP Indexes with Marketing Viewership



Appendix A: Primer on the Experimental Accounting for 'Free' Information

The basic premise of the economic accounting framework experimented with above is that values for 'free' information can be imputed in the Input-Output tables based on the marketing expenditures which fund 'free' information. Conceptually, the idea of imputing components of current production that are not paid out-of-pocket is not new to GDP accountants. The largest imputed estimate in the NIPA accounts is owner occupied housing services. Other examples include food furnished to employees and financial services indirectly measured (FISM).

The purpose of this section is to provide details and discussion of the experimental accounting framework for 'free' information and how it relates to the current treatment in BEA's accounts. We demonstrate our experimental approach to measuring marketing-supported information by presenting a series of input-output tables that include the pertinent transactions. An advantage of viewing this through the input-output accounts is that these accounts form the foundation both for measuring GDP by industry and also for measuring productivity at the industry level.

We begin with a stylized example with four sectors: a sector (I) that produces information (e.g. viral videos or recipes), a sector that produces marketing (M), an everything else sector (EE),[35] and a household viewership sector (HV). GDP is measured two equivalent ways: 1) the sales to final demand (labeled C for Consumption) and 2) the sum of value added generated by industry. Value added is comprised of payments to factor services and taxes, but can be thought of as payments to labor services in this example.

We start with the case of direct sales of information to final demand, compare this to the case of marketing-supported information under our current methodology and then proceed to marketing-supported information under our experimental methodology. In all of our initial examples with marketing-supported information, the full value of the information is supported

[35] Companies frequently produce market-supported information are produced entirely in-house. As a result, the current input-output tables will not show any flow of either marketing or information. But this stylized example shows separate industries in order to make the accounting easier to follow.

by marketing, so that the viewer pays zero for the content. Partially marketing-supported information can be treated within the same framework, but the free information highlights the conceptual issues involved.

Direct sales of information

Table A1 depicts the input-output table for this stylized economy with direct sales of the information to final demand. Nominal GDP is $1,000, comprised of $800 of industry EE sales to final demand and $200 sales of information directly to final demand. Total final sales equal $1,000, the value added generated by the four sectors. In this economy, advertising is required to sell industry EE's output (Industry EE purchases $250 worth of advertising services, think of this as direct mailings) and industry EE supplies $200 worth of product used in producing the advertising. In this example, the $200 of output of the information company I is sold directly to final demand. We imagine that this information comprises $100 of print information, like recipes, and $100 of digital information, like video games. The household viewership sector (HV) has no role in this economy.

Table A1.

	EE	M	I	HV	C	Commodity Output
EE		200			800	1000
M	250					250
I					200	200
HV						0
VA	750	50	200			
Gross Output	1000	250	200			

Current treatment of Marketing-Supported Information

To produce an input-output table with ad-supported media, we impose the following assumptions. First, actual consumption of the output of industry EE is unchanged from the case of direct sales. Second, real consumption and the price of apps is unchanged from the case of

direct sales. Third, by substituting the direct mailing with the information based marketing campaign, industry EE is able to save on labor dollar for dollar.[36]

Table A2 lays out an example of an economy with marketing-supported information and demonstrates some of the measurement drawbacks of the current approach to accounting for information's role in the economy.[37] In this example, we imagine print information is used to distribute marketing, but the two are basically equivalent in this stylized model. Because the consumer values this print information at $100, the M industry must pay the information company at least $100 for the information company to be willing to make the content free to consumers. We assume that the M industry pays exactly $100. In this economy, industry EE switches between direct marketing and marketing bundled with the print information. For this privilege, industry EE pays M $350 reflecting the value of the information content and other marketing-related services. The viewership sector has no explicit role in this representation, even though the M sector is implicitly serving as an intermediary in delivering ad viewership to sector EE.

Table A2.

	EE	M	I	HV	C	Commodity Output
EE		200			800	1000
M	350					350
I		100			100	200
HV						
VA	650	50	200			
Gross Output	1000	350	200			

[36] This precise assumption is made for modeling convenience. It ensures that GDP prices remain fixed. This may seem like a strong assumption, and it is, but it is relatively innocuous since the pertinent comparison is between the current treatment of marketing-supported information and our proposed treatment with the barter transaction. When comparing those two approaches, we need not make this assumption. We impose this here to make a broad comparison between how the input-output accounts would look with direct sales of information to make the point that the value of the information to the consumer must be bid away. We do not make use of any evidence to tell us how industries adjust when with the introduction of marketing supported information. We could have alternatively chosen to allow the value of the output of industry EE to increase, for example.

[37] We do not consider the underlying reason for the marketing-supported approach to selling information or the role of information in selling industry output, but our approach does allow for it to be used as a productive input.

It is worthwhile to compare the aggregate economy measured economy in Table A1 to Table A2 even though this comparison embeds the assumptions imposed above. Imposing fixed prices allows for an easy comparison of aggregate nominal and real GDP. By assumption, the marketing-supported information does not increase the final sales of industry EE, thus consumption of industry EE's output is unchanged from the example of direct sales. Similarly, the consumption of digital information and its price is the same. It is obvious from Table A2 that real measured GDP is lower than the economy measured in Table A1 because the same quantity of industry EE output is consumed, while only the digital information is measured in final consumption. Under this set of assumptions, the consumer is indifferent between the economy in Table A1 and A2 (the same level of real consumption) and real production measured from final demand is the same, but measured GDP is lower. This is the crux of the measurement issue.

We note that this representation highlights the similarity between print and digital information. In this case, if the digital information was sold as an marketing device instead of the print information, Table A2 would look exactly the same.

Information consumption as a barter transaction

Our experimental treatment of marketing-supported information recognizes the barter transaction that is implicit in the above example of marketing-supported information. The role of our imputed barter transaction is highlighted in Table A3. One way to think about the exchange is that the consumer was spending $100 for the print information (the direct sales case), but the current accounting does not capture this. Thus, we impute $100 to consumption of the information, which in this case is provided by the M industry to final consumers. How does the consumer fund this consumption? This $100 of consumption is funded by an implicit payment from the M industry which in exchange for this payment gets exposure to the household viewership sector (people watching their ads). Thus, the M sector generates marketing-supported information (to be viewed by the household viewership sector) in addition to primary marketing-services (which are purchased by the EE sector). Finally, the household viewership sector produces marketing viewership output. Note that the digital information still is sold directly to consumers in this example.

Table A3.

	EE	M	I	HV	C	Commodity Output
EE		200			800	1000
M	350				100	450
I		100			100	200
HV		100				100
VA	650	50	200	100		
Gross Primary Output	1000	350	200			
Imputed Output of 'Free' Information		100				
Marketing viewership Output				100		

A complimentary interpretation of the barter transaction in Table A3 is that the M industry needs to deliver marketing viewership to the EE industry. To deliver this marketing viewership, the M industry must compensate the HV sector. In this framework, the M industry compensates the viewership sector exactly the amount that the viewer is willing to pay for the information content.

At this point, we highlight that in our application we do not observe the amount that the consumer is willing to pay for the information if it was sold directly. To estimate these values, we use observed marketing expenditures. That is, we use observations on the output of the marketing industry (the $350 in Table A3) to estimate the value of content to consumers and use this estimate as the value of the barter transaction. Note that as Table A3 shows, this value includes the value of the information. This is discussed below in more detail. The key point from Tables A1-A3 is that our experimental methodology imputes a barter transaction valued at our estimate of the consumption value of the information.

It is instructive to compare the measurement framework with the imputed barter transaction to the current treatment. First, value added across the private industries is the same in the two treatments. The implication of this is that the additional imputed consumption is balanced by the additional value added produced by the viewership sector. Second, the level of real value added is higher than in the current treatment. One interpretation of this is that in comparison to the current treatment, the value added of the viewership sector allows the

consumer a higher level of consumption compared to the treatment without the barter transaction.

It is immediately apparent that conditional on the assumptions listed above, our experimental approach produces the same nominal and real GDP as would have occurred under the direct sales model. This is the fundamental justification for our experimental approach. Conceptually, we believe that marketing-supported information is a very close substitute for directly purchased information – and so the two information types should be handled similarly in the National Income and Product Accounts. Under the current GDP formula, marketing-supported information is entirely excluded from final expenditures and contributes to GDP only indirectly. In contrast, our experimental approach includes both directly purchased information and also marketing-supported information in final expenditures. Furthermore, we argue that this is a useful feature since a significant portion of information consumed is through marketing-supported information.

Viewership sector as part of the broader household sector

In these stylized examples, and in the analysis in the main text, we have introduced a viewership sector that is beyond the scope of BEA's current set of economic accounts. To minimize the deviation of our analysis from BEA's official accounts, we do not consider the production process for this viewership. Presumably, marketing viewership requires other inputs, such as a television, a mobile phone, or a kitchen table to read the magazine. Measuring the output and inputs of this process is entangled with measuring overall household production and productivity in the household sector. We intentionally avoid this due to the plethora of issues involved in measuring household production. Our estimates of TFP at the industry level, however, are separable from measuring the inputs to household marketing viewership, thus our focus is on the role of marketing-supported information in industry TFP measurement.

Information Use by Business

Our examples in Tables A1-A3 assumed that information content was valuable only to consumers. Tables A4-A6 revisit the same conceptual issues when the final content is valuable to

business. In Table A4, the information produced by industry I is purchased directly by industry EE. To clarify, we imagine a situation where the information itself is directly relevant to the production process of industry EE, for example an accounting manual for a financial industry, or cooking apps for a restaurant. This is distinct from the case above where the industry only valued the information a as a conduit to reach marketing viewers. Just like the earlier consumer entertainment example, businesses provide marketing viewership in return for information content.

Table A4.

	EE	M	I	HV	C	Commodity Output
EE		200			1000	1200
M	250					250
I	200					200
HV						0
VA	750	50	200			
Gross Output	1200	250	200			

In this example economy with direct sales of information to business, nominal GDP is $1000. Like the case above, industry EE requires $250 worth of marketing to sell its output and the information producer makes $200 worth of information. Unlike the case above, this information is purchased as an intermediate input into the production of EE.

Table A5 provides a demonstration on what happens to the IO account with marketing-supported information. Again, we imagine that $100 of the information is provided by the I industry, and as above whether it is the digital or print information, the input-output accounting is the same. In this case, the industry EE values the information at $100 so the M industry must pay the information producer, I, $100 to bid this away. Given the value of the information content embedded in the marketing services produced by the M industry, industry EE pays the marketing industry $350 for the marketing services including the information content. Under this model, industry EE is indifferent between the direct sales model and the marketing-supported information because it receives the same quantity of intermediate inputs for the same prices as under the direct sales. Because information is used as an intermediate input, aggregate GDP is

unchanged with the marketing-supported information model in comparison to the case where the information is purchased directly as an intermediate input.

Table A5.

	EE	M	I	HV	C	Commodity Output
EE		200			1000	1200
M	350					350
I	100	100				200
HV						
VA	750	50	200			
Gross Output	1200	350	200			

Like the case with marketing consumed by households, the marketing-supported information model leaves out the implicit transaction between the viewer and producer of the marketing. Table A6 highlights these barter transactions. In this case, industry EE produces marketing viewership in addition to its primary output. Like in the case of consumers, the M industries implicitly compensates the viewers $100 which funds the business consumption of the marketing supported information in sector EE. The M industry has $100 of imputed output of marketing supported media, so that a total of $450 of input from the M industry is purchased by industry EE. The intuition for this is that the since industry M paid $100 to obtain the rights to use the information content, this must be worth at least $100 to the M industry. This value accounts for an implicit payment that must be made to the viewers of the marketing. The account in Table A6 makes this payment explicit and produces an internally consistent accounting for marketing-supported information that reflects both the recorded and implicit payments for the information as an output and an input.[38]

[38] Note that the household viewership sector is uninvolved in this example. The payment for ad viewership goes to the business sector, which produces the ad viewership as a secondary product. Thus, there is no entry in the value added of the HV column.

Table A6.

	EE	APB	M	HV	C	Commodity Output
EE		200			1000	1,200
APB	450					450
M	100	100				200
HV		100				100
VA	750	50	200			
Gross Primary Output	1200	350	200			
Imputed Output of 'Free' Information		100				
Marketing viewership Output	100					

Industry and Aggregate Productivity measurement with our Experimental Approach

Given our reconstructed input-output table, measures of industry growth and productivity that reflect our experimental approach are relatively straight forward. Productivity measures require prices and quantities for the outputs and inputs of each sector. Productivity growth is defined as the growth rate of the ratio of the output quantity index to the input quantity index.

On the output side of each industry's production account there potentially eight new outputs discussed in the main text: 1) marketing-supported in-person information, 2) marketing-supported print information; 3) marketing-supported audio-visual information; 4) marketing-supported online information, 5) in-person marketing viewership, 6) print marketing viewership, 7) audio-visual marketing viewership; 8) online marketing viewership. We construct new measures of the price and quantity of industry output as the tornqvist index of the original industry output with these six new outputs. Data for the prices and quantities for each of these is described in the body of the paper and Appendix B.

At first glance, it seems surprising create so many new outputs for each industry. In fact, having a single industry produce multiple outputs is common in productivity measures. The official BEA-BLS integrated industry-level accounts employs this approach and industries are classified by their primary production. When a single industry produces multiple outputs in the official BEA accounts, industry output growth is a chained index over multiple outputs

On the input side of the production account, each industry has these same eight potentially new inputs. We construct new measures of the price and quantity of industry input as the tornqvist index of the original industry input with these eight new inputs. Data for the prices and quantities for each of these is described in the data appendix.

We reiterate that by construction the nominal value of new outputs equals the nominal value of new inputs by industry. However, the price of each of these is different on the output side and the input side of the account, thus the barter transaction has implications for measured industry TFP. The government and viewership sectors complicate aggregation across industries. Thus, we focus on the measured productivity impact on the private economy.

Free information in the 2007 IO accounts

Table A7 demonstrates how the barter transactions impact the 2007 BEA input output table (modified to include a viewership sector) for fifteen broad sectors that encompass the U.S. GDP. We reiterate that the starting point for these values is data on marketing expenditures. In the main text and Appendix B, we describe how we estimate the value of each form of information embedded in marketing viewership.

Table A7a shows the production and use of marketing-supported information content, that is, our estimate of the value of information content embedded in marketing expenditures. In 2007, in-person, print, audio-visual and online information combined for $199 billion in information content. We estimate that $100 billion accrued to the household viewership sector. The remainder of the value was used by U.S. businesses and government. To be clear, by construction, the sum of the value added generated by the viewership sector plus the intermediate use of the information equals the estimated value of marketing-supported information. Table A7b highlights that the value marketing-supported information content equals the value of viewership output across the economy, that is, the total value of output from marketing viewership across all sectors equals the value of marketing-supported information content. The table makes it clear that within industries, the value of information being used equals the secondary production value of information viewership.

Table A7a

Commodities/Industries	11	21	22	23	31G	42	44RT	48TW	51	FIRE	PROF	6	7	81	G	HV
11: Agriculture, forestry, fishing, and hunting	71.1	0.1	0.0	1.7	202.9	1.5	1.6	0.1	0.0	0.0	1.1	0.5	5.7	0.1	1.8	
21: Mining	2.1	54.7	74.7	12.3	422.2	0.1	0.2	4.6	0.3	4.8	1.3	0.6	1.3	0.5	18.6	
22: Utilities	5.2	4.9	5.2	3.3	80.2	6.9	16.1	6.4	3.8	80.7	11.5	19.8	15.3	4.3	26.5	
23: Construction	2.3	7.2	7.4	0.2	13.9	1.5	2.9	4.3	2.2	111.5	2.1	2.2	2.5	3.0	57.0	
31G: Manufacturing	70.6	37.2	31.5	364.0	1897	40.7	44.7	162.0	82.3	82.5	131.1	149.5	119	47.6	337.1	
42: Wholesale trade	21.6	5.7	5.2	51.0	257.3	28.0	17.0	22.0	12.9	11.6	17.8	31.7	16.7	7.0	37.0	
44RT: Retail trade	0.2	0.2	0.5	76.8	11.4	0.6	5.0	4.2	0.3	7.4	2.0	1.0	6.2	4.1	0.5	
48TW: Transportation and warehousing	10.3	9.0	23.1	21.4	123.2	46.4	54.7	93.8	16.6	28.1	35.2	16.2	11.0	4.2	48.8	
51: Information	0.4	0.9	2.1	3.8	22.8	12.2	13.3	5.4	164.4	65.0	56.2	22.6	9.2	8.1	72.3	
FIRE: Finance, insurance, real estate, rental, and leasing	15.5	13.8	19.4	29.2	92.6	92.6	140.9	76.8	61.3	928.5	222.6	231.9	83.5	80.2	115.6	
PROF: Professional and business services	4.2	22.7	28.5	44.0	339.6	146.0	124.0	51.0	124.2	420.3	419.0	166.2	106	31.9	254.2	
6: Educ. services, health care, and social assist.	0.2	0.0	0.1	0.0	0.1	0.5	2.2	0.1	0.2	0.1	0.5	20.4	1.3	1.5	13.8	
7: Arts, entertain., rec., accomm.., and food service	0.4	0.6	3.6	2.1	15.5	5.1	3.7	3.2	26.4	45.7	45.6	19.3	22.0	2.9	26.5	
81: Other services, except government	0.8	0.5	1.0	4.4	16.1	15.0	10.5	4.8	7.7	30.3	27.2	22.5	10.3	6.1	23.4	
G: Government	0.1	0.0	0.8	0.0	5.2	11.5	6.4	18.7	3.7	9.2	8.7	5.7	6.1	1.8	8.1	
Original Intermediate	205	157	203	614.4	3500	409	443	457	506	1826	982.0	710	416	203	1041	
Marketing-Supported In-person Demonstrations	1.5	0.6	0.3	1.4	9.2	0.7	1.7	1.1	0.5	1.0	0.6	0.3	0.7	0.5	1.0	
Marketing-Supported Print Information	1.5	0.6	0.3	1.3	8.8	0.7	1.6	1.1	0.5	4.3	0.5	0.3	0.7	0.5	0.9	
Marketing-Supported Audio-Visual Information	0.1	0.0	0.0	0.1	0.6	0.0	0.1	0.1	0.1	0.0	4.3	0.0	0.0	0.0	0.0	
Marketing-Supported Online Information	3.4	1.4	0.7	3.0	20.5	1.6	3.8	2.5	1.1	3.9	1.3	0.6	1.5	1.1	2.3	
In-person Demonstration Viewership	3.0	0.2	0.0	0.3	2.3	0.8	0.5	0.8	1.8	2.4	8.7	1.0	4.1	1.4	0.0	
Print Viewership	0.3	0.1	0.6	0.4	4.8	5.0	3.2	0.5	3.5	6.7	27.7	2.9	1.8	0.2	0.0	
Audio-Visual Viewership	0.2	0.1	0.5	0.3	3.7	3.8	2.5	0.4	2.7	5.2	21.4	2.2	1.4	0.2	0.0	
Online Viewership	0.3	0.6	1.0	0.5	7.8	10.2	2.5	1.4	3.9	3.8	35.8	3.3	0.3	0.4	0.0	
Total Intermediate	211.8	160.5	206.3	621.1	3,554.1	431.6	458.2	464.4	519.8	1,858.2	1,077.8	720.6	426.3	207.2	1041	.
V001: Compensation of employees	41.5	62.7	63.1	439.8	944.4	429.2	506.1	255.8	260.4	730.0	1183.3	895.8	324.7	231.1	1541.0	.

V002: Taxes on production and imports, less subsidies	-2.5	33.6	54.6	7.9	60.2	175.3	184.3	24.6	43.1	247.9	49.8	32.0	70.5	17.3	-18.7	.
V003: Gross operating surplus	103.0	217.7	117.4	267.3	849.7	256.3	187.2	129.1	398.8	1899.2	424.1	136.8	137.0	82.1	382.9	
Total Value Added	142.0	314.0	235.1	715.0	1854.3	860.8	877.6	409.6	702.4	2877.1	1657.2	1064.6	532.1	330.5	1905.2	100.0

Table A7b

Commodities/Industries	11	21	22	23	31G	42	44RT	48TW	51	FIRE	PROF	6	7	81	G	HV
Original Industry Output	346.9	471.4	438.2	1329.4	5354.4	1269.5	1320.7	866.9	1208.6	4702.8	2639.2	1774.7	948.0	533.8	2946.7	.
Media Related Output																
Marketing-Supported In-person Demonstrations	0.2	0.2	0.0	0.3	2.3	0.8	0.5	0.8	1.8	2.4	8.7	1.0	4.1	1.4	0.0	
Marketing-Supported Print Information	0.3	0.1	0.6	0.4	4.8	5.0	3.2	0.5	3.5	6.7	27.7	2.9	1.8	0.2	0.0	
Marketing-Supported Audio-Visual Information	0.2	0.1	0.5	0.3	3.7	3.8	2.5	0.4	2.7	5.2	21.4	2.2	1.4	0.2	0.0	
Marketing-Supported Online Information	0.3	0.6	1.0	0.5	7.8	10.2	2.5	1.4	3.9	3.8	35.8	3.3	0.3	0.4	0.0	
In-person Demonstration Viewership	1.5	0.6	0.3	1.4	9.2	0.7	1.7	1.1	0.5	1.0	0.6	0.3	0.7	0.5	1.0	3.6
Print Viewership	1.4	0.6	0.3	1.3	8.6	0.7	1.6	1.0	0.5	4.3	0.5	0.3	0.6	0.4	0.9	34.6
Audio-Visual Viewership	0.1	0.0	0.0	0.1	0.6	0.0	0.1	0.1	0.0	4.3	0.0	0.0	0.0	0.0	0.1	38.9
Online Viewership	3.4	1.4	0.7	3.0	20.5	1.6	3.8	2.5	1.1	3.9	1.3	0.6	1.5	1.1	2.3	23.0
Total Industry Output	353.7	474.9	441.5	5,408.5	1,292.1	1,335.9	874.3	1,222.4	4,735.0	2,735.0	1,785.3	958.3	538.0	534.1	2946.7	00.0

Appendix B: Detailed Discussion of Datasets Used

Not all 'free' information is genuinely marketing-supported. It is common for sellers to bundle information with a purchased good or service without charging separately for the information. For example, electronics generally come with a detailed manual that helps new owners set up and use the product. The value of this manual is already counted in the price of the electronics and so it would be double-counted if we included it in marketing-supported information as well. The crucial distinction between marketing information and bundled information is that marketing-supported information is available without any purchase requirement. For example, General Mills provides recipes to the general public at BettyCrocker.com and these recipes work for any brand of flour. In contrast, many software and electronics companies restrict their product upgrades and telephone support to individuals with proof of purchase. This paper attempts to measure only the portion of 'free' information which is supported by marketing and excludes the rest.

Nominal Expenditures on Marketing-Supported information from the Economic Census and OES, Covering 2002-2014

Our primary data is taken from the 2012 Economic Census. This survey reports revenue by product line and industry for the vast majority of the private business sector. We start out by identifying ten product lines which are associated with marketing-supported information and the primary industries which produce those product lines for sale. We will list those product lines later. We then adjust the Economic Census's product line sales data for non-employers, underreporting and misreporting. Our adjustments are all taken from BEA's most recent benchmark revision in 2013.

Our adjusted Economic Census product line sales yield the aggregate value of marketing produced and sold by primaries industries in the U.S. economy. Next, we use occupation data to estimate expenditures on marketing which is produced outside the primary industry. In our discussion, we will call marketing produced outside the primary industry 'in-house' marketing. In practice, it is possible that some industries may sell marketing as a secondary product. This

potential sales does not affect our aggregate estimates of overall marketing expenditures – but it might bias estimates of marketing output and productivity growth for individual industries.

For the first eight of the ten marketing categories, we use the following procedure to estimate total marketing expenditures. First, we identify the occupations which are primarily responsible for its production. We then focus on industries which produce sold marketing, and calculate the ratio of gross output to earnings for specialist workers for each marketing category. Finally, we use that ratio to estimate the value of in-house marketing produced by specialty workers employed in the broader economy.[39] For example, suppose that a public relations firm (NAICS 54182) sells $1 billion worth of public relation services, employs one thousand people in public relations (occupation codes 11-2031 and 27-3031) and pays each person an average salary of $100,000 each. In the rest of the industries studied, we observe ten thousand individuals employed in public relations with an average salary of $80,000 each. Based on those hypothetical numbers, we calculate that in-house expenditures on public relations are approximately $8 billion [$1 billion/ (1,000*$100,000)]*[(10,000*$80,000)].[40] Note that we exclude public relations specialists employed by the government or charitable institutions because the current GDP methodology already counts expenditures on public relations in measured output.[41] The last two marketing categories were harder to match with occupations, so we will use alternative techniques. Below is a list of the nine categories:

1) Media representation in NAICS 5418 (product line 37720). For this product, we use advertising sales agents (occupation code 41-3011) as a proxy.

[39]This formula misses the in-house marketing produced by industries which sell marketing as their primary product. In addition, we were forced to exclude some industries for some marketing categories because we felt that the occupation proxies might not be reliable for those industries. Furthermore, the OES does not cover the farm sector. For all of those missing industries, we assume the ratio of in-house marketing to total wages matches the broader economy. In practice, these industries account for a small fraction of total marketing expenditures.

[40] Even though this is a hypothetic example, the ten-fold markup from specialty worker earnings to gross output is not unusual. Public relations specialists generally require an IT staff to help them research and write press releases, a travel department to schedule interviews, etc. None of these support staff are identifiable in the OES, so we can't add their earnings to the public relations specialist earnings to get total output. Instead, we are forced to infer their contribution from the reported earnings for specialty workers.

[41]Non-profit hospitals generally receive the majority of their revenue from product sales and behave similarly to for-profit institutions in the same industries. We treat these sectors as if they were entirely in the private sector. Only educational institutions, religious institutions and other primarily charitable foundations are excluded.

2) public relations services in NAICS 5418 (product line 37700). For this product, we use public relation specialists (occupation code 27-3031) and public relations managers (occupation code 11-2031) as proxies.

3) TV/radio advertising planning, creation and placement services in NAICS 5418 (product lines 37710, 37670 and 37680). Unfortunately the Economic Census does not distinguish between TV/radio marketing and print/digital marketing. Both categories are combined each of the product lines tracked. For now, we assume that the ratio of TV/radio marketing to print/digital marketing tracks the ratio of TV/radio advertising to print/digital advertising.[42] For these products, we use multimedia artists (occupation code 27-1014) and producers/directors (occupation code 27-2012) as proxies.

4) Digital/print advertising planning, creation and placement services in NAICS 5418 (product lines 37710, 37670 and 37680). Just like before, we assume that the ratio of TV/radio marketing to print/digital marketing tracks advertising. For these products, we use art directors (occupation code 27-1011), graphic designers (occupation code 27-1024), editors (occupation code 27-3041) and writers/authors (occupation codes 27-3043) as proxies.

5) remaining marketing from NAICS 5418. This category includes a variety of small product lines that appear to marketing-supported information together with our best split for the ambiguous product lines. For proxies, we use all the occupation codes previously mentioned and the additional occupations of marketing managers (occupation code 11-2011), proofreaders (occupation code 43-9081) and all other media workers (occupation codes 27-3099).

6) Website development from NAICS 5415 (product line 37411). For this product, we use computer programmers (occupation codes 15-1131, 15-1132, 15-1133 and 15-1134) as proxies.

7) Website hosting from NAICS 518 (product line 35201). For this product, we use system administrators (occupation code 15-1142) as a proxy.

8) Commercial photography from NAICS 5419 (product line 37870). For this product, we use photographers as a proxy (occupation code 27-4021).

[42] The Economic Census does distinguish between media representation services for print, TV, radio, online and other advertising (product lines 37721-37725). Results are similar if we use that split instead, but the numbers are a little noisier. Results are also similar if we rely on the scattered industry literature available.

9) Yellow pages and other directory advertising from NAICS 511 (product line 364640, 34790, 3483, 34860 and 34980). Despite our best efforts, we were not able to find any occupations that were associated with directory production but nothing else. We will be conservative and set in-house production of yellow pages to zero.[44]

10) Event planning from NAICS 561 (product line 37820). This product was the most problematic. Based on the industry literature, we know that some companies do manage events in-house – but we were unable to find a good occupation proxy.[45] For this product, we use Outsell's research report as a proxy for total expenditures. We then assume all event planning not produced by NAICS 561 is produced in-house.

Adding up these ten categories, we estimate that U.S. businesses purchased $127 billion of marketing services and spent another $186 billion on in-house production. This $186 billion includes salaries for marketing specialists, salaries for support staff like human resources professionals, intermediate goods like electricity or paper and capital services. Note that our $186 billion estimate is based on the formula described earlier and might not match internal company calculations.[46] The exact level of in-house marketing calculated is somewhat sensitive to the exact product categories tracked and the occupations used as proxies for each category. The level is also sensitive to assumptions about international trade[47] and the assumed lifespan for

[44] It is very rare for corporations to publish their own directories as marketing. The only example we could think of is the Michelin restaurant guide. However, corporations do invest resources planning their yellow pages ad and checking directories for accuracy. In addition, phone companies sometimes require companies listed in the yellow pages to purchase business phone services and other expensive add-ons (Maher 1997).
Charities and trade groups often publish directories for their members, and those directories sometimes include advertising. However, the national accounts track non-profits differently than businesses and the revenue from directory advertising may already be included in measured GDP.

[45] At first glance, meeting and convention planners (occupation code 13-1121) seems like a good proxy. Unfortunately, that occupation code is involved with both marketing events like trade shows and non-marketing events like corporate training or even charitable events.

[46] A particular issue is that advertising agencies (NAICS 5418) appear to earn extremely high rates of return on their capital. We assume that companies producing in-house marketing would earn those same rates, so the opportunity cost of in-house marketing is equal to the purchase cost. However, companies calculating marketing expenditures may assume a more normal rate of return on the associated capital.

[47] The $313 billion estimate for 2012 tracks **production**, not consumption. Many multinational businesses produce marketing-supported information in the United States and use it globally or vice versa. We have not been able to find any data on either imports or exports of marketing-supported information.

marketing-supported information.[48] However, the general growth rate for marketing-supported information is much more robust to alternative product categories and occupation codes.

Nominal Expenditures on Marketing-Supported Information, Before 2002

Unfortunately, we cannot use the formulas and data described above to track marketing-supported information before 2001. Between 2001 and 2002, the OES changed from SIC codes to NAICS codes. This change makes it very difficult to identify which industries are producing marketing as their primary product – so we cannot calculate either purchased marketing or in-house marketing reliably. However, we are still able to track aggregate marketing expenditures by using total earnings for the marketing specialists as a proxy. For each of the first seven marketing categories described earlier, we use the occupation codes used earlier as proxies for total output.[50] Between 1998 and 1999, the OES changed its occupation codes dramatically. As a result, we cannot even calculate aggregate marketing using the OES data. Instead, we use a variety of datasets to estimate marketing expenditures back to 1929.

1) Media representation services. For this category, we use self-reported earnings for advertising sales agents as a proxy. We were not able to find any data tracking the ratio of media representation services to earnings, so we assume that it is fixed over time. Self-reported earnings are available from the decennial population Census for 1940, 1950, 1960, 1970, 1980, 1990 and 2000.[51] Before 1940 and between Census years, we use total advertising expenditures as an interpolator.

2) Public Relations Services. From 1960 onwards, we estimate expenditures using a two part process similar to the one used earlier for the OES. First, we collected data from the Economic

[48] For now, we treat all marketing-supported information as short-lived and assume production equals consumption for every year. However, the OES tracks a three-year rolling panel. So, we lag each published release by one year to match the actual data collection better.

[50] This formula assumes a constant ratio between aggregate output and earnings for specialty workers, so it might not be valid in the long-term or in rapidly changing environments.

[51] Between 1950 and 2000, advertising sales agents are identified as individuals that Ipums assigns an occ2010 code of 4800. Between 1930 and 1950, advertising sales agents are identified as individuals that Ipums assigns an occ1950 code of 400. We drop government workers and individuals in a few problematic industries. The 1940 Census only reports earnings for employees and the 1930 Census has no earnings data. Furthermore, some individuals do not report earnings. We impute earnings using our best judgement.

Census tracking revenue for public relations agencies.[52] Between Economic Census years, we use the Service Annual Survey as an interpolator when it is available after 1990. Before 1990, we use Compustat data on aggregate sales, general and administrative (SG&A) as an interpolator. Combining these datasets, we are able to create an index tracking purchased public relations from 1960 onwards. Next, we used the decennial population Census to estimate the share of public relations specialists[53] employed in the public relations industry.[54]

Before 1960, estimates are more speculative. Neither the Economic Census nor the decennial population Census track public relations. Between 1950 and 1960, we use a cross-walk published by Ipums that estimates what occupations people in 1950 might have had if the Census used the 1960 codes.[55] This cross-walk does not report earnings, so we use nominal output per employee in advertising agencies (SIC 7311) as a proxy. Before 1950, we assume that public relations expenditures track expenditures on print marketing.

3) TV/radio planning, creation and placement services. Unlike the earlier two marketing categories, we were not able to find any occupations to use as a proxy for advertising.[56] In the absence of any occupation data, we cannot estimate the share of audio-visual marketing produced in-house over time. Instead, we are forced to assume that the in-house share is constant over time. Based on that assumption, we can use the production of purchased audio-visual marketing as a proxy for total production.

Our primary data on purchased planning, creation and placement services is taken from the Economic Census. We use total revenue for the sub-industry 'In 1997, the Economic Census used the same NAICs and product codes as in 2002. Therefore, it is straightforward to calculate

[52]From 1997 onwards, they are tracked in NAICS 54182. In 1987 and 1992, they are placed in SIC 8743. Between 1963 and 1982, these agencies are part of SIC 7392. Finally, the Economic Census does not split out public relations agencies in 1958. We use output for 'Business management, Consulting and Public Relations' as a proxy.
[53] From 1980 onwards, we identify public relations people as individuals that Ipums assigns an occ2010 code of 2825. In 1970, public relations people are identified as individuals with occ code 192 and in 1960, public relations people are identified as individuals with occ code 163.
[54] From 1970 onwards, we identify people employed in the public relations industry as individuals that Ipums assigns an ind1990 code of 892. For some reason, this code was not used in 1960, so we cannot observe the in-house share directly. Instead, we set the public relations share for 1960 equal to the 1970 share.
[55] Available at https://usa.ipums.org/usa/resources/chapter4/occ_50-60.pdf
[56] The population census contains an occupation codes for actors/producers/directors (occ2010 = 2700) and broadcast technicians (occupation code = 2900). Unfortunately, relatively few individuals with those occupation codes report working in the advertising industry and the reported in-house share is too volatile to use.

a growth rate between 1997 and 2002. Before 1997, the Economic Census used different industry codes and provides less detail on product lines. However, the vast majority of purchased planning, creation and placement services are produced by the industry 'advertising agencies'. We use total revenue for that industry as a proxy. That data is available in 1935, 1939, 1948, 1954, 1958, 1963, 1967, 1972, 1977, 1982, 1987 and 1992.[57] Between years with data, we use the Service Annual Survey as an interpolator when it is available. When it is not available, we use total advertising as an interpolator.

Only a portion of the revenue earned by SIC 7311 can be attributed to audio-visual marketing. Just like before, we were not able to find any data splitting digital/print marketing from audio-visual marketing. We will assume that the audio-visual share of marketing tracks the audio-visual share for advertising throughout the entire time period. Prior to 1960, it was common for advertising agencies to produce shows in-house rather than buying slots from media companies. In our previous paper on advertising-supported media (Nakamura, Samuels and Soloveichik 2016), we chose to count shows like 'Kraft Television Hour' together with advertising-supported media. To avoid double-counting, we will subtract them from marketing-supported information in this paper.

4) Digital/print planning, creation and placement services. This category is the largest historical marketing category and the most precisely estimated. Throughout the entire time period, we use a two-step formula very similar to the two-step formula used earlier to calculate marketing expenditure for the past decade. First, we use the same Economic Census data described earlier to estimate purchased digital/print marketing for every year from 1929 until 2000. Next, we use the decennial population Census to estimate the share of writers, editors, artists and designers working in the advertising sector.[58] The occupation codes in the Census are much broader than

[57] NAICS 54181 corresponds perfectly with SIC 7311 and so there is no need for adjustment. A crosswalk is available online at https://www.census.gov/eos/www/naics/concordances/concordances.html. Between 1954 and 1972, the Economic Census reports gross billing rather than net billing in the aggregate revenue statistics. However, a separate table tracks the major source of receipts for advertising agencies. From 1958 onwards, that table implicitly reports net billing and so we can calculate revenue consistently.

[58] From 1950 until 2010, we identify individuals using Ipum's occ2010 codes. The exact codes used are 2600 (artists and related workers), 2630 (designers), 2810 (editors, news analysts, reporters and correspondents), and 2850 (writers and authors). For 1930 and 1940, we identify individuals using Ipum's occ1950 codes. The exact codes used are 4 (artists and art teachers), 6 (authors), 33 (designers), and 36 (editors and reporters). We use Ipum's ind1950 code to identify individuals employed in the advertising sector (ind1950 =806). Even though this code is supposed to be comparable over time, it actually switches from covering SIC 731 in 1990 to covering NAICS

the occupation codes in the OES. As a result, we are forced to exclude certain industries that are included in the OES data.[59] Even after the exclusions, we still find far too many creative individuals working outside the advertising sector. To avoid a trend break, we benchmark our in-house share to the OES data.

5) Remaining marketing. The category is relatively small and diverse. For simplicity, we did not try to collect data back to 1929. Instead, we use the previous four categories of marketing-supported information as proxies.

6) Website development. As discussed earlier, we use the OES data to get aggregate spending back until 1998. Before 1998, this category was small and so new that the 1997 Economic Census did not even have product codes for it. We were not able to find any official data tracking website development costs during the 1990's. For now, we use online advertising expenditures as a proxy.

7) Website hosting. We use the same proxy described earlier for website development.

8) Commercial stock photography. This product was studied earlier in the paper 'Miscellaneous Artwork as Capital Assets' (Soloveichik 2013d). We took the existing estimate of revenue from commercial stock photography and use that as a proxy back until 1929.

9) Yellow pages and other directory advertising. Since 1920, the CS ad expenditure dataset has tracked the advertising revenue earned by telephone directories.[60] During the 2000's, these telephone directories accounted for the vast majority of total directory advertising. Accordingly, we believe telephone directory advertising is an excellent proxy for total directory advertising.[61]

10) Event planning. Neither the Economic Census nor the decennial population Census has much useful data on this category. Instead, we will use a historical time series published by the

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5418 in 2000. Based on comparing OES data by SIC in 2001 and OES data by NAICS in 2002, we calculate that this switch increases the number of creative people in advertising by approximately 15%. Hence, we adjust the Ipums data in 1990 to avoid a trend break.

[59] A particular problem is retail florists, who are reported as designers in the Census data.

[60] The data is available online at www.galbithink.org/directory-advertising.xls

[61] One potential problem is that many households did not have telephones in the 1930's. It is possible that households without telephones might have relied on other directories. However, most yellow page directories list addresses and most households without telephones had access to pay phones. Accordingly, we believe that telephone yellow pages were still the dominant director category in the 1930's.

Center for Exhibition Industry Research (CEIR). We located an article which reported a real revenue index from 2000 until 2015.[65] Before 2000, we were not able to find any CEIR data on real revenue, but did find two articles tracking net exhibit space from 1968-1985 and 1987-2009.[66] Between 2000 and 2015, net exhibit space was highly correlated with real revenue – so we use net exhibit space as a proxy for real revenue back to 1968. Finally, we multiply the CEIR real index by the consumer price index to get nominal revenue back to 1968.[67] Before 1968, we were not able to find any data on event planning. For now, we use the previous nine categories of marketing-supported information as a proxy for event spending.

Nominal Expenditures on Marketing-Supported Information in 2015

It might seem that the OES data tracks marketing up until 2015. After all, the last publicly available dataset is labeled May 2015. In fact, the OES data is based on a three year rolling panel – so the 2015 dataset actually tracks employment for 2013-2015. We use the 2015 OES data to measure marketing expenditures in 2014, and so on. Future drafts of this paper may use the 2016 OES data once it is released. Until that data is available, we used a variety of proxies to estimate marketing expenditures for 2015. These proxies are probably less reliable than the OES data.

Nominal Opportunity Costs of In-House Marketing-Supported Information

Our data is taken from a variety of industry sources. For newspapers and magazines, we rely on the Pew Article 'Who Is Placing Ads?' (Matsa, Olmstead, Mitchell and Rosenstiel 2012), which estimated that 9-10% of print advertising is promoting the newspaper or magazine. For cable television, we used data from Kantar Media which directly tracks own-account television

[65] The article is located at http://southwestshowcase.org/wp-content/uploads/2016/01/Expos-The-Big-Picture.pdf.
[66] Summary statistics are available for free at http://www.cityofpalmer.org/vertical/sites/%7BCEEE28AE-9003-4337-8BE2-A1961FF16E3D%7D/uploads/%7B42276640-9670-42DB-AABD-7A149975A1EE%7D.PDF; and https://www.esca.org/documents/RCSR%2021.09%20lo%20res.pdf
We were not able to find any time series on attendance from 1985 to 1987. For now, we assume that those two years had the same growth rate as occurred from 1987 to 1988.
[67] None of the articles mention the exact deflator used, but the CEIR reports using the CPI as a deflator elsewhere.

advertising time from 1995 to 2010. That data is described in much more detail in a previous paper 'Television Originals as Capital Assets' (Soloveichik 2013b). For theatric movie trailers, we rely on the NPR article 'Theaters and Studios Squabble Over Shortening Movie Trailers' (Holmes 2013). That article does not give a precise value for movie trailers, but it estimates they average 20 minutes per movie. If a typical movie is 2 hours, then movie trailers account for approximately 14% of active theater time.[69] For freemium games, we rely on two separate news articles: 'Here's How Much You Spend on Iphone Apps Each Year' (Reisinger 2016) and 'iOS App Store Brings in 75% More Revenue than Play Store Despite Difference in Downloads' (Miller 2016) to estimate total expenditures by US consumers on freemium games in 2015. We were not able to find any articles which track US expenditures over time, but the article 'App Revenue Statistics 2015' (Dogtiev 2015) gives global expenditures on in-app purchases from 2011 onwards. We use those global revenues as a proxy for US freemium game revenue.

We only count a portion of in-house ads in our category of opportunity cost marketing. Broadcast television and online search engines both earn the vast majority of their revenue from paid advertising. If we counted their in-house ads as opportunity cost marketing, then we would need to reduce the net revenue from advertising-supported media by the exact same amount. The end result would be a reclassification between types of 'free' media with no aggregate change. In order to avoid this problem, we will only count in-house ads which promote subscription content. In many cases, the same newspaper or cable show earns revenue from both subscribers and advertisers. When that is the case, we split in-house ads in proportion to the revenue share. For example, suppose that a cable network allocates 20% of its advertising slots to in-house ads and earns 50% of its revenue from subscriptions. We calculate that the opportunity cost of in-house ads is equal to 10% (20%*50%) of total advertising revenue.

The opportunity costs calculated above represent an upper bound. For movie theaters, cable networks and print media, we assume a perfectly competitive market. Because of that assumption, we can use the average price for sold advertising slots or movie theaters tickets to estimate the potential revenue from shifting in-house ads to the sold market. If perfect competition does not hold, then the estimated opportunity cost for in-house ads may be

[69] Movie studios receive a small amount of advertising revenue for showing trailers. So a portion of this category could be classified as out-of-pocket expenditures. We kept this category together for simplicity.

significantly lower. For freemium games, we assume that the production cost for premium items like extra lives is nearly zero. As a result, the entire revenue earned from in-app purchases can be allocated to the game development costs. In practice, Figure 2 shows that even the upper bound of opportunity cost marketing is much lower than the marketing expenditures tracked in Figure 1. Accordingly, adjusting our opportunity cost estimates has little aggregate effect.

Price Indexes for Marketing-Supported Information

In this paper draft, three of our price indexes are taken directly from our previous work on advertising-supported media (Nakamura, Samuels and Soloveichik 2016). That paper contains a detailed discussion of the time series used to construct our price indexes. To save space, we will not repeat it here. The last price index used is BEA's pre-existing price index for commercial and vocational schools. The methodology behind that index is described in BEA's published handbook at https://www.bea.gov/national/pdf/allchapters.pdf.

Quantity Indexes for Marketing Viewership

For print marketing, we calculate quantity indexes indirectly. We assume prices for print marketing viewership track the prices for print advertising viewership calculated in our previous work (Nakamura, Samuels and Soloveichik 2016). That paper contains a detailed discussion of time series used to construct the price index for print advertising viewership. To save space, we will not repeat it here. Similarly, our online marketing viewership quantity index is identical to the online advertising viewership quantity index calculated earlier.

For audio-visual marketing, our quantity index is based on the data collected earlier for advertising-supported media, but it is not identical. Both radio and television programs typically differentiate clearly between paid advertising slots and programs. As a result, it is possible to calculate a quantity index for advertising viewership alone. We use that quantity index in our paper on advertising-supported media. In contrast, neither radio nor television programs differentiate clearly between marketing-supported information, programs and advertising slots. Accordingly, it is not possible to calculate a quantity index for marketing viewership alone. In the absence of any other information, we use total viewership time as our quantity index.

For in-person marketing, our quantity index is based on trade show attendance. As described earlier, we rely on CEIR data indirectly. The CEIR attendance data is available for 2000-2015, 1987-2008 and 1968-1985. Between 1985 and 1987, we assume the same annual growth rate as between 1987 and 1988. Before 1968, we use print marketing viewership as a proxy variable.

Calculating Total Factor Productivity by Industry

It is often quite difficult to determine which industries are bartering marketing-supported information for marketing viewership. Unlike advertising-supported media, virtually all industries produce some marketing-supported information. In addition, most industries outsource a portion of their marketing to specialty industries like computer consultants. We have not been able to find any data tracking expenditures on marketing-supported information by industry or category. In this paper, we use OES data tracking employment for meeting and convention planners as a proxy for total expenditures on in-person marketing;[70] OES data tracking employment for computer related occupations as a proxy for total expenditures on online marketing; and OES data tracking advertising and creative occupations as a proxy for total expenditures on print and audio-visual marketing. In order to reduce the random variation, we combine all of the OES sample waves into one and use that as a snapshot of marketing-supported information output in 2009. Finally, we extrapolate expenditures on marketing-supported information from 1948 until 2014 based on pre-existing estimates of gross output by industry.

[70] This proxy works well for most categories and industries, but a few industries require adjustment. In order to protect respondent confidentiality, the OES sometimes suppresses employment counts or wage data. We used our best judgment to impute data for these suppressed observations. Most of the suppressed observations are relatively small, so aggregate totals are relatively similar if we drop the imputed observations.
In addition, we also adjusted industries where we felt the marketing-related occupations might be inaccurate.