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Outsourcing and the Rise in Services

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Abstract
This paper investigates the impact of outsourcing on sectoral reallocation in the U.S. over the period 1947-2007, and on the rise in services in particular. Roughly 40% of the growth of the service sector comes from professional and business services. This is an unusual industry as more than 90% of its output is an intermediate input to other firms, and it is where most of the service outsourcing activity is concentrated. These facts are essential to understanding the structure of the economy: professional and business services have experienced an almost fourfold increase in their forward linkage, the largest change in input-output linkages over the past 60 years. Using a simple gross output accounting framework, I calculate the contribution of the change in the composition of intermediates and their sourcing mode to the reallocation of employment across sectors. I find that the evolution of the input-output structure accounts for up to 33% of the increase in service employment, and professional and business services outsourcing alone contributes almost half of that amount.

Keywords: Structural transformation, outsourcing, professional and business services, input-output tables, intermediates
JEL Classifications: D57, L16, L24, L84, O14, O41, O51

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1 Introduction

The process of economic development is characterized by the reallocation of resources across the broad sectors of agriculture, manufacturing and services. As Kuznets noted in his Nobel Prize lecture, restricting attention to advanced stages of development, structural transformation coincides with the rise of the service sector and the decline of manufacturing.[1] In the U.S., the service sector (including government) today accounts for more than 83% of total employment, compared to 60% in 1947. In order to explain structural change in recent years, it is therefore key to understand the reasons behind the remarkable rise in services.

The literature on structural transformation has mainly focused on final demand channels. Yet final demand is not the only driver of the increase in services, as firms are in turn 'consumers' of goods and services through intermediate inputs. A closer look at the data reveals that a large share of the growth of the service sector is explained by industries for which final demand plays a relatively small role, namely professional and business services, finance and real estate. In particular, professional and business services account for roughly 40% of the total growth, both in terms of total GDP and total employment; when finance and real estate are added, these three industries account for 50% of the service sector growth in terms of employment and 94% in terms of GDP. Starting from this basic fact, this paper analyzes the production side of the economy and the role played by firms in shaping the reallocation of labor across sectors. I propose two unexplored channels that help explain the recent rise in services: changes in the composition of intermediates and their sourcing mode.

Intermediate goods account for roughly 50% of total gross output across a large number of countries (Jones, 2011b). However, a large intermediate multiplier is not sufficient per se to affect sectoral reallocation over time: some additional variation is needed. In this paper, I first provide novel evidence for the evolution of the input-output structure of the U.S. economy over the past 60 years. In particular, I show that the most important changes are related to service sectors that are intensive in the production of intermediates. For instance professional and business services have experienced an almost fourfold increase in their forward linkage, a measure of the interconnection of an industry to the rest of the economy through the supply of intermediate inputs. Second, by providing a simple gross output accounting framework that captures the full sectoral linkages of the economy, I show that changes in intermediate demand account for a significant share of the total reallocation of labor across sectors, improving the predictive power of a traditional value added model. Third, I quantify the contribution of service outsourcing to the rise of the service sector.

The strong empirical regularities unveiled by Kuznets have spurred a large body of literature, which can be divided into two main categories, depending on the explanation put forward to rationalize sectoral reallocation. The first explanation, often referred to as "utility-based" or "demand-based", highlights the role of different income elasticities for different goods and dates

[1] "The rate of structural transformation of the economy is high. Major aspects of structural change include the shift away from agriculture to non-agricultural pursuits and, recently, away from industry to services." Lecture to the memory of Alfred Nobel, December 11, 1971.

back to Engel.[2] The second explanation, labeled "technological" or "supply-side" and first proposed by Baumol (1967), rationalizes structural change drawing on the different rates of sectoral productivity growth and on standard homothetic preferences with a less than unitary elasticity of substitution between goods.[3]

Despite the extensive work on the subject, there is still no consensus on the empirical identification of the key economic forces that drive structural transformation, as argued by Herrendorf et al. (2013b). They show that the choice of consumer preferences is just an empirical issue and depends on how final consumption is measured. This is a key point of disagreement between the two streams of existing literature, as both mechanisms ultimately depend on the form of consumer preferences. Moreover Buera and Kaboski (2009) argue that the standard theories of structural change cannot account for the steep decline in manufacturing and rise in services in recent years, and for the large deviations between value-added shares and labor shares. This paper departs from the existing literature by analyzing the production side of the economy and proposing new channels that shape structural transformation and at the same time are unrelated to final demand.

Changes in the composition of intermediates are reflected in the structure of input-output tables. Despite the growing use of input-output data, there is no systematic evidence for the evolution of the structure of sectoral linkages over time.[4] Jones (2011b) compares the input-output structure of the U.S., Japan and China in 2000, and argues that they are not very different: they all display a sparse pattern with a strong diagonal (output of an industry used as intermediate input in the same industry) and similar intermediate multipliers. The main difference Jones points out is that business activities are less important in China, in that they are not as widely used as in Japan and in the U.S. I find the same difference for the U.S. over time. I show that the largest change in the structure of the input-output tables involves an increase in the use of services specializing in the production intermediates, especially by manufacturing industries. Professional and business services have experienced an almost fourfold increase in their forward linkage and the use of finance and real estate has also risen, albeit to a lesser extent, with their forward linkages increasing by 83% and 42%, respectively.

I study the changes in intermediate demand in a standard growth accounting framework with intermediate inputs as in Hulten (1978), expanded to capture the fully fledged input-output structure of the economy similar to Horvath (1998, 2000).[5] In this setting, not only

[2]This strand of the literature employs non-homothetic preferences to achieve non-unitary income elasticities. A non-exhaustive list of works in this area includes: Matsuyama (1992), Laitner (2000), Gollin et al. (2002), Caselli and Coleman II (2001), Restuccia et al. (2008) for two-sector models focusing on the movement of labor away from agriculture; Echevarria (1997) and Kongsamut et al. (2001) for three-sector models, where the latter authors propose a model that features both structural change and constant aggregate growth. Foellmi and Zweimüller (2008) also combine the Kaldor and Kuznets' facts in a model with hierarchic preferences.

[3]Two recent contributions that combine structural change and aggregate balanced growth are: Ngai and Pissarides (2007) in a standard three-sector model; and Acemoglu and Guerrieri (2008) in a two-sector model of high versus low capital intensive industries.

[4]Caliendo and Parro (2012), di Giovanni and Levchenko (2010), Johnson and Noguera (2012), and Jones (2011a,b) are some examples of recent works that use input-output data, but all for a given year. Acemoglu et al. (2012) look at the U.S. input-output tables for the benchmark years between 1972 and 2002 but focus on the empirical densities of the total intermediate input shares.

[5]Recent examples that employ a framework with intermediate inputs and full sectoral linkages include, among

do sectoral labor shares depend on consumption shares as in a standard value added model, but also on the input-output structure of the economy through the Leontief inverse matrix. Changes in intermediate demand therefore induce a reallocation of labor across sectors. When final demand is kept constant over time, the sole evolution of the input-output structure of the economy accounts for 33% of the total increase in service employment. Although demand-side factors are certainly important, this exercise quantifies the proposed channels in a neat and simple setting, which avoids confounding the results with the choice of data and parameters not specifically related to the forces under study. Then I allow final demand to evolve over time and show that the results are not wiped out by other channels previously discussed in the literature. In fact, accounting for intermediates improves a traditional value added model prediction for the share of services by 4.7 percentage points of total employment, an amount that corresponds to 21% of the actual increase in services over the period.

What drives the changes in the use of intermediates over time? I show that one of the key forces is outsourcing. The intuition is simple: if firms contract out part of their production processes, they will have to buy these inputs from external providers, and this change will be reflected in the data as an increase in the use of intermediates. In particular, if a manufacturing firm outsources part of its headquarter services, the intermediate use of services will increase because it is likely that these inputs will be purchased from firms specializing in services. The idea that outsourcing might drive structural transformation goes back to Fuchs (1968) but, to the best of my knowledge, it has never been formally tested in a model of structural transformation.[6] Herrendorf et al. (2013b) briefly discuss this idea, arguing that outsourcing is unlikely to play a major role. Although outsourcing alone certainly cannot explain the entire process of structural transformation, at the same time the data reveal that its impact can be sizable. In fact more than 90% of the output of professional and business services is used by firms, either as intermediate input or in the form of investment. Hence final demand plays essentially no role in the growth of an industry that accounts for almost half of the total rise of the service sector.

Given the high share of intermediate production and the high substitutability that characterize business services, it is common in the literature to identify the rise of this industry as an increase in outsourcing. I take a similar approach in this paper and improve on the literature by controlling for internal production. In principle input-output data do not clearly distinguish the boundary of the firm. However, in the case of business services, most of the internal production is classified in auxiliary units (headquarters), which can be excluded. I show that the increase in the demand of business services comes from transactions across the boundary of the firm, and is not matched by a parallel increase in internal production. I then quantify how much of the change in intermediate use is due to business services, thereby providing an estimate of the contribution of service outsourcing to the change of sectoral employment shares.[7] I do this

others, Ngai and Samaniego (2009) and Caliendo and Parro (2012).

[6] Fuchs points out that: "As an economy grows, there is some tendency for specialized firms to be organized to provide the business and professional services that were formerly taken care of within manufacturing and other goods-producing firms or were neglected."

[7] Given the very small role played by imported services in the change of the input-output structure of the economy over time, the adopted measure of outsourcing essentially coincides with domestic outsourcing.

performing a simple counter-factual exercise that fixes the demand of business services to their 1947 level and keeps it constant over time. I find that, had firms produced all their business services in-house, the service sector employment share would have been 3 percentage points smaller, which is equivalent to 14% of the total increase in the share of services.

There is much evidence that many other types of services have been outsourced over the same period, especially bearing in mind the very long time frame of the analysis. By focusing on business services only, I therefore take a conservative approach and provide a lower bound for the contribution of outsourcing to structural change. Yet I capture a large share of the total actual contribution. For instance I find that finance, despite having experienced an almost double increase in its forward linkage and having contributed to the recent rise of macroeconomic volatility as showed by Carvalho and Gabaix (2012), does not play a major role in the reallocation of labor across sectors. A potential concern is that final demand might drive the rise in business services indirectly, with firms increasing their use of services as a result of a shift in consumers' tastes. Yet an analysis of occupational data shows that, to a first approximation, the overall composition of business services has not changed over time, supporting the view of an organizational change with a reallocation of activities across the boundaries of the firms; and even where specific activities have increased their importance over time, final demand is unlikely to play a role in that change.

The paper is organized as follows. The next section discusses the main stylized facts on the rise of the service sector and critically assesses the measure of outsourcing used in the analysis. I then outline the accounting framework in Section 3, and present the main results of the paper in the following section. Section 5 shows that the results are robust to the inclusion of traditional final demand channels. Finally section 6 discusses potential determinants of outsourcing and Section 7 concludes. The details on the data and extra results are presented in the Appendix.

2 The Rise of the Service Sector in the U.S.

Over the past 60 years, structural transformation in developed countries has mostly coincided with the impressive rise in the share of services. For instance, in the U.S., the share of services in total GDP has risen to 80% in 2007 from 60% in 1947, as displayed in Figure 1a (left-hand side axis). This is a well-known fact but what has not been sufficiently appreciated in the literature is that this growth is almost entirely explained by three industries only, namely Professional and Business Services (hereafter PBS), Finance and Real Estate.[8] Figure 1a also shows the total growth of the service sector and its components (right-hand side axis); PBS, Finance and Real Estate account for a growth of 18.8 percentage points of GDP, versus a total growth of 20.1 points. Adding Health Care, these four industries account for more than the total growth, meaning that other service sectors have seen their shares decreasing. PBS have increased their share in total GDP by 8.8 percentage points, accounting for 43.6% of the total growth of the

[8]Many authors have discussed the important contribution of PBS to job growth; see for instance Abramovsky and Griffith (2006), Abramovsky et al. (2004) for the U.K.; Goodman and Steadman (2002), and Yuskavage et al. (2006) for the U.S. But, to the best of my knowledge, no previous work has attempted to quantify the impact of PBS outsourcing on structural transformation.

entire service sector, the biggest contribution among all industries. The same graph drawn for employment is revealing (Figure 1b). PBS have grown by 9.2 percentage points of total employment, roughly the same amount in terms of GDP. On the other hand, Finance and Real Estate combined have increased their share in total employment by only 2.3 percentage points, versus a combined increase of 10.1 in terms of GDP. This highlights the asymmetric contribution of these industries; Finance and Real Estate contributed a lot in terms of value added but not that much in terms of employment. Given the importance of PBS, the rest of this section will investigate the implications of their rise on the structure of the economy and the determinants of the rise itself, which can be ascribed mainly to outsourcing.

2.1 The Change in the Input-Output Structure of the U.S. Economy

The PBS industry is unusual. In fact, in 2002 roughly 83% of its output was sold to firms as intermediate inputs compared to 44% for the economy as a whole; an additional 8% of its output was used for investment, while final consumption accounted for just 7%. One of the implications of these characteristics is that the remarkable growth in the share of PBS is reflected in a parallel change of the Input-Output (I-O, hereafter) structure of the economy; a fact that has been overlooked in the literature despite the widespread use of I-O data. Jones (2011b) asks the question how much the I-O structure of an economy differs across countries; his answer is "not much". Looking at the I-O matrices for the U.S., Japan and China in 2000, he notices that they all display a sparse pattern with a strong diagonal and just a few inputs that are widely used by all other sectors. The main difference is that business activities are less important in China: they are not as widely used as in Japan and in the U.S. A very similar picture holds true for the U.S. over time. Figure 2 shows the evolution of the total requirements table from 1947 to 2002.[9] The main change is the significant increase in the use of PBS (sector 73) in the production of all other goods, and to a smaller extent the increase in the use of Finance (sector 70) and Real Estate (sector 71), other two industries for which final demand plays a relatively small role. The horizontal line corresponding to PBS was almost absent in 1947 but becomes more and more visible over time. This change is clearly depicted in Figure 3a that shows, for all commodities in the economy, the increase in the share of PBS in the total requirements.

The horizontal sum of the coefficients in the total requirements table is usually referred to as forward linkage, a measure of the interconnection of a sector to all other sectors through the supply of intermediate inputs. In light of the insights provided by Acemoglu et al. (2012), the sharp rise of the PBS forward linkage implies that this sector has greatly increased its influence on the rest of the economy and any shock to it will now propagate directly to a large part of the economy. Figure 3b shows, for some selected industries, the evolution of the forward linkage divided by the total number of sectors; in Acemoglu et al.'s (2012) setting, this quantity essentially corresponds to the elements of what they define "influence vector" (up to the labor share). The figure confirms that PBS have experienced a sharp increase in their forward linkage,

[9]The total requirement table shows for each commodity at the bottom of the table the inputs required, both directly and indirectly, from all industries in the economy to produce a dollar of output. The strong diagonal in this case is obtained by construction.

overcoming sectors with a traditionally high forward linkage like transportation. PBS have in fact become the sector with the highest influence on the rest of the economy, considerably higher than the influence of the average or median sector. The forward linkage of the finance sector (sector 70) has also increased, although more moderately compared to PBS. This fact is in line with the results of Carvalho and Gabaix (2012), who show that the recent rise of macroeconomic volatility is largely explained by the rise of finance, or more specifically of its Domar weight. Their results are suggestive for the impact that the PBS sector might have on aggregate outcomes. Finally, this change is not a specific characteristic of the U.S economy; in fact, in ongoing research, I show that the same pattern holds true for most OECD countries.[10]

The PBS intrinsic nature of being mainly specialized in the production of intermediate inputs calls for an investigation of the role of firms in driving the rise of the PBS share in total employment. In particular, changes in intermediate demand or managerial decisions like producing in-house or outsourcing affect the share of services in total intermediates, increasing the use of PBS. These channels remain unexplored in the literature of structural change, given the focus on final demand. PBS are the industry where most of the service outsourcing takes place; it is very common in the literature to identify the rise in use of PBS as an increase in outsourcing, and the same approach is taken here. There could be other explanations though: an overall increase in service activity both inside and outside the firm or, more simply, problems in precisely identifying the boundary of the firm in the data. The next sub-section provides evidence showing that the rise in the use of PBS is mainly driven by outsourcing.

2.2 The Rise in PBS and Outsourcing

The identification of the rise in PBS use with a rise in outsourcing is quite common in the literature[11], but this assumption could raise some concern since the I-O data do not clearly distinguish the boundary of the firm. The data are collected at the establishment level; hence, all the in-house services provided by the headquarters or by separate service-providing units will be accounted within services, and the increase of PBS use could just be an increase in the use of services produced by the same firm and not purchased from the market. Yet, a deeper analysis of industry employment data shows that most of the transactions take place across the boundaries of the firms, and they are not matched by a parallel increase of services produced inside the firms. Mainly using occupational data, Section 6 will provide further insights and evidence on the potential mechanisms that drive the rise in outsourcing.

Industry employment data offer two main arguments in support of the idea that the increase in PBS mostly coincides with an increase in service outsourcing. First of all, it is true that the data are collected at the establishment level, but service reporting units are classified within services only under the new NAICS classification, which was adopted in 1997. This means that for all previous years, under the SIC classification, the establishments providing support services

[10] See Berlingieri (2013b). In the case of the U.K., Oulton (2001) reports a sharp increase of the Domar weight (the ratio of sectoral gross output to aggregate value added) for the combined sector finance and business services over the period 1979-1995.

[11] Among others, see Abraham and Taylor (1996), Fixler and Siegel (1999), ten Raa and Wolff (2001) and Abramovsky and Griffith (2006).

were classified on the basis of the industry of the establishment they were serving, and not their primary activity.[12] Hence, all the establishments providing support services to manufacturing firms were classified within manufacturing, and the increase of PBS use by these firms necessarily coincided with transactions outside the boundary of the firm. Secondly, the share of value added or employment accounted by auxiliary units is remarkably constant over time, and it cannot explain the increase in the share of PBS. Figure 4 shows the share of PBS in GDP and in total employment over time, according to the two different classifications. It is evident that their difference does not vary much over time. In fact, when the sub-sector corresponding to auxiliary establishments is removed from the NAICS data in Figure 4b, the series look extremely similar under the two different classifications.

In other words, one could think of the creation of auxiliary units as a temporary phase in the life-cycle of a company. As pointed out by Young and Triplett (1996), it is possible to outline four main phases in the evolution of a firm that eventually lead to service outsourcing. Initially, services are performed internally at the manufacturing plant. The CEO sits in the back of the production site performing its accounting, billing, marketing and other services. No separate unit exists and no separate records are kept, hence the production of these services does not show up in the data. At the second stage, the company becomes bigger, with increased specialization of economic functions, and it sets up an accounting department. But still, no separate records are kept, and intra-company users are not charged for these services. At the third stage, the company has grown further, it has become a large multi-establishment enterprise. The company has established a separate accounting and marketing unit. This separate auxiliary unit may bill other parts of the enterprise for its services, or can even sell services to other enterprises. It is at this stage that the two classifications differ. Under SIC, this new auxiliary unit is classified according to the industry of the establishment it serves, that is manufacturing; instead, under NAICS, the unit is classified on the basis of its primary activity, which is PBS. At the last stage, increased economic specialization leads the enterprise to outsource its accounting and marketing functions to an external provider. Therefore both classifications will account for these activities within PBS, and the services bought by the manufacturing enterprise will show up as an increase of PBS intermediate use.

The same sharp conclusion cannot be drawn in the case of I-O data, or at least not entirely. In fact, although the Bureau of Economic Analysis (BEA) constructs I-O tables using the same definition of industries, it applies some modifications in the case of commodities.[13] As for industry data, the BEA classifies establishments according to their primary activity; occasionally, however, it identifies some secondary products and re-classifies them into other commodities, in contrast with the Economic Census that classifies everything in the industry of the primary product. This re-classification mostly affects small single establishment firms with one single

[12] These establishments were called auxiliaries units in the SIC nomenclature. For further details see the U.S. Census Bureau Clarification Memorandum (www.census.gov/epcd/www/naimemo3.htm) and Office of Management and Budget (1987).

[13] The definition of industries corresponds to the SIC or NAICS definition when the standard tables, that is before industry redefinitions, are used. See Appendix B.2.

secondary product (but large enough to keep separate records).[14] In fact, whenever two or more support activities cross six-digit NAICS industries, they are treated as auxiliary units and are already classified in sector 55 (Management of Companies and Enterprises) under NAICS. This is the case for medium and large multi-establishment enterprises that usually internally produce more than one support activity.

Since auxiliary units will be completely excluded in the main results of the paper, the problem of internal transactions will be ruled out for medium to large enterprises, and it only remains for those small firms whose secondary products are re-classified by the BEA from manufacturing to PBS services. These transactions are small in absolute terms and they are unlikely to drive the results. This statement is consistent with the evidence for goods provided by Atalay et al. (2012) for the domestic operations of U.S. multi-plants firms, and by Ramondo et al. (2011) for intra-firm trade of U.S. multinational firms. In fact both papers show that shipments between establishments owned by the same firm are surprisingly low and extremely skewed towards towards large plants: the internal shipments of the median plant are zero or very low in both studies. Hence, by controlling for the internal transactions of medium and large plants, I am likely to capture the vast majority of internal service production recorded in the data.[15]

Moreover, there are two extra reasons to believe that the results will provide a robust estimate for outsourcing. First, I only consider PBS outsourcing, while there is much evidence that many other types of services have been outsourced, especially bearing in mind the long time frame of the analysis: transportation and warehousing are good examples.[16] Even though a small fraction of the change in PBS use accounted as outsourcing might come from internal transactions, many other types of services are not included, possibly causing an even larger bias in the opposite direction. I do not include them in the baseline results to be more conservative. In fact other services like transportation and wholesale trade are not classified within auxiliary units, hence contrary to PBS I would not be able to properly control for internal transactions. The second reason is that only the difference in service outsourcing will matter in the analysis. If the internal production of secondary products stays constant in relative terms over time, these internal transactions cannot possibly drive the result. The constant share accounted by auxiliary units, as shown in Figure 4, confirms this view.

This fact also provides evidence that the increase in the intermediate use of services is not a simple progressive shift towards service activity: the increase of purchased services is not matched by an equal increase of services internally produced. Or, to put it another way,

[14] An example is a small newspaper publisher that produces advertising as its single secondary product. For further details see Horowitz and Planting (2006).

[15] Appendix B.2 shows that the industry redefinitions performed by the BEA have a negligible impact on the magnitude of the results. It is reasonable to assume that the commodity re-classifications, which unfortunately cannot be observed, will have a similar small effect. Moreover any re-classification that takes place within manufacturing will not matter for the analysis; only the re-classifications from manufacturing to services, and PBS in particular, are a source of concern. The only examples provided by the BEA that fall into this category are advertising and data processing services.

[16] For instance, as reported by Alvarenga and Malmierca (2010), most companies managed the physical distribution of their own products in the '50s. Then two new companies, FedEx and DHL, together with UPS, started specializing only in that and quickly their logistical skills significantly eclipsed those of many manufacturing companies. What was done in-house in the '50s now is seen as a function best performed by external providers.

even if firms started using more services for technological or other motives, they decided to purchase them from the market rather than produce them in-house. PBS are intrinsically very substitutable: for instance, a firm always has the option to employ an accountant or an engineer in-house instead of buying accounting and engineering services from specialized firms. Whether a firm today needs more accounting inputs due to the more complex regulatory environment or the firm is simply outsourcing the very same tasks it used to produce with internal employees, it is not of primary importance for the quantitative analysis performed in this paper. Despite the option of internal production the firm decided to purchase the input from the market, so whatever the fundamental reason behind this choice may be, what is key in order to calculate the impact of outsourcing on the reallocation of labor across sectors is to correctly identify market transactions.[17] Of course understanding why firms are outsourcing more services today is another interesting - albeit difficult - question to answer; the main problem is that it is hard to observe what a firm produces in-house. Despite a full analysis being beyond the scope of the paper, Section 6 will try to shed some light on this important issue and show that, to a first approximation, the overall composition of business services has not changed over time.

Overall, the analysis of industry level data supports the view that most of the increase in the share of PBS has been driven by outsourcing. Firms, and manufacturing firms in particular, have increasingly bought services from the market instead of producing them in-house, causing a reallocation of resources across sectors. Herrendorf et al. (2013b) briefly discuss the role of outsourcing in shaping structural transformation; they claim that is not a major driving force arguing that PBS account for less than half of the increase in services and that a substantial share of PBS might reflect purchases directly made by consumers. Yet final demand accounts for just 7% of total PBS output and, according to their findings, PBS account for 41.5% of the total increase in services. Even though structural transformation cannot be entirely driven by outsourcing, at the same time the data reveal that its impact can be sizable. A back-of-the-envelope calculation using their results shows that, once the share of intermediates in Finance and Real Estate is also included, more than 53% of the total change in services comes from an increase in the use of intermediates.[18] Firms can therefore play an important role in driving structural transformation, and managerial decisions like outsourcing are likely to have a sizable impact.

3 A Simple Gross Output Accounting Framework

I use a simple accounting framework in order to quantify the contribution of the evolution of sectoral linkages, and of outsourcing in particular, to the reallocation of employment across sectors. The framework builds on standard growth accounting with intermediate inputs, widely

[17] The definition of outsourcing is standard; in Helpman's (2006) words: "outsourcing means the acquisition of an intermediate input or service from an unaffiliated supplier".

[18] This result is simply obtained by summing up the contributions of Finance & Real Estate and PBS to the total increase in services, 48.8% and 41.5% respectively, weighted by the average share of intermediates in their output, which is 39% for the former and 82% for the latter. If owner-occupied dwellings are excluded, the share of intermediates in Finance & Real Estate output increases to 61% (in 2002) and the overall contribution to 64%.

used in the productivity literature since Hulten (1978), and expanded to capture the fully fledged I-O structure of the economy as in the work of Horvath (1998, 2000). The main aim of this study is to perform an accounting exercise and not to explain why firms are changing their sourcing behavior over time.[19] The changes in the I-O structure of the economy are therefore taken as given and simply regarded as exogenous changes in the production function. In this respect, the approach is close in spirit to the work of Carvalho and Gabaix (2012), who take the change of the Domar weights as given. The model is in a closed economy. The main reason for this choice is that, although the importance of imported services has risen in recent years, their magnitude is still very low, accounting for just 2.7% of total PBS in 2004 as reported by Yuskavage et al. (2006). This fact is also confirmed by the results of this paper, which find that imported services play a very small role in the change of the I-O structure of the economy over time. Therefore the measure of outsourcing considered in this paper almost coincides with domestic outsourcing, given that the international dimension still plays a small role in the case of services.

3.1 The Economic Environment

3.1.1 Technology and Production

There is an arbitrary number of J sectors in the economy, even though in the baseline case I will consider just three aggregate sectors: agriculture, manufacturing and services. The production function for the good in sector j is given by:

$$Y_j = A_j L_j^{\beta_j} \left[\prod_{k=1}^{J} M_{kj}^{\gamma_{kj}} \right]^{1-\beta_j} \tag{1}$$

where A_j is the level of productivity, L_j is the amount of labor and $\beta_j \geq 0$ is the share of value added in sector j. M_{kj} is the amount of intermediate good from sector k used to produce the good in sector j. Note that the production function employs intermediate goods potentially from all sectors; $\gamma_{kj} \geq 0$ is the share of intermediates from sector k and such that $\sum_{k=1}^{J} \gamma_{kj} = 1$ for any sector j. There is no capital in the model, so there is no dynamics and the equilibrium is simply a sequence of static economies. Hence time subscripts are not reported unless explicitly needed.

The Cobb-Douglas formulation for the production of gross output is quite common in growth accounting.[20] It is assumed here to keep the framework as standard as possible and, most importantly, because it can be very easily and intuitively calibrated in the data. On the other hand, the intuition for outsourcing in its starkest form is a pure relabeling effect, according to which the same tasks previously performed inside the firm are simply outsourced to external providers. If the new supplier is classified in a different sector, for instance a manufacturing

[19] In order to unveil the causes of this process, it is key to understand the main reasons why firms have started outsourcing more services over time. Section 6 provides some insights on this important issue, but a full response to this question is beyond the scope of this paper and it is left for future research. See Berlingieri (2013a).

[20] Ngai and Pissarides (2007) show that a Cobb-Douglas functional form is needed in order to obtain a balanced growth path. Herrendorf et al. (2013a) find that a Cobb-Douglas production function well captures US postwar structural transformation, and even more so in a gross output framework like the present one.

firm that contracts out its accounting to a specialized service provider, this will bring about a reallocation of resources across sectors. Under this interpretation, the outsourced task is considered as essentially the same, regardless whether it is produced inside or outside the firm.[21] Therefore the Cobb-Douglas formulation is not the ideal one, as one would think of those tasks as almost perfectly substitutable. Nevertheless, for the reasons just outlined, the production function is assumed to be Cobb-Douglas and the perfect substitutability is imposed through some simple counterfactual exercises, which are described at the end of this section.

Each sectoral good can be either consumed or used as an intermediate in the production of the other goods according to (1), so the market clearing for each sector requires:

$$Y_j = C_j + \sum_{k=1}^{J} M_{jk} \tag{2}$$

where C_j is consumption of good j. Households are endowed with L units of labor that supply inelastically at the rental price w. All factor and goods markets are characterized by perfect competition and labor is perfectly mobile across sectors. Producers of each good solve the following problem:

$$\min_{L_j, \{M_{kj}\}_{k=1}^{J}} wL_j + \sum_{k=1}^{J} P_k M_{kj} \qquad \text{s.t.} \qquad A_j L_j^{\beta_j} \left[\prod_{k=1}^{J} M_{kj}^{\gamma_{kj}}\right]^{1-\beta_j} \geq Y_j \tag{3}$$

The conditional factor demands are:

$$L_j = \beta_j \frac{P_j Y_j}{w} \tag{4}$$

$$M_{kj} = \gamma_{kj}(1-\beta_j)\frac{P_j Y_j}{P_k} \tag{5}$$

3.1.2 Sectoral Labor (Re-)Allocation

Using the good market clearing condition in (2) and the equilibrium demand for intermediates according to (5), it is possible to get an expression for the value of gross output for each sector j as follows:

$$P_j Y_j = P_j C_j + P_j \sum_{k=1}^{J} M_{jk} = P_j C_j + \sum_{k=1}^{J} \gamma_{jk}(1-\beta_k) P_k Y_k \tag{6}$$

Using the equilibrium demand for labor according to (4), the labor share l_j of each sector can be written as follows:

$$l_j = \frac{L_j}{L} = \frac{\beta_j P_j Y_j}{wL} = \beta_j X_j + \beta_j \sum_{k=1}^{J} \gamma_{jk} \left(1-\beta_k\right) \frac{P_k Y_k}{wL} \tag{7}$$

[21] Notice that this very stark interpretation is not the only explanation; outsourcing can in fact take several forms. For instance outsourcing could entail the substitution of an old superseded task with a new more technologically advanced one. In this sense outsourcing could be a way of accessing new technologies that would be too costly to be produced in-house, as Bartel et al. (2012) have argued. See Section 6.

where $X_j = \frac{P_j C_j}{wL}$ is the consumption expenditure share of sector j, or, using a terminology more consistent with the empirical application, the final uses expenditure share.[22] Therefore the labor shares reflect the presence of intermediates and the interrelation of sectors. In fact, the labor share of sector j depends on the value of gross output of all other sectors, their share of intermediates in gross output $(1-\beta_k)$, and the share of the intermediate good from sector j in total intermediates of all other sectors $\{\gamma_{jk}\}_{k=1}^{J}$.

Note that equation (6) forms a system of J equations; it is convenient to re-write and solve it using matrix algebra as follows:

$$\mathbf{Y} = \Omega^{-1}\mathbf{C} \tag{8}$$

where:

$$\mathbf{Y} = \begin{pmatrix} P_1 Y_1 \\ \vdots \\ P_J Y_J \end{pmatrix} \quad \mathbf{C} = \begin{pmatrix} P_1 C_1 \\ \vdots \\ P_J C_J \end{pmatrix} \quad \Omega = \begin{pmatrix} 1-\gamma_{11}(1-\beta_1) & \cdots & -\gamma_{1J}(1-\beta_J) \\ \vdots & \ddots & \vdots \\ -\gamma_{J1}(1-\beta_1) & \cdots & 1-\gamma_{JJ}(1-\beta_J) \end{pmatrix} \tag{9}$$

The matrix Ω is a J by J matrix and it can be expressed as $\Omega = I - D$, where I is an identity matrix and D is a industry-by-industry direct requirement matrix with a generic element defined as $d_{j,k} = \gamma_{jk}(1-\beta_k)$. Ω^{-1} is referred to as the total requirements table, or the Leontief inverse matrix, and can be directly obtained from I-O data. Having solved for gross output, the vector of labor shares is obtained as follows:

$$\boldsymbol{l} = \frac{1}{wL}\boldsymbol{\beta}\mathbf{Y} = \boldsymbol{\beta}\frac{\Omega^{-1}\mathbf{C}}{wL} = \boldsymbol{\beta}\Omega^{-1}\mathbf{X} \tag{10}$$

where:

$$\boldsymbol{l} = \begin{pmatrix} l_1 \\ \vdots \\ l_J \end{pmatrix} \quad \boldsymbol{\beta} = \begin{pmatrix} \beta_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \beta_J \end{pmatrix} \quad \mathbf{X} = \begin{pmatrix} X_1 \\ \vdots \\ X_J \end{pmatrix} \tag{11}$$

Therefore the labor shares differ from consumption expenditure shares due to the fully fledged I-O structure of the economy, captured by the total requirement table. The labor share in each sector is, in general, a function of the consumption share of all other sectors.

Introducing time subscripts, equation (10) can be re-written as:

$$\boldsymbol{l}_t = \boldsymbol{\beta}_t \Omega_t^{-1} \mathbf{X}_t \tag{12}$$

The sectoral labor shares can evolve for two main reasons: either because of changes in final uses, $\mathbf{X}_t$, as the literature on structural transformation has highlighted so far; or because the I-O structure of the economy changes over time. Note that the latter channel can affect employment shares in isolation, even if consumption expenditure shares do not change. This is precisely what I do in the main results of the paper: I keep final uses constant and simply evaluate the

[22] Only final consumption is explicitly modeled, but in the empirical implementation other final uses are considered as well, like government consumption and investment. Final uses would therefore be the appropriate terminology. Nevertheless, the two terms are used interchangeably in the rest of the paper.

impact of the evolution of the I-O structure on the sectoral labor shares taking the matrices $\boldsymbol{\beta_t}$ and Ω_t from the data.[23] Then, as a robustness check, I allow for consumption shares to vary over time and show that the main results are not wiped out by the standard channels proposed in the literature. To this purpose preferences will be introduced in Section 5.

3.2 Accounting for Outsourcing: Three Simple Counterfactual Exercises

In order to quantify the contribution of outsourcing to structural change, I perform three counterfactual exercises. The first one consists in fixing the I-O coefficients for manufacturing to their 1947 level, which implies taking the values for the elements of the direct requirement matrix $\{d_{j,m}\}_{j=1}^{J}$ in 1947 and keeping them fixed over time. This exercise shows what would have happened to sectoral employment shares, had manufacturing firms not changed their intermediate demand over time. In the data, the importance of services in the total intermediates of the manufacturing sector ($d_{s,m}$) has strongly risen over time. Therefore fixing this coefficient to its 1947 level implies a lower labor share for the service sector, as equation (7) shows. The difference with the predictions obtained allowing for the full change in the I-O structure can be regarded as an upper bound for the contribution of outsourcing to sectoral reallocation. It would in fact correspond to assuming the whole increase in the use of service intermediates by manufacturing firms as coming from outsourcing. Not only are PBS included, but all other possible types of services like transportation, wholesale trade, health care, government inputs, etc... Although slightly overstretched, this is not totally implausible, as outsourcing is indeed observed even outside the PBS industry; finance, transportation and warehousing are all good examples of services that have been increasingly outsourced over time.[24] The second and third exercises are very similar; instead of fixing the direct requirements coefficients from all other sectors, only the share of inputs coming from PBS and the one coming from Finance are fixed, one at a time. Table 1 summarizes the exercises.

Table 1: Counterfactual Exercises

1: No Service Outsourcing	2: No PBS Outsourcing	3: No Finance Outsourcing
$d^t_{j,m} = d^{1947}_{j,m} \quad \forall j \in J$	$d^t_{PBS,m} = d^{1947}_{PBS,m}$	$d^t_{F,m} = d^{1947}_{F,m}$

The counterfactual corresponding to fixing the share of PBS inputs is the main focus of the paper; it answers the question of what would have happened if the share of PBS intermediate inputs to manufacturing had been fixed at its 1947 level and all PBS had been produced internally within manufacturing. Of course this exercise is correct only if the rise in PBS use comes from market transactions outside the boundary of the firm, otherwise it would not be possible to identify the result of this counterfactual as the contribution of outsourcing. Due to the reclassifications performed by the BEA, it is not possible to completely rule out the eventuality that a few transactions may come from establishments within the same firm. But, as already

[23] This is obviously not possible in a value added model: if the share of intermediates is zero in all sectors, the matrix Ω is an identity matrix and the labor shares coincide with the final uses shares: $\boldsymbol{l}_t = \mathbf{X}_t$ if $\beta_j = 1, \forall j \in J$.

[24] See footnote 16.

noted in Section 2.2, this problem only affects those small firms whose secondary products are re-classified from manufacturing to PBS services by the BEA. As for the case of redefinitions discussed in Appendix B.2, it is very unlikely that these re-classifications can have a big impact on the results. Moreover, as it is clear from the case of transportation, outsourcing also takes place in other sectors within services, especially because the focus is on the total change since 1947 and it is well documented that many of other types of services were performed internally at the beginning of the period. All in all, the contribution of PBS outsourcing is a reasonable estimate and possibly a lower bound for the overall contribution of service outsourcing.

4 Sectoral Reallocation in the U.S., 1948-2002

I use the accounting framework outlined in the previous section to predict structural transformation in the U.S. The advantage of using U.S. data is the very long time span; I-O tables are in fact available dating from 1947. Hence, compared to other countries, it is possible to investigate sectoral reallocation over a time horizon that is long enough to display the clear pattern of structural change. This section shows that it is possible to keep the final uses expenditure shares constant and still get a positive sectoral reallocation, by allowing the I-O structure of the economy to change over time. By shutting down the final demand channel, the only driving forces come from the production side. This setting is therefore a neat environment in which to investigate the role played by firms in shaping the reallocation of labor across sectors, and in particular quantify the contribution of changes in the composition of intermediates and their sourcing mode.

4.1 Calibration

Following most of the literature on structural transformation, I consider three sectors in the baseline case: agriculture, manufacturing and services; hence $J = 3$ and $j \in \{a, m, s\}$. This choice implies that all the total requirements tables have to be aggregated up to three sectors only.[25] I calibrate final uses to match the employment shares in 1948, the first year for which employment data are available. Inverting equation (12) it is possible to get the final uses shares from the employment shares according to:

$$\mathbf{X}_t = \Omega_t \boldsymbol{\beta}_t^{-1} \boldsymbol{l}_t \tag{13}$$

This is the only step required to predict the evolution of labor shares when the contribution of outsourcing and of the evolution of sectoral linkages are analyzed in isolation. In fact, by keeping final uses shares constant over time, I only need data on Ω_t and $\boldsymbol{\beta}_t$ to predict labor shares according to (12).[26]

[25] I consider a more disaggregated level only for the counterfactual exercises, in order to account for the specific PBS and finance shares.

[26] These matrices are directly available for all benchmark years, while I use interpolated values for all other years. Further details on the data and on the methodology are contained in the Appendix.

Armed with data from the I-O tables, I then predict employment shares until 2002. In recent years, the I-O tables are available annually, not just for the benchmark years; hence the analysis can be extended until 2007 and not just until 2002, the last benchmark year. However, some caution in interpreting the results is needed. In fact, the annual tables are computed using more aggregate data and they do not match the statistical quality of tables in benchmark years. In particular, the intermediate inputs at the detail level are estimated assuming the industry technology to be constant, undermining the precise aim of this study. The results are therefore relegated to Appendix B.1.

4.2 Results and Counterfactuals

4.2.1 Predicting Sectoral Reallocation: the Role of the I-O Change

The results in this section answer the question of how much of the total labor reallocation can be explained by the change in the I-O structure of the economy alone. Figure 5a shows the results of the exercise. The variation in the sectoral linkages of the U.S. economy is indeed capable of capturing a sizable amount of the overall labor reallocation across sectors. By omitting all other possible channels, the present accounting framework clearly falls short of the actual data, but the predictive power is substantial, considering the simplicity of the exercise. As shown in Table 2, the increase in the services share is equal to 10.35 percentage points of total employment until 2002, almost half of the actual change. The result for agriculture is noteworthy; the sole variation in the I-O linkages accounts for 82% of the total drop in the employment share of this sector.

Table 2: Predicted vs. Actual Changes in Employment Shares

Sector	Data	Prediction	Ratio
Agriculture	-3.99	-3.28	82%
Manufacturing	-18.46	-7.07	38%
Services	22.45	10.35	46%

Note: The actual and predicted changes in the employment share are expressed as percentage points of total employment. The predicted changes are obtained using the proposed Gross Output framework. Period: 1948-2002.

Looking at the evolution of the prediction over time, it is evident that it does not increase linearly over time. Even though the changes in I-O linkages drive the result in the right direction, there are other forces that counterbalance this effect. One of these forces is the change in β_j, the sectoral share of value added in gross output; a fall of this share implies that an industry depends more on intermediate inputs from other sectors, hence its overall weight in GDP and in total employment is reduced. For instance, the service sector has experienced a decrease of β_s from 67% to 63%; in particular, this share rose until 1972 to 72% and then fell sharply until 1987. This fact explains why accounting for intermediates does not capture much of the change during the 1972-1987 period. In recent years, the predictive power of the gross output framework clearly improves. There are two main reasons for this; first the fall in β_s has been less pronounced, and second it is precisely during this period that the forces that are the focus

of this study really take off. In particular outsourcing has increased much more sharply during the second half of the analyzed period, as already shown in Figure 4. The share of PBS in total employment rose from 2.2% in 1948 to 11.2% in 2007, but the growth was uneven: 2.8 percentage points accrued between 1948 and 1977, while the increase in the 1977-2007 period was 6.2 percentage points, more than twice as large as the first half.

4.2.2 The Rise in Services: the Role of Outsourcing

The other main goal of this study is to quantify the impact of outsourcing on labor reallocation, and on the rise in services in particular. This goal is achieved through the three counterfactual exercises described in Section 3.2. Table 3 summarizes the results. The overall estimates for the baseline case are again displayed: the current accounting framework can explain an increase of 10.35 percentage points in the employment share of services. When the first counterfactual experiment is performed, namely when all I-O coefficients for manufacturing are kept constant to their 1947 level, the prediction drops to 4.01 percentage points, 39% of the value for the baseline case. This result implies that outsourcing could explain 61% of the total prediction obtained in the current framework, in the admittedly far-stretched case that the entire observed change in the shares of intermediate use was coming from outsourcing. Still, this constitutes a useful upper bound for the quantity of interest.

Table 3: Effect of Outsourcing on the Service Employment Share

Counterfactual	Predicted Change	Ratio to Baseline	Diff. wrt Baseline
Baseline	10.35	100%	0.00
1: No Service Outsourcing	4.01	39%	6.34
2: No PBS Outsourcing	6.38	62%	3.97
3: No Finance Outsourcing	10.27	99%	0.08

Note: The predicted change and the difference with respect to the baseline setting are expressed in percentage points of total employment. Period: 1948-2002.

Instead when only the PBS share is fixed to its 1947 level, the prediction drops to 6.38 percentage points, 62% of the value for the baseline case. Hence PBS outsourcing accounts for 38% of the prediction generated by the model, which corresponds to an absolute change of 3.97 percentage points, or 18% of the total increase in service employment. This is not a negligible contribution considering that it is considerably more than half of the upper bound and that other types of services are subject to outsourcing, not only PBS. On the other hand, Finance does not seem to contribute much to structural transformation. When the intermediate share of financial services is fixed at its 1947 level, the prediction almost does not move: it drops to 10.27 percentage points, a mere 1% less than in the baseline case.[27]

[27] In results not shown, I perform another exercise in order to investigate the importance of imported services. The results confirm those already shown by Yuskavage et al. (2006); although the importance of imported services has risen in recent years, their magnitude is still very low, accounting for just 2.7% of total PBS in 2004. Therefore adding non-comparable imports, where most of PBS are concentrated, does not affect the contribution of outsourcing by much.

4.2.3 Correcting for the Classification Change

A potential problem with the results presented in the previous section comes from the changes in the classification over time. In fact, while the data for employment and GDP are based on the NAICS classification over the whole period, the data for I-O tables are not. In particular the classification changes in 1997 and, in all previous years, I-O tables are constructed according to the SIC classification. Given that the study is performed at a quite aggregate level, considering three sectors only, most of the changes are not a source of concern because they take place within each sector. Unfortunately there are two major changes that can affect the results: the treatment of publishing and the treatment of auxiliary units. Both were classified within manufacturing under SIC, but they are now classified within services under NAICS; this change causes a jump of the data in 1997. In the case of publishing one might argue that the intrinsic characteristics of the activities in the industry have truly shifted over time, from a pure manufacturing task to a more complex, diversified and service oriented business. Hence, if that was true it would be even more correct not to adjust the data in order to pick up this transformation. In fact, the analysis focuses on the change over the entire period, so it is not really important to determine exactly when this shift took place, and even a gradual change would not invalidate the results. Instead the treatment of auxiliary units is more problematic because, as already noted in Section 2.2, they are now classified within PBS, while they were in manufacturing under SIC. Hence the change in the classification of this sector in 1997 may cause problems for the quantification of the contribution of PBS outsourcing.

In order to avoid these issues, I rectify the I-O data after 1997 to keep these two sectors within manufacturing. This adjustment also solves most of the concerns with the measure of outsourcing. Auxiliary units are in fact those establishments dedicated to services within a firm; by excluding this sector, the vast majority of the internal transactions is eliminated. Unfortunately I cannot perform this adjustment in an ideal way. Auxiliary units are classified within sector 55 of NAICS, namely "Management of Companies and Enterprises". This sector is composed of three sub-sectors: "Corporate, Subsidiary, and Regional Managing Offices" (551114); "Offices of Bank Holding Companies" (551111); and "Offices of Other Holding Companies" (551112). The first sub-sector was moved from manufacturing to PBS services but the last two were not, in fact they were already classified within services under SIC as well. The trouble is that I-O data are not disaggregated enough to distinguish these three sub-sectors, hence by re-classifying the entire sector within manufacturing I underpredict the contribution of PBS. In the case of publishing instead, the re-classification can be performed quite precisely, at least for the benchmark years. Finally, the definition of the PBS industry under the two classifications does not match exactly and I have to perform a further finer adjustment within PBS.[28]

Figure 5b compares the predictions of the models against the data after the re-classification.[29]

[28] See Appendix A.1.1 for the details.

[29] Also the actual data have been adjusted in order to reflect the re-classification of Publishing and auxiliary units. Instead the adjustment within PBS cannot be performed because the industry data are not detailed enough. This introduces a lower bias when the predictions are compared with the data. In fact, when I only exclude the auxiliary units but do not perform the PBS adjustment, the total PBS employment under NAICS is larger than under SIC, as shown in Figure 4b. Hence the predictions are compared against employment data that are larger

As expected, the change in the services share that can be accounted for is lower, but the picture is not so different from before. The change in the I-O structure of the economy is still capable of capturing a sizable amount of the overall labor reallocation across sectors. Also note how the predicted increase in the service share gets smoother over time, reflecting the elimination of the problems caused by the change of the classification in 1997. Tables 4 and 5 report the results. The predicted change in the service share is equal to 7.42 percentage points of total employment, which corresponds to 33% of the actual change. Given that all other channels have been shut down, the prediction is sizable, and it might be a lower bound. The estimate of the drop in the agriculture sector even improves; the changes in the I-O linkages alone account for 86% of the actual drop in agriculture.

Table 4: Predicted versus Actual Changes in Employment Shares - No Auxiliaries

Sector	Data	Prediction	Ratio
Agriculture	-3.99	-3.43	86%
Manufacturing	-18.28	-3.99	22%
Services	22.28	7.42	33%

Note: See notes in Table 2.

Table 5: Effect of Outsourcing on the Service Employment Share - No Auxiliaries

Counterfactual	Predicted Change	Ratio to Baseline	Diff. wrt Baseline
Baseline	7.42	100%	0.00
1: No Service Outsourcing	2.81	38%	4.61
2: No PBS Outsourcing	4.40	59%	3.02
3: No Finance Outsourcing	7.21	97%	0.21

Note: See notes in Table 3.

The results on the contribution of outsourcing are also robust. Service outsourcing potentially accounts for 62% of the total prediction; and if the contribution is more plausibly narrowed to PBS only, outsourcing explains 41% of the total, corresponding to 3.02 percentage points of total employment. Given the actual change of 22.3 percentage points, PBS outsourcing alone can explain 14% of the total increase in the share of services in total employment. This share could be subject to a downward bias given the problems with the re-classification and the impossibility of fully adjusting the actual data. Moreover, if the analysis is restricted to 1987-2002, the period in which outsourcing was more pronounced, PBS outsourcing can explain 21% of the total increase in services.

than they should be.

5 Final Demand Channels

In this section I allow for for the final uses expenditure shares to vary over time. This exercise proves that the contribution of outsourcing is not wiped out by the traditional final demand channels, and quantifies the extra prediction obtained by accounting for intermediates with respect to a traditional value added model. In the previous section final demand channels were completely shut down, hence a value added model would have simply predicted no reallocation: what the framework in gross output accounted for was essentially an extra prediction with respect to a value added model. In this section, a value added model is capable of predicting a positive labor reallocation through the change in final uses shares, hence the comparison becomes more meaningful. In what follows, I first modify the accounting framework to allow for the traditional final demand channels, then calibrate the model in this more complicated setting and finally replicate the results of the previous section.

5.1 Back to the Accounting Framework: Preferences

As pointed out in the introduction, two main channels have been proposed in the structural transformation literature to model the evolution of consumption shares: income effects due to nonhomothetic preferences as in the "utility-based" explanation or substitution effects due to differential productivity growth across sectors as in the "technological" explanation. The main purpose of modeling the evolution of consumption shares is to show that the contribution of sectoral linkages, and of outsourcing in particular, is not negligible even when the standard channels in the literature are present. There is no strong reason to choose one explanation versus the other, but the "technological" approach is adopted here because it is closer to the spirit of this paper and, as pointed out by Ngai and Pissarides (2007), it maintains the independence between parameters of preferences and technologies. Moreover it is more conservative in the number of parameters that need to be estimated, in fact, only the elasticity of substitution is needed while everything else is directly observable.

Consumers take the sector prices P_j as given and maximize their period utility subject to their budget constraint as follows:

$$\max_{\{C_j\}_{j=1}^J} \left(\sum_{j=0}^{J} \psi_j C_j^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}} \qquad \text{s.t.} \qquad \sum_{j=0}^{J} P_j C_j \leq wL \tag{14}$$

where ψ_j and $\sum_{j=0}^{J} \psi_j = 1$. $\epsilon > 0$ represents the elasticity of substitution across sectoral goods. The optimal consumption of each sectoral good is given by:

$$C_j = \frac{\psi_j^{\epsilon} P_j^{-\epsilon} wL}{P^{1-\epsilon}} \tag{15}$$

where $P = \left(\sum_{j=0}^{J} \psi_j^{\epsilon} P_j^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}}$ is the aggregate price index. It is possible to define the con-

sumption (or final uses) expenditure share of each sector j as follows:

$$X_j = \frac{P_j C_j}{wL} = \psi_j^{\epsilon} \left(\frac{P_j}{P} \right)^{1-\epsilon} \tag{16}$$

To simplify the empirical implementation, let x_j denote the ratio of the consumption expenditure on the good j to the consumption expenditure on the manufacturing good. Re-introducing time subscripts, the new variable is defined as follows:

$$x_{jt} = \frac{X_{jt}}{X_{mt}} = \left(\frac{\psi_j}{\psi_m} \right)^{\epsilon} \left(\frac{P_{jt}}{P_{mt}} \right)^{1-\epsilon} \tag{17}$$

And its logarithmic growth rate, $\hat{x}_{jt}$, is simply:

$$\hat{x}_{jt} = ln(x_{jt}) - ln(x_{jt-1}) = (1-\epsilon)(\hat{P}_{jt} - \hat{P}_{mt}) \tag{18}$$

Given the absence of capital and investment in this economy, the previous expressions hold for any sector j, including manufacturing for which the growth rate is obviously zero and x_{mt} is always equal to one, at any time t. Exactly as in Ngai and Pissarides (2007), if the elasticity of substitution across composite goods is less than one, the consumption expenditure share expands in sectors with relatively high price growth rates. The opposite holds true if the elasticity is larger than one; and there is no change in consumption shares if the elasticity is exactly equal to one. Given that the sectoral price indexes can be obtained from the data, equation (18) is all one needs to get the evolution of the consumption expenditure ratios over time. At each point in time, the sectoral consumption expenditure share, defined in (16), can be obtained as follows:

$$X_{jt} = \frac{x_{jt}}{\sum_{k=0}^{J} x_{kt}} \tag{19}$$

These shares can then be plugged into equation (12) to get the labor shares.

5.2 Calibration

When final uses shares are allowed to vary over time, the calibration procedure is a bit more involved. I calculate the final uses ratios relative to manufacturing using (17) and their evolution over time using equation (18). It is evident from the latter equation that the extra information needed are the sectoral price growth rates and the value of the elasticity of substitution. The latter is set to 0.5, as in Buera and Kaboski (2009). Although there is no final consensus in the literature about the value of this key parameter, $\epsilon = 0.5$ seems a sensible choice given that it is in between the unitary elasticity case often used in the "utility-based" structural transformation literature[30] and the Leontief preferences case ($\epsilon = 0$), which is obtained by Herrendorf et al. (2013b) by minimizing the distance between the expenditure shares predicted by their model and the data. This choice is not far from the value of 0.4 found by Duarte and Restuccia (2010)

[30] This strand of the literature usually uses "Stone-Geary" preferences, as, for instance, in Caselli and Coleman II (2001) and in Kongsamut et al. (2001) .

by matching the share of hours in manufacturing over time and the annualized growth rate of aggregate productivity; and it is slightly smaller than the value of 0.76 found by Acemoglu and Guerrieri (2008) in a two-sector model of high versus low capital intensive industries. Notice that keeping final uses shares constant over time is equivalent to setting the elasticity of substitution to 1. With a unitary elasticity, households use a constant share of their income on each good, and there is no change in final uses shares, as equation (18) shows. The results in the previous section precisely correspond to this case.

In order to evaluate the empirical contribution of accounting for intermediates, I compare the results obtained in the proposed gross output framework with those of a benchmark value added model; this is easily obtainable in the present accounting framework by setting $\beta_j = 1$, $\forall j \in J$. When the price channel is shut down as in the previous section, the predictions of the benchmark model are rather humdrum, as it simply predicts no labor reallocation. With less than unitary elasticity and differential price growth rates across sectors, the empirical comparison with the value added model becomes more meaningful. The exercise requires some care, though, as the right set of prices needs to be chosen. For the value added model the choice is quite simple since value added price indexes by industry are immediately available. The sectoral prices indexes provided by the BEA are chain-type annual-weighted indexes, which are not additive. I therefore use the standard methodology for chain price indexes in order to aggregate them up at the three sector level.[31] Figure 6 displays the calculated price indexes for the three main sectors; as well-known, when valued added prices are used, services are the sector with the highest increase, followed by manufacturing and then agriculture. These patterns produce changes in the employment shares that are consistent with the stylized facts on structural transformation; according to the model, a higher relative growth in the sectoral price index implies an increase in the consumption share of that sector, and in turn an increase in the employment share.

However, setting a less than unitary elasticity poses extra difficulty when the proposed accounting framework is used. The model is expressed in gross output, hence naively using value added price indexes would not be correct. A first fix would be to use the final consumption expenditure prices, as in Herrendorf et al. (2013b). They use the NIPA tables from the BEA to obtain the price indexes for personal consumption expenditures. They define the three main sectors of interest as follows: agriculture is identified with the NIPA category "food and beverages purchased for off-premises consumption"; manufacturing includes "durable goods" and "nondurable goods" apart from food; services include "services" and "government consumption expenditure". Unfortunately, this approach cannot be adopted in the current framework because it does not match the definition of final uses in the I-O data. A more involved procedure is therefore needed for two main reasons. First of all, the identification of agriculture with the food and beverages category is not correct because it also includes processed products, which are actually produced by the manufacturing sector and hence are classified as manufacturing commodities according to I-O data. Suffice to notice that, in 2002, the expenditures on food and beverage are seven times larger than the personal consumption expenditure associated with agriculture in I-O data. Second, I-O data are in producers' prices while NIPA tables are in

[31] See for instance Whelan (2002).

purchasers' prices, thus transportation, retail and wholesale margins have to be removed.

I therefore use more disaggregated data to match the I-O final uses to the corresponding NIPA categories, and then transform the series in purchasers' prices; all the details and data sources are described in Appendix A.3.[32] Figure 7 displays the obtained price indexes for final uses in the three main sectors; they are also compared to the price indexes used by Herrendorf et al. (2013b). As a robustness exercise, results are also obtained with this alternative set of price indexes; it is already clear from this figure that the predictions will improve considerably in this case. In fact, the price index for services displays a higher growth rate, causing a stronger reallocation. It is also interesting to notice that, in both sets of price indexes and conversely to value added data, final uses prices for agriculture grow more than the corresponding prices for manufacturing.

5.3 Results with Variation in Final Uses

The results of the previous section are re-obtained here allowing for the final uses expenditure shares to vary over time. By setting a less than unitary value of the elasticity of substitution, the differential in the price growth across sectors induces a reallocation in the consumption shares, as equation (18) shows. In predicting the changes in the sectoral employment shares, the proposed gross output framework reacts to changes in the I-O structure of the economy as before. On top of that, both models are now driven by the changes of the sectoral price indexes over time. The results therefore depend on the choice of the price indexes, which have to be constructed in the case of the gross output framework. Moreover, the results also hinge on the value of the elasticity of substitution, and hence on the form of consumer preferences. Although this exercise blurs the contribution of all these different channels, it constitutes a good robustness check for the main results of the paper and proves that the contributions of the I-O change and of outsourcing are not wiped out by the standard channel proposed in the literature.

Figure 8 plots the predictions of the two models over time, where results have been computed after the re-classifications outlined in Section 4.2.3. Given that final uses shares are also allowed to vary over time, the predictions clearly improve but still fall short of the actual data. As shown in Table 6, the increase in the services share is equal to 12.98 percentage points of total employment until 2002, which corresponds to 58% of the actual change. If the results (not shown) are computed without performing the re-classification, the share goes up to 69%, which corresponds to 15.45 percentage points of GDP. The overall predictive power also depends on the value of the elasticity of substitution. If one is ready to assume Leontief preferences, the predicted increase in the service share goes up to 17.91 percentage points, 80% of the actual change.

Moreover the results are also affected by the choice of the price indexes. In the current framework, price indexes for final uses are obtained by matching the I-O data to the corresponding NIPA categories and accounting for trade and retail margins. If the personal consumption expenditures indexes proposed by Herrendorf et al. (2013b) are used, the predictions improve

[32] A further extra adjustment in the price indexes is needed in case investment is also considered. Results for this case are obtained in Appendix B.3.

Table 6: Predicted vs. Actual Changes in Employment Shares - No Auxiliaries

		Gross Output		Value Added	
Sector	Data	Prediction	Ratio	Prediction	Ratio
Agriculture	-3.99	-3.57	89%	-2.82	71%
Manufacturing	-18.28	-9.42	52%	-5.44	30%
Services	22.28	12.98	58%	8.26	37%

Note: The predicted changes are obtained using both the Gross Output framework and the Value Added benchmark model. The elasticity of substitution $\epsilon = 0.5$. See also notes in Table 2.

considerably. For instance, the predicted change in the service sector employment share rises to 14.82 percentage points, which amounts to 67% of the actual change. As already noted in Figure 7, services experience a much higher growth in their price index in this alternative case, and the sectoral reallocation is therefore stronger. Although this alternative set of price indexes is not correct in the current framework, it helps in providing a sense of the robustness of the results with respect to the assumptions I had to take to obtain the preferred set of price indexes. In particular, in order to adjust the prices for the retail and wholesale margins, I have to use value added price indexes instead of the correct gross output prices. This forced choice is likely to have caused a lower bias in the price index for services. In fact, in more recent years, when gross output prices for the retail and wholesale sectors are available, value added prices have experienced a much lower growth compared to gross output prices.[33]

In any case, even if the proposed gross output framework cannot perfectly match the data, it is capable of capturing more of the sectoral reallocation compared to the benchmark value added model, over the whole time period. Table 6 also shows the predictions obtained with the benchmark value added model. The comparison of the results in the two cases points out that, by accounting for intermediates and allowing for the I-O structure of the economy to change over time, the predictive power is improved. In fact, the extra prediction obtained for the services share amounts to 4.72 percentage points, since the standard model can only predict 37% of the actual change. The prediction for the manufacturing employment share is also much closer to the data: the value added model predicts a drop of just 5.44 percentage points while the proposed gross output framework can account for 52% of the total fall, equal to 9.42 percentage points. Finally, it is interesting to note that the prediction is considerably improved in the case of agriculture as well, despite the fact that the gross output price index for agriculture rises more than that for manufacturing; this result once again highlights the importance of the change in sectoral linkages.

Given that more channels are now operating at the same time, I compare the contribution of outsourcing against the portion of the prediction that comes from the change in the I-O structure of the economy. The value of interest is therefore the difference in the predictions

[33]For instance, the value added price for the retail sector, which accounts for most of the margins, experienced a total growth of 14% in the 1987-2007 period; whilst the growth for the gross output price was 28% over the same period. For the wholesale sector the difference is even sharper: the total growth of value added price was just 2% versus a growth of 16% for gross output. See Appendix A.3 for the details on the construction of price indexes.

Table 7: Effect of Outsourcing on the Service Employment Share - No Auxiliaries

Counterfactual	Predicted Change		Extra Prediction		
	Value Added	Gross Output	Difference	Ratio to Baseline	Diff. wrt Baseline
Baseline	8.26	12.98	4.72	100%	0.00
1: No Service Outsourcing	8.26	9.16	0.90	19%	3.82
2: No PBS Outsourcing	8.26	10.47	2.20	47%	2.52
3: No Finance Outsourcing	8.26	12.81	4.55	96%	0.17

Note: The Extra Prediction is defined as the difference between the employment share change predicted by the proposed Gross Output framework and the change predicted by the Value Added benchmark model. The elasticity of substitution $\epsilon = 0.5$. See also notes in Table 3.

of the two models (extra prediction). What is predicted by the benchmark value added model is in fact driven by other channels, like consumer preferences and price changes. Similarly to Tables 3 and 5, the results of the counterfactual exercises are summarized in Table 7; the only difference is that the contribution of outsourcing is now compared against the extra prediction. The overall estimates for the baseline case are again displayed: the current accounting framework can account for an increase of 12.98 percentage points in the employment share of services, 4.72 percentage points more than the benchmark model. When the first counterfactual experiment is performed, namely all I-O coefficients for manufacturing kept constant to their 1947 level, the extra prediction drops to 0.9 percentage points, 19% of the value for the baseline case. This result implies that, when the price channel is also at work, the difference between the two models is almost entirely captured by the variation in the linkages of the manufacturing sector. Therefore a change in outsourcing policies of manufacturing firms could explain up to 81% of the total extra prediction implied by the current framework, in the admittedly far-stretched case that the entire observed change in the shares of intermediate use was coming from outsourcing. Instead when only the PBS share is fixed to its 1947 level, the extra prediction drops to 2.2 percentage points, 47% of the value for the baseline setting; this implies that PBS outsourcing accounts for 53% of the entire extra prediction generated by the model. In absolute terms the contribution of outsourcing amounts to 2.52 percentage points of total employment, slightly lower than the value estimated earlier. Still, this is not a negligible contribution considering that it exceeds 11% of the total increase in service employment and that other types of services are subject to outsourcing, not just PBS.

6 Mechanisms of Service Outsourcing

In the simple accounting framework proposed in this study, I take the changes in the I-O structure of the economy directly from the data, which corresponds to taking the changes in the parameters of the production functions as exogenous. As firms are changing the mix and the sourcing mode of their inputs over time, an immediate question arises: why is this the case? And in particular, why are firms outsourcing more services over time? A full answer to this question is beyond the scope of this paper, but this section offers some suggestive evidence on the matter, analyzing

occupational data and discussing some of the potential drivers.

Outsourcing can take several forms and it is interesting to understand whether firms have: a) outsourced the very same tasks formerly produced in-house; b) substituted inputs produced internally with alternative ones purchased from specialized external suppliers; c) purchased more services from the market in response to new needs. In the first case the change is clearly driven by organizational decisions and represents the starkest form of outsourcing, which would involve a simple relabeling of the same tasks; the mix of activities actually does not change and firms simply outsource what they used to perform in-house. In the second case the firms' choice to outsource might interact with other changes that lead firms to upgrade their activities and outsource them at the same time. In the last case the overall firms' demand for services increases and firms satisfy it through market transactions, rather than internal production.

The results of the previous section apply irrespective of the particular form of outsourcing. Section 2.2 showed that the increase in the use of PBS comes from market transactions, and is not matched by a parallel increase in internal production of services. Given the substitutable nature of business services, firms always have the option to employ specialists in-house. If they did not do so there must have been organizational decisions at play. The only potential problem lies with the possibility that the increase in services might be indirectly driven by a change in consumers' tastes. In this particular case organizational changes could be a by-product of a shift in final demand. This section shows that, to a first approximation, the overall composition of activities has not changed over time, and even where specific activities have increased, final demand is unlikely to play a role in that change.

6.1 Outsourcing as Relabeling? Evidence from Occupations

Investigating whether firms have outsourced the same tasks they used to produce in-house is an intrinsically difficult exercise because firms' internal activities are very hard to observe (even using data at the firm level). Nevertheless, aggregate occupational data provide some evidence in this regard. In fact, if firms needed more services over time, the occupations involved in the production of these services should become progressively more important, and one should observe an increase of their share in total employment. The challenge is to identify the occupations that best represent the PBS industry. For any given occupation, workers are employed in several sectors and the choice is the result of a trade-off: if only a few occupations are included they will not be representative of the entire PBS industry, but if too many are included the share of workers becomes too large compared to the share of PBS in total employment. I define *PBS Occupations* on the basis of how many workers within each occupation are employed in the PBS industry in 1990. In the baseline definition (Definition 1) I select the occupations that have at least 9% of their workers employed in PBS. As a robustness check, I propose four alternative definitions. Definition 2 uses a threshold of 10%. On the other hand, Definition 3 and Definition 4 are based on the analysis of the PBS industry itself; an occupation is included if at least 0.2% or 0.4% of total workers employed in PBS are classified within that particular occupation. Finally in the "Manual" Definition, I hand pick each occupation on the basis of its job description and

whether it could fit in the PBS industry.[34]

Figure 9 shows the results of this exercise. Each line plots the share of the selected occupations in total employment over time, according to the different definitions. Interestingly, these shares are fairly constant over time. According to Definition 1, the share of workers classified within the PBS Occupations goes from 24.2% of total employment in 1950 to 28.2% in 2010 but stays essentially flat from 1970 onwards.[35] It is in this second half of the analyzed period that outsourcing has played a much more important role, as shown in Figure 4. In fact, the growth of the share of the PBS industry in total employment in the 1977-2007 period was more than twice as high as in the 1947-1977 period. Therefore PBS increased more sharply in a period when the share of workers classified within PBS Occupations remained constant.

This fact seems to support the idea that what has changed over time are not so much the underlying activities but rather the boundaries of the firm. Given the rise in the share of the PBS industry in total employment, we expect workers to move from other industries to PBS, or at least the PBS industry to disproportionately employ more workers over time. This is precisely what happens. The share of workers within the selected PBS Occupations that is employed in manufacturing falls over time, while the share that is employed in the PBS industry rises. Figure 10a shows the latter share for six main categories used to subdivide PBS Occupations: Managers (and management related occupations); Professionals; Computer related occupations; Clerks, which include various administrative support occupations and some "Service occupations";[36] Technicians; and Other occupations, mainly operators and laborers. Within each category it is evident that the share of workers employed in PBS increases, especially since 1970 when outsourcing really starts taking off. The pattern is particularly sharp for Professionals: the share of workers employed in the PBS industry was 17.5% in 1950, declined to 16.1% in 1970 and has constantly increased since then, reaching 33.2% in 2010 But the growth was even stronger for Technicians and especially for Managers.

Figure 11 displays the share of workers employed in PBS for specific occupations. The pattern is quite similar across the board, with a constant increase in this share over time. It is interesting to note that this is true for both high and low skilled occupations. For instance, a very similar growth is experienced by Civil Engineers displayed in panel 11c and Guards in panel 11d. This fact shows that the rise of PBS is not driven by a particular type of skill and is consistent with both an explanation that focuses on the importance of low-skilled jobs, like in Autor and Dorn (2012), and an explanation that hinges on the rise of high-skilled jobs, like in Buera and Kaboski (2012). At the same time, there are some interesting counter examples.

[34] Data are described in Appendix A.1.2. To obtain consistent occupations over time, the OCC1990 occupational classification scheme is used; occupations are therefore selected using data in 1990.

[35] According to Definition 2 and the Manual Definition, the share of PBS Occupations even falls in the second part of the period. The other two definitions are instead a bit more problematic: they include a share of the total work force that is too large. The trade-off between representativeness and over-inclusion becomes clear; Definition 3 includes almost 90% of workers employed in PBS, but at the same time it captures 50% of the total labor force. In the case of Definition 1 the trade-off looks better, in fact it accounts for 82% of the workers employed in PBS but captures just 29% of the total workers.

[36] Note that "Service occupations" is a specific category of the Census Bureau classification and should not be confused with the service sector; it mainly includes low-skilled jobs like Guards, Janitors, and Cleaners, but also mid-skilled jobs like Dental assistants and Health aides. See Appendix A.1.2 for precise definitions.

For instance, the share for Lawyers (panel 11a) did not change much over time, and was already over 75% in 1950.

The graphical intuition can be more formally established with a standard growth decomposition following Foster et al. (2001). The share of the PBS industry in total employment can be re-written as follows:

$$l_{pbs} = \frac{L_{pbs}}{L} = \sum_o \frac{L^o_{pbs}}{L^o}\frac{L^o}{L} = \sum_o \omega^o_{pbs} l^o \tag{20}$$

where ω^o_{pbs} represents for a given occupation o the share of workers that are employed in the PBS industry (displayed in Figure 10a and Figure 11), and l^o is the share of occupation o in total employment. The change in the PBS employment share becomes:

$$\Delta l_{pbs} = \underbrace{\sum_o \Delta\omega^o_{pbs} l^o_1}_{Within} + \underbrace{\sum_o \omega^o_{pbs,1}\Delta l^o}_{Between} + \underbrace{\sum_o \Delta\omega^o_{pbs}\Delta l^o}_{Cross} \tag{21}$$

where l^o_1 and $\omega^o_{pbs,1}$ indicate quantities at the beginning of the period. The first term is a within-occupation component that captures how much of the increase in PBS employment is due to workers within each occupation moving to the PBS industry, while the second term is a between-occupation component that captures the contribution of employment share reallocations among occupations. I perform the decomposition for the 1970-2010 period and split occupations according to the main categories previously introduced, plus an extra category that includes all other occupations not classified as PBS Occupations.

Table 8: Decomposition of the PBS Employment Share Growth

Category	Within	Between	Cross	Total
Managers	0.86	0.01	0.05	0.92
Professionals	1.04	0.16	0.17	1.36
Computer	0.11	0.27	0.38	0.76
Clerks	1.39	-0.16	-0.18	1.05
Technicians	0.17	-0.04	-0.03	0.10
Others	0.05	-0.05	-0.02	-0.02
Not-PBS Occupations	1.52	-0.01	-0.01	1.50
Total	5.14	0.19	0.34	**5.67**

Note: The grand total (in bold) is the increase in the PBS industry share in total employment over the 1970-2010 period, all numbers are in percentage points of total employment. Data from IPUMS-USA, unemployed and workers with unknown occupation or industry are excluded.

Table 8 reports the results of the decomposition. Most of the growth comes from the within component: workers do not change occupation but move to PBS from other industries, mainly manufacturing (or are disproportionately more likely to be hired in PBS). The between component accounts for a very marginal share of the total growth, so the rise or fall of certain types of occupations does not account for much of the increase in PBS employment, which supports the idea that the underlying activities have remained roughly constant over time. The same

result holds true for almost all categories. The main exception is Computer related occupations for which the between and the cross components play a bigger role, but this is intuitive given that this type of occupation did not exist before 1970. Although marginal in relative terms, the between and cross components for Professionals and Clerks are smaller but comparable to those for Computers in absolute terms. So, to further investigate the role of the reallocation of employment shares among occupations, Figure 10b shows the breakdown of PBS Occupations into their main categories, where, for each category, I plot its share in total employment (l^o). Despite the total share of PBS Occupations being roughly constant over time, there is some heterogeneity across categories, as partially revealed by the decomposition. In particular, the share of Clerks falls when the share of Computer related occupations rises.

This pattern provides suggestive evidence about other changes that occurred over the period. Outsourcing might not take place through the mere substitution of the very same task from inside to outside the firm, but it could entail the substitution of an old superseded task with a new, more technologically advanced one. In this sense, outsourcing could be a way of accessing new technologies that would be too costly to produce in-house, as Bartel et al. (2012) have argued. The substitution of computer specialists employed in specialized service firms for clerks employed internally is a fitting example. At the same time, the share of Professionals also rises over time, suggesting an increase in the need of specialized knowledge. The next section discusses these two potential drivers of outsourcing.

6.2 Determinants of Service Outsourcing

So why have firms outsourced more services over time? The answer is likely to be related to two intertwined changes. The first comes from the service supply side and consists in the rise of an external market for PBS. Over time more and more firms have specialized in services, and slowly best practices have been established. As argued by Deblaere and Osborne (2010), services have been broken into their components and optimized by eliminating redundancies, automating and standardizing wherever possible. Essentially the production of services has been industrialized, creating a proper market for them, and economies of scale have allowed external providers to beat internal production. This explanation is formalized by Garicano and Rossi-Hansberg (2012) in a model of growth where organizations develop to exploit existing technologies. They model the process through the emergence of markets for specialized services that are slowly created to satisfy the demand of agents that, facing some exceptional problems, do not have the incentive to acquire the specialized expertise to solve them. The creation of these referral markets takes time because experts have to learn the problems and invest in the knowledge to solve them. The high share of lawyers employed in the PBS industry over the entire period is suggestive in this regard. Law firms have a long history in the U.S. and were already well established in 1950; as a result most lawyers were employed within PBS at the beginning of the period. This shows how the decision of outsourcing services is very much related to the existence of external providers, that is, a market that can provide the services at a given price.

Service outsourcing as a way to access the external provider's specialized skills was first

proposed by Abraham and Taylor (1996). The intuition again comes from the fact that it might not be optimal for a firm to invest in these competencies while an external provider can enjoy economies of scale and amortize the sunk costs of these investments across several clients. Although focused on parts and components rather than service outsourcing, Bartel et al. (2012) build on the same intuition to provide a model in which the probability of outsourcing production is positively related to the firm's expectation of technological change. Investing in a new technology implies some sunk costs; the faster technological change takes place, the shorter the lifespan of a new technology will be and firms will have less time to amortize the sunk costs. Therefore firms outsource to avoid these costs and substitute the old technology with the latest version provided by external suppliers, which can enjoy economies of scale and spread those costs over a larger demand.

On the other hand, from the service intermediate demand side, manufacturing firms constantly strive to grow to increase their scale and profits. The problem is that growing is painful and comes at a cost, for instance, in terms of coordination across business units. Outsourcing has helped firms to grow, allowing them to focus on their core competencies and externalizing the tasks that were not a source of competitive advantage. In essence, outsourcing has been a way to support a more complex environment. In an ongoing research project, I investigate the firm's demand side and build a model of the boundary of the firm based on adaptation costs and diminishing return to management. I look at one possible driver of managerial/coordination complexity: the internationalization decision of the firm. In doing so, I unveil new systematic evidence about domestic service outsourcing. For a large panel of French firms, I find that the share of purchased business services in total costs is positively and significantly related to the number of export destination countries and to the number of products.[37]

A full empirical investigation of the determinants of outsourcing is difficult because firm-level data are not available for the long period of the present analysis. However, interesting insights can be obtained from industry level data over the second part of the period. In particular, I test whether coordination complexity and the need for accessing external skills and new technologies are drivers of service outsourcing. I capture coordination complexity with the complexity of the division of labor, as proposed by Michaels (2007). Specifically complexity of an industry is measured as one minus the Herfindahl index of the occupations of its workers, excluding managers (but results do not change if managers are included). In the absence of exogenous variation in the main variables, it is not possible to give a full causal interpretation of the results. The results are nevertheless informative, and robust to the inclusion of industry fixed effects, year fixed effects and other potential drivers of outsourcing.

I run the following reduced form regression:

$$OUT_{it} = \beta_1 C_{it} + \beta_2 P_{it} + \boldsymbol{W_{it}'\beta_3} + \delta_i + \delta_t + \epsilon_{it} \tag{22}$$

where OUT_{it} is the share of purchased business services over total sales for industry i at time t, C_{it} is the complexity of industry i, P_{it} is the number of patents used by industry i, $\boldsymbol{W_{it}}$ is a vector

[37] See Berlingieri (2013a).

of controls, and δ_i and δ_t are industry and time fixed effects, respectively. I take the measure outsourcing from I-O tables, where I exclude auxiliary units as in Section 4.2.3. Outsourcing is defined as the share of PBS inputs over total sales (direct requirement coefficient) and the industries are defined at the 4-digit SIC level. The analysis is restricted to the manufacturing sector and the data are from the benchmark years 1972, 1982, 1992 and 2002.[38] Occupational data are from the IPUMS-USA database and I use the variable IND1990 to get a consistent definition of industries over time.[39] Following Bartel et al. (2012), I proxy technological change as the number of patents used by an industry. Patents data according to the International Patent Classification come from the NBER U.S. Patent database (updated version), described in Hall et al. (2001) and available from 1976 onwards. I obtain the number of patents used by an industry (as opposed to patents created by an industry) using the concordance table provided by Silverman (2002).

Table 9: Determinants of PBS Outsourcing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Complexity	2.850^a	5.766^a	5.614^a	5.643^a	6.604^a	6.492^a	6.487^a
	(0.585)	(1.183)	(1.193)	(1.278)	(0.965)	(1.010)	(1.010)
Num. Patents			0.270^b	0.276^b	0.259^b	0.254^c	0.256^c
			(0.128)	(0.129)	(0.130)	(0.134)	(0.133)
Num. Inputs				0.150	0.187^c	0.185^c	0.185^c
				(0.098)	(0.095)	(0.096)	(0.096)
K/L					0.050	0.045	0.051
					(0.064)	(0.065)	(0.069)
S/L						0.045	0.044
						(0.099)	(0.099)
Scale							-0.014
							(0.065)
Observations	1,789	1,340	1,338	1,338	1,329	1,329	1,329
Number of ind.	459	459	458	458	458	458	458
R-squared Within	0.294	0.267	0.276	0.280	0.283	0.283	0.283
Fixed effects	ind&year	ind&year	ind&year	ind&year	ind&year	ind&year	ind&year

Note: The dependent variable is the share of PBS over total sales (direct requirement coefficient). All variables are in logs. Data in column (1) are for years 1972, 1982, 1992 and 2002; in the remaining columns year 1972 is dropped because the number of patents is not available in that year. Industry-clustered standard errors are in parentheses; (a, b, c) indicate 1, 5, and 10 percent significance levels.

Table 9 shows the results. Controlling for industry and year fixed effects, coordination complexity is positively and significantly related to service outsourcing. The effect has strengthened over time: from column (2) onwards year 1972 is dropped and the magnitude is higher. The need to access external skills and new technologies, measured as the number of patents used by the industry, also has a positive effect, but it is less robust to the inclusion of year fixed effects and other controls. As an alternative measure of complexity, I also include the number of inputs, or more precisely the share of the number of commodities that the industry uses over the total

[38]The concordance table created to obtain a consistent definition of SIC industries over time is available on request.

[39]The concordance table from IND1990 to SIC is available on request. Occupational data are available every ten years, so I measure complexity with a 2-year lead with respect to outsourcing. I do not use data before 1970 because I would lose 25% of the industries.

available commodities (to control for changes in the classification over time). As expected, the impact is positive but only marginally significant after including year fixed effects.

The results are confirmed when other determinants of outsourcing are included. In particular, I add capital intensity, human-capital intensity, and a measure of scale economies at the plant level, as proposed by Antràs (2003).[40] None of the controls have a significant effect in the case of service outsourcing. In Appendix C.1, I also test the robustness of the findings to an alternative measure of service outsourcing taken from the Census of Manufacturing, which avoids all the issues with internal transactions. This alternative data source also allows me to test other determinants of outsourcing as proposed by Yeaple (2006), Nunn (2007), and Costinot et al. (2011), but the data are available from 1992 only. The picture is very similar and both measures of complexity are positively and significantly related to service outsourcing.

The evidence shown in this section supports the view that the overall composition of firms' activities has remained roughly constant over time. And even if few specific activities and occupations have increased their importance over time, the mechanisms at play seem to be related to technology or other supply side channels. Further research at a more micro level is needed but the analysis so far shows that final demand does not play a major role, even an indirect one, in the rise of PBS, an industry that accounts for almost half of the total rise of the service sector.

7 Conclusions

By presenting a simple gross output accounting framework that can capture the fully-fledged input-output structure of the economy, this paper investigates the role played by firms in shaping the reallocation of resources across sectors. In doing so, it contributes to the structural transformation literature by shifting the focus to forces that drive the process of structural transformation but that, at the same time, are completely unrelated to consumer preferences, namely the choice of the input mix and sourcing mode.

I use the gross output accounting framework to evaluate the sectoral reallocation of employment in the U.S. over the period 1948-2007. When both the standard channels in the literature and the forces proposed in this study are at play, the predicted change in the service share is equal to 13 percentage points of total employment in the baseline estimates. This prediction amounts to 58% of the actual change, and is larger than the 37% estimated by a benchmark value added model. When the channels proposed in the literature are shut down by keeping the final uses expenditure shares constant over time, the sole evolution of the input-output structure of the economy can explain a change in the service share equal to 7.4 percentage points of total employment, 33% of the actual change. I perform a counterfactual experiment in order to quantify the contribution of professional and business services outsourcing to the sectoral reallocation. In the same specification, this particular type of outsourcing explains 41% of the prediction, which amounts to 3 percentage points. Given the actual change of 22.3 percent-

[40] The data come from the NBER Manufacturing Industry Productivity Database; the number of establishments used to calculate the scale variable is from the County Business Patterns of the U.S. Census Bureau.

age points, professional and business services outsourcing alone accounts for 14% of the total increase in the share of services in total employment. Interestingly, this estimate is not too far from the back-of-the-envelope calculation performed by Fuchs (1968) over forty years ago. In fact, he showed that the growth of intermediate demand for services by goods-producing industries accounted for less than 10% of the total employment change between 1947 and 1958. The fact that professional and business services outsourcing alone now accounts for more than 10% of the total increase in services can be explained in light of the remarkable increase of this phenomenon in more recent years.

Further research is needed to understand why firms have been outsourcing more services over time. In its starkest form, outsourcing can be interpreted as a mere relabeling of economic activity. According to this view, the service sector would be growing simply because some workers move out of manufacturing into services but the intrinsic characteristics of their jobs do not actually change: they produce the same services from the desk of a service company instead of a manufacturing firm. The constant share of business services occupations in total employment over time supports this view, but it is not the only interpretation of outsourcing and there is some variation at a more disaggregated level. Under an alternative interpretation, outsourcing entails the substitution of old superseded tasks with more technologically advanced ones. In this sense outsourcing is a way of accessing new technologies or knowledge that would be too costly to produce in-house. By concentrating resources in firms specializing in the production of particular services, economies of scale can be reached, ensuring cost reductions and higher productivity levels. Furthermore, outsourcing can be seen as a way to support a more complex business environment, helping firms to grow and at the same time focus on their core competencies by externalizing the tasks that are not a source of competitive advantage. A general message of this paper is that more attention should be devoted to services, since future growth will more and more depend on the productivity gains accrued in this sector.

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Appendix A

A.1 Data Description

A.1.1 Industry and I-O Data

All the industry and I-O data come from the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce. Employment, value added and relative price indexes come from the Annual Industry Accounts, according to the December 2010 release; final uses price indexes come from the National Income and Product Accounts (NIPA) tables. The I-O data for years 1947, 1958, 1963, 1967, 1972, 1977, 1982, 1987, 1992, 1997 and 2002 come from the Benchmark Input-Output Accounts; while data for years 1998-2001 and 2003-2007 come from the Annual Industry Accounts, according to the December 2010 release. Both the standard and the supplementary versions of the tables are considered. The standard versions of the tables are available for years starting from 1992; under this version, the output of industries corresponds to the published output in the Industry Accounts because the redefinitions for secondary products performed by the BEA are not present, as in the supplementary tables. The re-classifications of secondary products carried out by BEA to define commodities cannot be avoided however. I-O tables until 1992 are based on the SIC classification while they are based on NAICS for later years.

The allocation of industries to the three main sectors under investigation is performed as follows:

- Agriculture: Agriculture, forestry, fishing and hunting
- Manufacturing: Mining, Construction, Manufacturing
- Services: all other industries including Government (excluding Scrap, which is kept as a separate sector)

Given the high level of aggregation, the definition of the three main sectors is not heavily affected when the classification switches from SIC to NAICS because most of the changes take place within each aggregate sector. Only two sub-sectors switch from one main sector to another: publishing and auxiliary units. They were both classified within manufacturing under SIC, but are now classified within services under NAICS. Unfortunately it is not possible to perform this adjustment in an ideal way. In particular there is a problem with auxiliary units, which are classified within the sector 55 of NAICS, namely Management of Companies and Enterprises. This sector is composed by three sub-sectors: 551111 (Offices of Bank Holding Companies); and 551112 (Offices of Other Holding Companies); 551114 (Corporate, Subsidiary, and Regional Managing Offices). The latter was moved from manufacturing to PBS services but the first two were not. In fact, they were already classified within services under SIC as well. The trouble is that I-O data are not disaggregated enough to distinguish these three sub-sectors, hence, by re-classifying the entire sector within manufacturing, the contribution of PBS is underpredicted. In the case of publishing the re-classification can be precisely performed by bringing industry 5111 - Newspaper, periodical, book, and directory publishers - back to manufacturing. Yet this

can be done for the benchmark years only, because in the case of the Annual I-O Accounts the level of disaggregation is not detailed enough to identify sector 5111; the re-classification has to be performed by moving the entire sector 511 - Publishing Industries (except Internet) - to manufacturing. This latter sector includes 5112 - Software Publishers - that is actually classified in PBS under SIC. This brings about an even more severe underprediction for Annual Accounts, not only for the overall service sector but more importantly for PBS, the main sector of interest in the paper.

The Professional and Business Services (PBS) industry in this study is identified with sector 73 of the SIC I-O classification (until 1992), which includes: 73A (Computer and data processing services); 73B (Legal, engineering, accounting, and related services); 73C (Other business and professional services, except medical); and 73D (Advertising). In terms of the 1987 SIC classification, the sectors included are:

- 73: Business Services:
  - 731: Advertising
  - 732: Consumer Credit Reporting Agencies, Mercantile
  - 733: Mailing, Reproduction, Commercial Art and Photography, and Stenographic Services
  - 734: Services to Dwellings and other Buildings
  - 735: Miscellaneous Equipment Rental and Leasing
  - 736: Personnel Supply Services
  - 737: Computer Programming, Data Processing, and Other Computer Related Services
  - 738: Miscellaneous Business Services
- 76: Miscellaneous Repair Services
  - 769: Miscellaneous Repair Shops and Related Services
- 81: Legal Services
  - 811: Legal Services
- 87: Engineering, Accounting, Research, Management, and Related Services
  - 871: Engineering, Architectural, and Surveying
  - 872: Accounting, Auditing, and Bookkeeping Services
  - 873: Research, Development, and Testing Services (excluding sector 8733 - Noncommercial Research Organizations)
  - 874: Management and Public Relations Services
- 89: Miscellaneous Services
  - 899: Miscellaneous Services

The definition of PBS is slightly more restrictive compared to the one employed in the aggregate SIC data presented in Figure 4. In particular the following SIC sectors are not included: 762 (Electrical Repair Shops); 763 (Watch, Clock, and Jewelry Repair); 764 (Reupholstery and Furniture Repair); 84 (Museums, Art Galleries, and Botanical and Zoological Gardens); and 8733 (Noncommercial Research Organizations).

The definition of the PBS according to the 2002 NAICS I-O data include sectors: 54 (Professional and Technical Services); 55 (Management of Companies and Enterprises); and 56 (Administrative and Waste Services). The codes coincide with the standard 2002 NAICS codes. This definition does not exactly match the one used under the SIC I-O classification and some adjustments are necessary in order to improve the consistency of the data over time. The reclassification of the sector "Management of Companies and Enterprises" within manufacturing is the first obvious one, given what has just been discussed. Finer adjustments can only be performed for benchmark years because the Annual Accounts lack the needed level of detail; they involve the exclusion of some sub-sectors from the NAICS definition and the inclusion of others that were previously classified within PBS under the SIC definition. Unfortunately it is not possible to get a perfect match; a conservative approach has therefore been used, by moving only sectors whose entire output or the vast majority of it needs to be re-classified. The NAICS I-O sub-sectors that have been excluded from the PBS definition under NAICS are:

- 5615: Travel arrangement and reservation services[41]
- 5620: Waste management and remediation services[42]

The sub-sectors that have been moved to PBS because they belong to it according to SIC are:

- 5112: Software publishers
- 5180: Internet service providers, web search portals, and data processing
- 5324: Commercial and industrial machinery and equipment rental and leasing[43]

Notice that the following SIC sectors cannot be correctly re-classified so they are completely missing from the new definition under NAICS: 7352 (Medical Equipment Rental and Leasing); 7377 (Computer Rental and Leasing); 7378 (Computer Maintenance and Repair); 7383 (News Syndicates); 7384 (Photofinishing Laboratories); and 8741 (Management Services). The vast majority of 769 (Miscellaneous Repair Shops and Related Services) and parts of few other small sub-sectors are missing as well. Instead the NAICS sub-sectors that are kept while they should have been completely dropped because they were not in PBS under SIC are: 541191 (Title Abstract and Settlement Offices); 541213(Tax Preparation Services); 541921 (Photography Studios, Portrait); 561730 (Landscaping Services); and 561740 (Carpet and Upholstery Cleaning Services).

[41] Part of the sector should have been kept because it corresponds to SIC sector 7389 (Business Services, NEC)

[42] Part of the sector should have been kept because it corresponds to SIC sectors 7359 (Equipment Rental and Leasing, NEC) and 7699 (Repair Shops and Related Services, NEC)

[43] This also includes SIC sector 4741 (Rental of Railroad Cars), which was not in PBS; however, the vast majority of it corresponds to SIC sector 735 (Miscellaneous Equipment Rental and Leasing), which is in PBS.

A.1.2 Occupational Data

Occupational data come from the IPUMS-USA database. In order to compare occupations over time, the classification proposed by Meyer and Osborne (2005) is used.[44] The occupations associated with PBS are selected according to the different definitions described in the main text using data in 1990. The list of occupation selected according to the 9% definition are listed in Table A.1. The table also shows the codes corresponding to the categories used to subdivide the occupations. They are:

- 1: Managers
  - 11: Top Managers
  - 12: Other managers
  - 13: Financial Managers
- 2: Professionals
  - 21: Lawyers
  - 22: Architects
  - 23: Engineers
  - 24: Accountants
  - 25: Advertisers
  - 26: Other professions
- 3: Computer related occupations
  - 30: Computer system analysts, software developers etc.
- 4: Clerks
  - 41: Administrative related occupations
  - 42: Service occupations
  - 43: Sales occupations
- 5: Technicians
  - 50: Technicians and repairers
- 6: Other occupations
  - 61: Construction and precision production occupations
  - 62: Operators and laborers

[44] The corresponding variable is named OCC1990.

Table A.1: PBS Occupations - 9% Definition

Occupation Description	**OCC1990**	**Category**
Human resources and labor relations managers	8	11
Managers and specialists in marketing, advertising, and public relations	13	25
Managers and administrators, n.e.c.	22	12
Accountants and auditors	23	24
Management analysts	26	12
Personnel, HR, training, and labor relations specialists	27	12
Business and promotion agents	34	12
Management support occupations	37	12
Architects	43	22
Civil engineers	53	23
Electrical engineer	55	23
Not-elsewhere-classified engineers	59	23
Computer systems analysts and computer scientists	64	30
Operations and systems researchers and analysts	65	30
Statisticians	67	26
Mathematicians and mathematical scientists	68	26
Physicists and astronomers	69	26
Chemists	73	26
Atmospheric and space scientists	74	26
Geologists	75	26
Physical scientists, n.e.c.	76	26
Agricultural and food scientists	77	26
Biological scientists	78	26
Medical scientists	83	26
Economists, market researchers, and survey researchers	166	26
Sociologists	168	26
Social scientists, n.e.c.	169	26
Urban and regional planners	173	26
Lawyers	178	21
Writers and authors	183	26
Technical writers	184	26
Designers	185	26
Art makers: painters, sculptors, craft-artists, and print-makers	188	26
Photographers	189	26
Art/entertainment performers and related	194	26
Editors and reporters	195	26
Electrical and electronic (engineering) technicians	213	50
Engineering technicians, n.e.c.	214	50
Mechanical engineering technicians	215	50
Drafters	217	50
Surveyors, cartographers, mapping scientists and technicians	218	50
Other science technicians	225	50
Computer software developers	229	30

Legal assistants, paralegals, legal support, etc	234	21
Technicians, n.e.c.	235	50
Advertising and related sales jobs	256	25
Sales demonstrators / promoters / models	283	43
Computer and peripheral equipment operators	308	30
Secretaries	313	41
Stenographers	314	41
Typists	315	41
Interviewers, enumerators, and surveyors	316	41
Receptionists	319	41
Information clerks, n.e.c.	323	41
File clerks	335	41
Bookkeepers and accounting and auditing clerks	337	24
Billing clerks and related financial records processing	344	24
Duplication machine operators / office machine operators	345	41
Mail and paper handlers	346	41
Office machine operators, n.e.c.	347	41
Other telecom operators	349	41
Mail clerks, outside of post office	356	41
Messengers	357	41
Customer service reps, investigators and adjusters, except insurance	376	41
Bill and account collectors	378	41
General office clerks	379	41
Proofreaders	384	41
Data entry keyers	385	41
Statistical clerks	386	41
Housekeepers, maids, butlers, stewards, and lodging quarters cleaners	405	42
Supervisors of guards	415	42
Guards, watchmen, doorkeepers	426	42
Supervisors of cleaning and building service	448	42
Janitors	453	42
Pest control occupations	455	42
Small engine repairers	509	50
Repairers of data processing equipment	525	50
Repairers of household appliances and power tools	526	50
Precision makers, repairers, and smiths	535	50
Locksmiths and safe repairers	536	50
Office machine repairers and mechanics	538	50
Mechanics and repairers, n.e.c.	549	50
Paperhangers	583	61
Precision grinders and filers	644	61
Furniture and wood finishers	658	61
Upholsterers	668	61
Photographic process workers	774	62
Welders and metal cutters	783	62
Hand painting, coating, and decorating occupations	789	62

A.2 Construction of Aggregate I-O Tables

For the purpose of this study, I-O tables have to be aggregated in order to obtain the I-O linkages for the three main sectors: agriculture, manufacturing and services. The matrix Ω in the model corresponds to an industry-by-industry total requirements table. The methodology to obtain this matrix is described by Horowitz and Planting (2006). In brief, there are two main methods to obtain the matrix corresponding to the different I-O conventions used before and after 1972. For the benchmark years until 1967, one symmetric industry-by-industry transaction matrix is published under the assumption that each industry only produces one commodity and that each commodity is only produced by one industry. The total requirements table is then simply obtained as a Leontief inverse. Since 1972 instead, the symmetry assumption has been dropped and two distinct tables have been published: the commodity-by-industry use table that shows the uses of commodities by industries and final consumers; and the industry-by-commodity make table that shows the production of commodities by industries. The methodology is slightly more involved, but again it is possible to obtain an industry-by-industry total requirements table. In this study, transaction, make and use tables are first aggregated and then inverted to obtain the total requirements table according to the two different methodologies. Moreover, following the documentation for benchmark years, the Commodity Credit Corporation adjustment is performed for years between 1963 and 1977; and the Scrap adjustment is carried out for years between 1972 and 1997.

A.3 Construction of the Price Indexes

The aggregated value-added price indexes for agriculture, manufacturing and services have been computed from the chain-type price indexes for value added at the industry level, following the methodology described by Whelan (2002). The price index for agriculture is readily available and corresponds to the aggregate industry "agriculture, forestry, fishing, and hunting". Manufacturing includes the industries "mining", "construction" and "manufacturing". Services include "private services-producing industries" and "government".

The procedure to obtain the final uses price indexes is a bit more involved. All data come from the NIPA tables and since all price indexes are chained, any manipulation described here requires the methodology for chain-type indexes. The procedure involves three main steps: 1) identify the NIPA categories that better represent the I-O definition of commodities; 2) remove transportation, retail and wholesale margins to obtain producers' price indexes; 3) add investment to the relevant sectors and obtain an aggregate price index for each sector that reflects the price of investment as well. The first two steps are described here, while the adjustment for investment is analyzed in Appendix B.3. The first step consists in matching the personal consumption expenditures from the I-O side to the appropriate NIPA categories. Since the NIPA tables were extensively revised in 2009 to incorporate the results of the 2002 benchmark I-O accounts, I perform the match using the 2002 Bridge Table, which links the two data sources. As pointed out in the main text, the identification of agriculture with the NIPA category "food and beverages purchased for off-premises consumption" is not correct because it is seven times larger than personal consumption expenditures for the I-O commodity agriculture; a finer

definition is therefore needed. This is achieved by using the underlying NIPA tables, which contain categories at a more disaggregated level. The trouble is that the underlying tables are only available since 1959, hence it is not possible to keep the same exact definition for the three main sectors throughout the entire time period. After 1959, the personal and government consumption expenditures categories are allocated to the three main I-O commodities as follows:

- Agriculture: "Fish and seafood"; "Eggs"; "Fresh fruits and vegetables"; "Food produced and consumed on farms"; "Flowers, seeds, and potted plants"
- Manufacturing: "Durable goods" except "Net purchases of used motor vehicles", "Recording media", "Computer software and accessories" and "Corrective eyeglasses and contact lenses"; "Nondurable goods" except categories already included in Agriculture and "Net expenditures abroad by U.S. residents"; "Food furnished to employees (incl. military)"
- Services: "Services" except "Food furnished to employees (incl. military)"; "Recording media"; "Computer software and accessories"; "Corrective eyeglasses and contact lenses"; "Net expenditures abroad by U.S. residents"; "Government consumption expenditures"[45]

The match cannot be perfect because each NIPA category is often associated with more than one I-O commodity. For instance, "Cereals" are allocated in part to "Crop products", which fall in agriculture, and in part to "Food products", which fall in manufacturing. A conservative approach is used and a category is moved only if the majority of its expenditures falls in another sector. In the case of "Cereals", they are moved to manufacturing because only 1% of their expenditures are associated to agricultural commodities. Despite the imperfect match, the magnitudes are now much more in line with I-O data; for instance the personal consumption expenditures allocated to agriculture amount to 47.4 billions of dollars (at producers' prices) in 2002 while they are 48.2 billions of dollars in the I-O data. Unfortunately the same level of disaggregation is not available before 1959 and a much coarser match has to be used.[46] The three main sectors are identified as follows:

- Agriculture: "Food and beverages purchased for off-premises consumption" except "Alcoholic beverages purchased for off-premises consumption"
- Manufacturing: "Durable goods" except "Net purchases of used motor vehicles"; "Nondurable goods" except categories already included in Agriculture; "Food furnished to employees (incl. military)"

[45] The treatment of government consumption expenditures changed in 1998. The reason is that the gross output for the general government industry did not include intermediate inputs before 1998 and they were accounted for as government consumption expenditures. Therefore the complete association of government consumption expenditures with services is correct only in recent years. Before 1998, one should allocate part of the government expenditures to agriculture and manufacturing; unfortunately the Bridge Tables are not available for government consumption expenditures and it is not clear which NIPA categories should be reallocated. In any case this is unlikely to have a major impact; in fact the government expenditures on agriculture were almost nil in all years and the expenditures on manufacturing commodities that should be reallocated were just 15% of the total in 1997.

[46] As a robustness exercise, in order to exclude this initial period, the main results of the paper are replicated starting from the benchmark table in 1958. They are very robust if not stronger. In fact PBS outsourcing accounts for 2.4 percentage points of the change; given the shorter period this corresponds to 14.4% of the total increase in the share of services in total employment.

- Services: "Services" except "Food furnished to employees (incl. military)"; "Government consumption expenditures"

The price indexes obtained so far are in purchasers' prices, however; this implies that part of their value reflects margins that actually belong to the service sector. The second step therefore consists in obtaining the transportation, retail and wholesale margins for agriculture and manufacturing from I-O tables. The data are available only for benchmark years starting from 1967; thus interpolated values are used in missing years and the margins for the 1947-1966 period are assumed to be equal to their value in 1967. The agriculture and manufacturing price indexes are adjusted to remove these margins, which are then moved within services. To achieve this, price indexes for transportation, retail and wholesale trade are needed. For transportation I take the price index for "Public Transportation" from NIPA tables. For retail and wholesale trade instead there is no direct counterpart in the NIPA tables (there is no final demand for retail trade as such). The obvious choice would be to take price indexes for gross output from the Industry Accounts; unfortunately gross output prices are available only since 1987, therefore valued added price indexes are used instead.

Appendix B

B.1 Results until 2007

In recent years, the I-O tables are available annually and not only for the benchmark years. Unfortunately, the annual tables are computed using more aggregate data and do not match the statistical quality of tables in benchmark years. In particular, the intermediate inputs at the detail level are estimated assuming the industry technology to be constant, undermining the precise aim of this study. Moreover, the annual tables are revised periodically over time[47], when new information becomes available; instead the benchmark tables are usually published with a 5-year lag and are not subject to further updates. Also the correction for the classification change cannot be performed as precisely as for benchmark years, as pointed out in Appendix A.1.1. The finer adjustment for PBS cannot be done; and, in the case of publishing, I have to re-classify a larger sector that includes Software Publishers, causing an even bigger underprediction of the overall service sector. For all these reasons, the data for years after 2002 are particularly inaccurate, and the results should be therefore treated with care.

Table B.1: Predicted versus Actual Changes in Employment Shares - No Auxiliaries

Sector	Data	Prediction	Ratio
Agriculture	-4.05	-3.27	81%
Manufacturing	-19.35	-3.15	16%
Services	23.41	6.41	27%

Note: Period: 1948-2007. See also notes in Table 2.

[47]This study uses data from the December 2010 revision.

Table B.2: Effect of Outsourcing on the Service Employment Share - No Auxiliaries

Counterfactual	Predicted Change	Ratio to Baseline	Diff. wrt Baseline
Baseline	6.41	100%	0.00
1: No Service Outsourcing	1.90	30%	4.51
2: No PBS Outsourcing	3.87	60%	2.55
3: No Finance Outsourcing	6.13	96%	0.28

Note: Period: 1948-2007. See also notes in Table 3.

I replicate the results of Section 4.2.3 over the period 1948-2007. As expected, given the warning on data quality, the predictions drop slightly in recent years. As shown in Table B.1, the predicted change in the service share is equal to 6.41 percentage points of total employment, which corresponds to 27% of the actual change. An extra reason for the drop in the estimate is that, after having somewhat leveled in the '90s, the employment share of services experienced a sharp increase in the last decade. Looking at the contribution of outsourcing in Table B.2, PBS still account for around 40% of the total. The contribution is lower in absolute terms, 2.55 percentage points of total employment, but is not far from the 3 percentage point change obtained in the main results. Despite the data quality issues, PBS outsourcing still accounts for a sizable share of the total labor reallocation.

B.2 Results with Standard I-O Tables

This appendix shows the results obtained using the standard I-O tables. In these tables output of industries corresponds to the published output in the Industry Accounts because the redefinitions for secondary products performed by the BEA are not present. As a robustness exercise, I report the estimates obtained using these tables for the change in the employment share until 2002. Tables B.3 and B.4 show the results of the exercise, which is performed according to the setting of Section 4.2.3 where the elasticity was fixed to one in order to isolate the forces under study. Tables that replicate results of other sections of the paper are available on request; they are not reported here because they do not add any extra evidence. As expected, there is almost no impact on the contribution of outsourcing; here PBS outsourcing accounts for 40% of the change, against 41% in the results reported in the main text. The impact of the redefinition is mainly on the magnitude of the results, but again it is very marginal. The proposed gross output framework is capable of explaining a change in the service share equal to 7.3 percentage points of total employment in 2002, versus the 7.4 percentage points found when supplementary tables are used. In absolute terms, outsourcing accounts for 2.9 percentage points, just 0.1 percentage points less than before.

Ideally one would like to obtain the results using tables that exactly match the Industry Accounts data, that is, tables without the re-classification of secondary products performed by BEA to define commodities. These re-classifications are the main reason why it is not possible to affirm as strongly as for industry data that the change in PBS coincide with a rise in outsourcing.

Table B.3: Predicted versus Actual Changes in Employment Shares - Standard Tables - No Auxiliaries

Sector	Data	Prediction	Ratio
Agriculture	-3.99	-3.45	86%
Manufacturing	-18.28	-3.85	21%
Services	22.28	7.30	33%

Note: Period: 1948-2002. See also notes in Table 2.

Table B.4: Effect of Outsourcing on the Service Employment Share - Standard Tables - No Auxiliaries

Counterfactual	Predicted Change	Ratio to Baseline	Diff. wrt Baseline
Baseline Model	7.30	100%	0.00
1: No Service Outsourcing	3.01	41%	4.28
2: No PBS Outsourcing	4.41	60%	2.89
3: No Finance Outsourcing	7.10	97%	0.20

Note: Period: 1948-2002. See also notes in Table 3.

Unfortunately tables before re-classifications are not published. However, as pointed out in Section 2.2, these re-classifications mainly affect small single-establishment firms and internal transactions seem to be constant over time, so they are unlikely to have a strong impact on the change. The results obtained for tables before redefinitions offer further strong evidence. In fact, the redefinitions are performed using exactly the same logic of the re-classifications, only they are applied to the definition of industries and not commodities. The very small impact of these redefinitions on the magnitude of the results is reassuring and proves that what is observed in the data is mainly driven by outsourcing: similarly the re-classifications are likely to have a very marginal impact.

B.3 Results with Investment

Despite being by far the largest component (85.6% in 2002), personal and government consumption expenditures do not account for the total of final uses, and a further extra adjustment in the price indexes is needed in case investment is to be considered as well. This adjustment involves the allocation of private fixed investment and government gross investment to the three main sectors. The agriculture sector is not a recipient of investment, so no further modification is needed. Unfortunately the NIPA tables are again not detailed enough, and the allocation is quite coarse. All of investment apart from investment in software is allocated to manufacturing; hence the investment allocated to services are just software plus the transportation, retail and wholesale margins associated with investment in manufacturing.[48] The share of investment allocated to services is therefore lower than the actual one. For instance, part of the investment

[48]Margins for fixed private investment and government gross investment are again obtained from benchmark I-O tables and interpolated in missing years. Unfortunately the first year in which these margins are available is 1982; hence in all previous years the margins are assumed to be equal to their value in 1982. This does not seem to be a particular source of concern given that the margins are quite constant over time.

in structures should be allocated to Real Estate, which is in services; PBS is another recipient of investment, which cannot be clearly identified.

The results of the paper are re-obtained here to show the robustness to the inclusion of investment. Clearly the relevant results are those of Section 5 when the final uses expenditure shares are allowed to vary, since with a unitary elasticity the choice of the price indexes do not matter at all. An extra step is required to allow for investment in the value added model, otherwise the comparison between the two models would not be correct. The treatment of investment in the value added model is performed as in Ngai and Pissarides (2004); they assume that all of investment is performed in manufacturing and set the aggregate investment rate to 20% of output, matching the average investment rate for the period 1929-1998. Note that this is similar to the adjustment performed for the gross output prices, since, also in that case, the share of investment performed in the service sector cannot be properly accounted for.

Table B.5: Predicted vs. Actual Changes in Employment Shares - Investment and No Auxiliaries

		Gross Output		Value Added	
Sector	Data	Prediction	Ratio	Prediction	Ratio
Agriculture	-3.99	-3.53	88%	-2.90	73%
Manufacturing	-18.28	-8.01	44%	-3.01	16%
Services	22.28	11.54	52%	5.90	27%

Note: The predicted changes are obtained using both the proposed Gross Output framework and the Value Added benchmark model. Period: 1948-2002. The elasticity of substitution $\epsilon = 0.5$. See also notes in Table 2.

Table B.6: Effect of Outsourcing on the Service Employment Share - Investment and No Auxiliaries

	Predicted Change		Extra Prediction		
Counterfactual	Value Added	Gross Output	Difference	Ratio to Baseline	Diff. wrt Baseline
Baseline	5.90	11.54	5.64	100%	0.00
1: No Service Outsourcing	5.90	7.52	1.62	29%	4.03
2: No PBS Outsourcing	5.90	8.90	2.99	53%	2.65
3: No Finance Outsourcing	5.90	11.36	5.46	97%	0.18

Note: The Extra Prediction is defined as the difference between the employment share change predicted by the proposed Gross Output framework and the change predicted by the Value Added benchmark model. Period: 1948-2002. The elasticity of substitution $\epsilon = 0.5$. See also notes in Table 3.

Tables B.5 and B.6 report the results of the exercise. The overall predicted sectoral reallocation is reduced in both models; this result comes from the fact that most of the investment is accounted for in manufacturing, hence this sector experiences a lower drop in total employment. In fact, according to the gross output model, the change in the share of manufacturing is equal to -8.01 percentage points of total employment in 2002, a lower drop compared to the 9.42 points predicted in the main text without accounting for investment. Also the predicted increase in

services is lower, amounting to 11.54 percentage points versus the 12.98 points predicted without investment. But the contributions of the change in the I-O structure and of outsourcing are very robust, displaying even higher values compared to the results without investment. In fact, accounting for intermediates improves the prediction of the rise in the service share by 5.64 percentage points. For what concerns the contribution of outsourcing the results are also robust, if not stronger. Service outsourcing potentially accounts for 71% of the total extra prediction; and if the contribution is more plausibly narrowed to PBS only, outsourcing explains 47% of the total. This is a smaller share compared to the 53% in the main text, but it corresponds to a higher amount in absolute terms: 2.65 percentage points of total employment compared to 2.52 points predicted without including investment.

Appendix C

C.1 Determinants of PBS Outsourcing: Census data

The measure of purchased PBS services used in Section 6.2 is obtained from I-O tables. As argued in the main text, this measure of PBS outsourcing is reliable once auxiliary units are excluded; in fact, the problem of internal transactions only remains for those small companies whose secondary products are re-classified by the BEA from manufacturing to PBS services. These transactions are likely to account for a very small share of the total. In any case, to dispel any doubt on this issue I perform a robustness exercise and use a second more precise measure of service outsourcing. It comes from the quinquennial Census of Manufactures, which directly asks firms the cost of services purchased from other companies. The problem of internal transactions is therefore completely eliminated. Unfortunately the first year in which data are available is 1992, and only a limited range of services is available: legal, accounting, advertising, software and data processing, and refuse removal. These constitute a subset of the services contained in the PBS sector.

The industry classification employed is NAICS, and I convert the data in 1992 from SIC to NAICS using the weighted concordance table available on the U.S. Census Bureau website. The measure of coordination complexity is obtained using the Occupational Employment Statistics published by the U.S. Bureau of Labor Statistics. The data are available at a 4-digit NAICS level only from 2002, therefore I cannot exploit the within variation and the analysis only focuses on the cross-sectional variation by adding year fixed effects. A further reason for this choice is that the measure of service outsourcing is not completely consistent across the different Censuses; in fact the 2002 Census also includes purchases of computer hardware, which cannot be excluded[49].

Table C.1 shows the results of the regressions. Coordination complexity again has a strongly positive and significant effect on PBS outsourcing. The adoption of new technologies, measured by the number of patents used by the industry, has a positive effect but not robust to the inclusion of all controls. Allowing for cross-industry variation only, I can include other determinants of

[49]Data in 2002 also include the cost for management consulting and administrative services. Since the time variation is not exploited, they are not excluded because they are contained in PBS.

Table C.1: Determinants of PBS Outsourcing - Census data

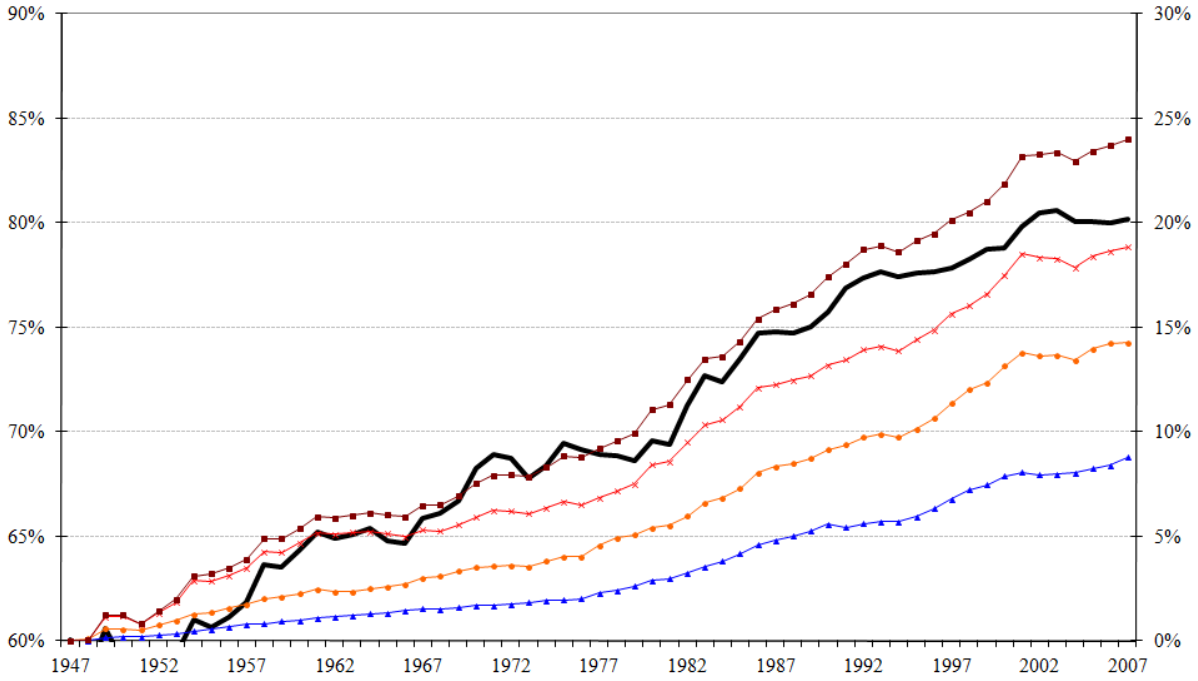
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Complexity	1.909^a	1.478^b	1.564^b	3.554^a	2.590^a	2.426^a	2.386^a	2.357^a	2.538^a	2.783^a
	(0.544)	(0.627)	(0.636)	(0.484)	(0.475)	(0.468)	(0.475)	(0.474)	(0.474)	(0.497)
Num Patents		0.071^a	0.062^a	0.090^a	0.049^a	0.053^a	0.043^b	0.035^c	0.028	0.031
		(0.021)	(0.021)	(0.018)	(0.019)	(0.019)	(0.020)	(0.020)	(0.020)	(0.020)
Num Inputs			0.151	0.229^b	0.201^b	0.219^b	0.223^b	0.236^b	0.194^c	0.217^b
			(0.113)	(0.097)	(0.099)	(0.102)	(0.102)	(0.103)	(0.105)	(0.105)
K/L				-0.406^a	-0.406^a	-0.330^a	-0.322^a	-0.308^a	-0.245^a	-0.241^a
				(0.031)	(0.031)	(0.057)	(0.059)	(0.063)	(0.067)	(0.067)
S/L					0.302^a	0.290^a	0.261^a	0.277^a	0.254^a	0.280^a
					(0.049)	(0.048)	(0.054)	(0.055)	(0.056)	(0.060)
Scale						-0.052	-0.058	-0.074^c	-0.079^c	-0.076^c
						(0.034)	(0.036)	(0.042)	(0.042)	(0.042)
R&D/Sales							0.038	0.042	0.024	0.035
							(0.027)	(0.027)	(0.027)	(0.029)
Dispersion								0.054	0.058	0.051
								(0.057)	(0.055)	(0.055)
Contract Int									0.151^a	0.148^a
									(0.053)	(0.053)
Routine										0.407
										(0.302)
Observations	1,386	1,383	1,383	1,376	1,376	1,376	1,367	1,352	1,352	1,352
R-squared	0.043	0.062	0.064	0.229	0.263	0.265	0.268	0.279	0.286	0.287
Fixed effects	year	year	year	year	year	year	year	year	year	year

Note: The dependent variable is the share of purchased professional and business services from other companies over total sales. All variables are expressed in logs. Data are from the Census of Manufactures for years 1992, 1997 and 2002. Industry-clustered standard errors in parentheses; (a, b, c) indicate 1, 5, and 10 percent significance levels.

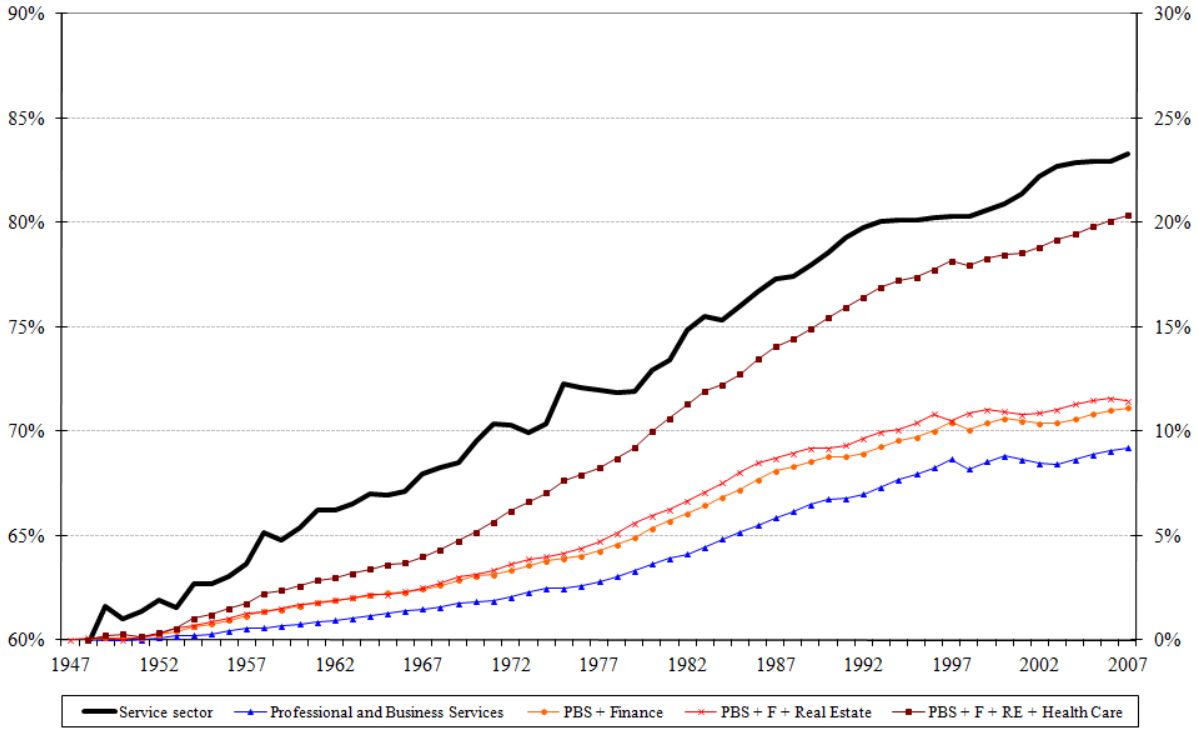
outsourcing, whose measure is only available in a given year. They include: a measure of productivity dispersion as in Yeaple (2006); the ratio of R&D expenditures to sales from the FTC Line of Business Survey; the measure of contract intensity proposed by Nunn (2007); and the measure of routine introduced by Costinot et al. (2011). Analyzing the control variables, human-capital intensity again has a positive effect, and this time it is strongly significant. Capital intensity is instead negative and significant, in contrast with the previous results that gave a positive estimate. The positive and significant effect of the contract intensity variable can be interpreted as another support, albeit indirect, to the complexity and core-competencies story. Under the standard Property Right Theory interpretation, a firm will in-source more contract intensive inputs. Given that all of the inputs used to construct this variable are goods, the positive impact on service outsourcing can be rationalized by arguing that a manufacturing firm with more contract intensive inputs will focus on its core-competencies by producing more goods in-house and outsourcing more of the non-core services.

Figure 1: Service Sector Growth in the U.S.

(a) Share of GDP

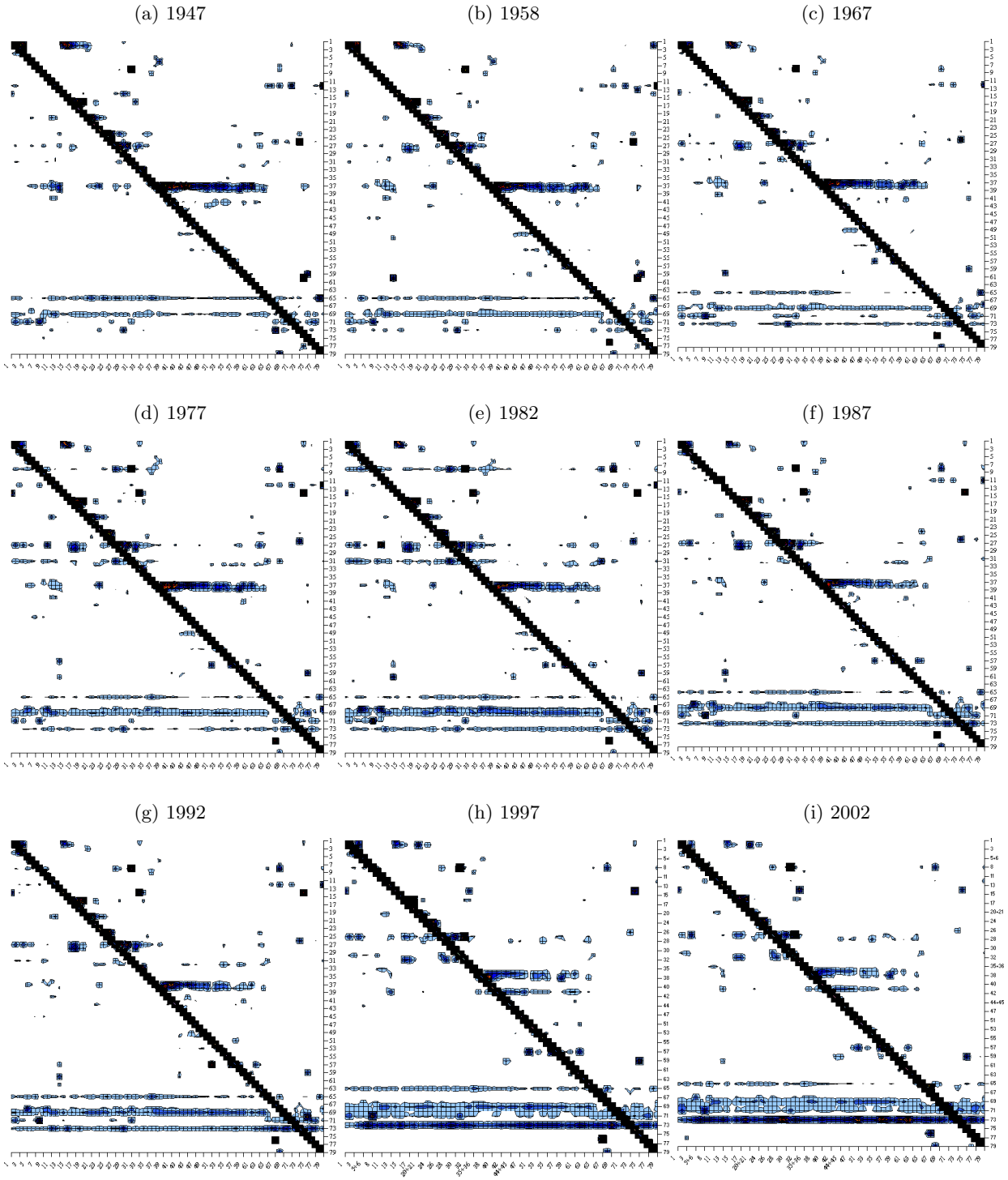


(b) Share of total employment



Source: BEA Annual Industry Accounts, release: December 2010.
Note: The left-hand side axis displays the absolute share of the entire service sector (thick black line) in terms of either GPD (panel a) or total employment (panel b). The right-hand side axis applies to all series and displays the change in percentage points of either GPD or total employment. The triangle marked line represents the percentage point change of Professional and Business Services (PBS); the circle marked line represents the percentage point change of the combined sector PBS and Finance; analogously the cross marked line for the combined sector PBS, Finance and Real Estate, and the square marked line for the combined sector PBS, Finance, Real Estate and Health Care.

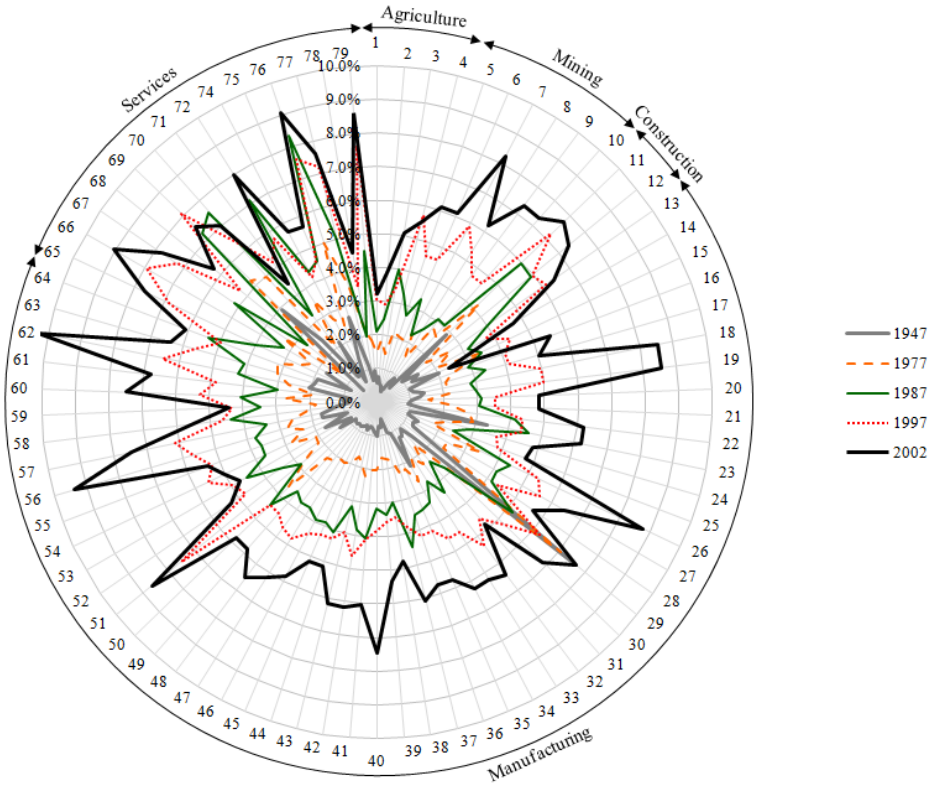
Figure 2: Total Requirements Tables in the U.S., 1947-2002



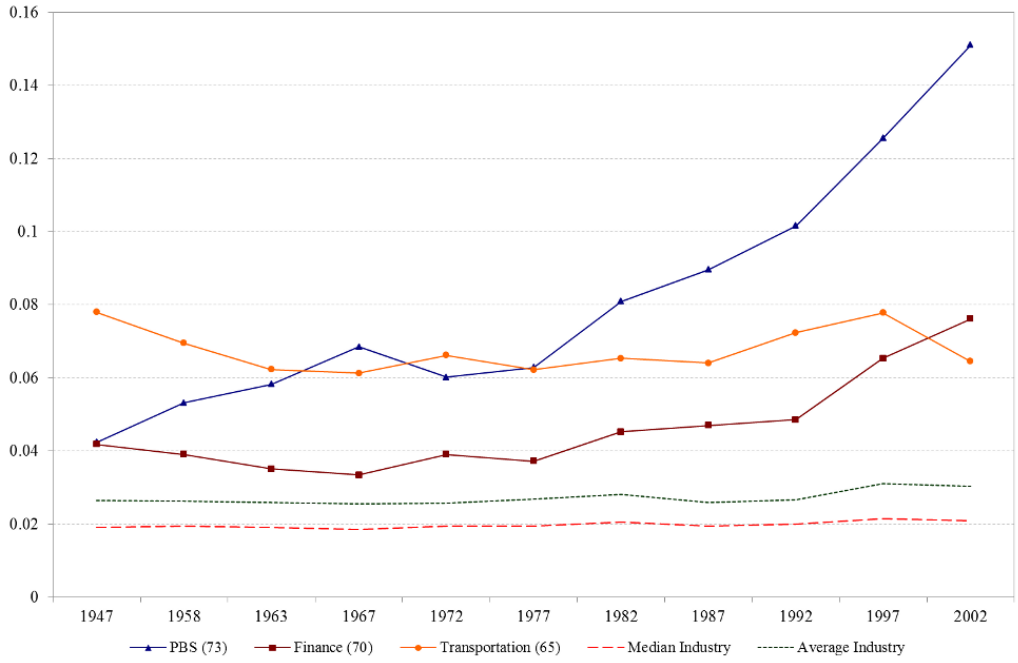
Source: BEA Benchmark Input-Output Accounts.
Note: The tables for years 1947 to 1967 show the 85-industry level total requirements coefficients, the tables for years 1972 to 1982 show the 85-industry level IxC total requirements coefficients; all data are readily available on the BEA website. The tables for years 1987 and 1992 are obtained from the Use and Make tables at the six-digit level. The tables for years 1997 and 2002 are obtained from the Use and Make tables at the summary level and transformed into I-O SIC codes using a concordance table available on request. A contour plot method is used, showing only shares greater than 2% of the total output multiplier (or backward linkage).

Figure 3: The Influence of PBS on the U.S. Economy

(a) PBS Total Use



(b) Influence Vector

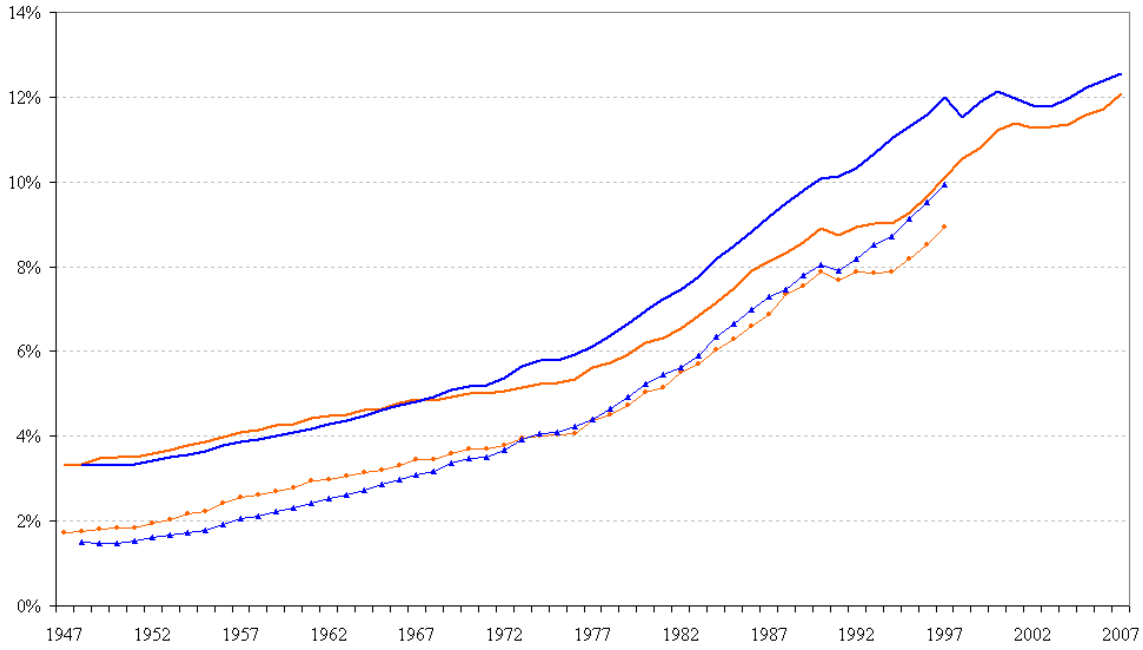


Source: BEA Benchmark Input-Output Accounts and author calculations.

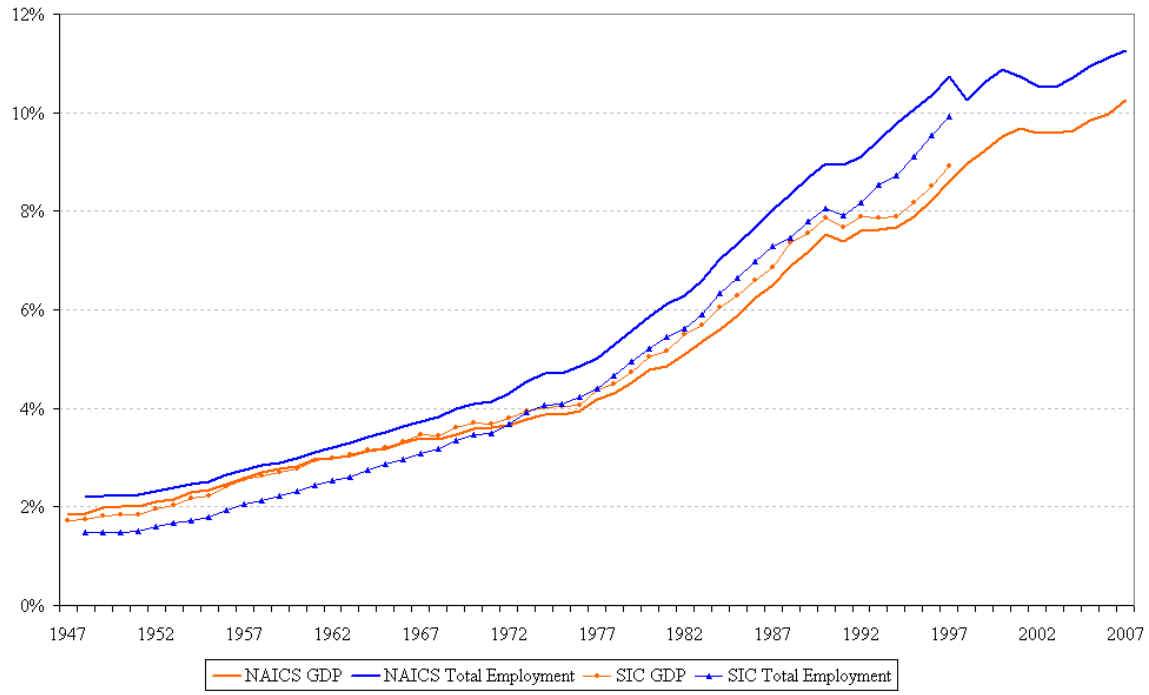
Note: Panel (a) displays the share of PBS in the total requirements for all commodities in the economy (one outlier - Radio and television broadcasting, 67 - is excluded in 1947 for graphical reasons). The influence vector is defined as: $v = \frac{1}{J}\Omega^{-1}\mathbf{1}$, where J is the number of sectors and Ω^{-1} is the total requirements table (see Section 3). Panel (b) plots over time the elements of the vector v corresponding to PBS, Finance, Transportation, and the average and the median industry. Auxiliary units are excluded; see Section 4.2.3.

Figure 4: Professional and Business Services (Share of)

(a) Published Series



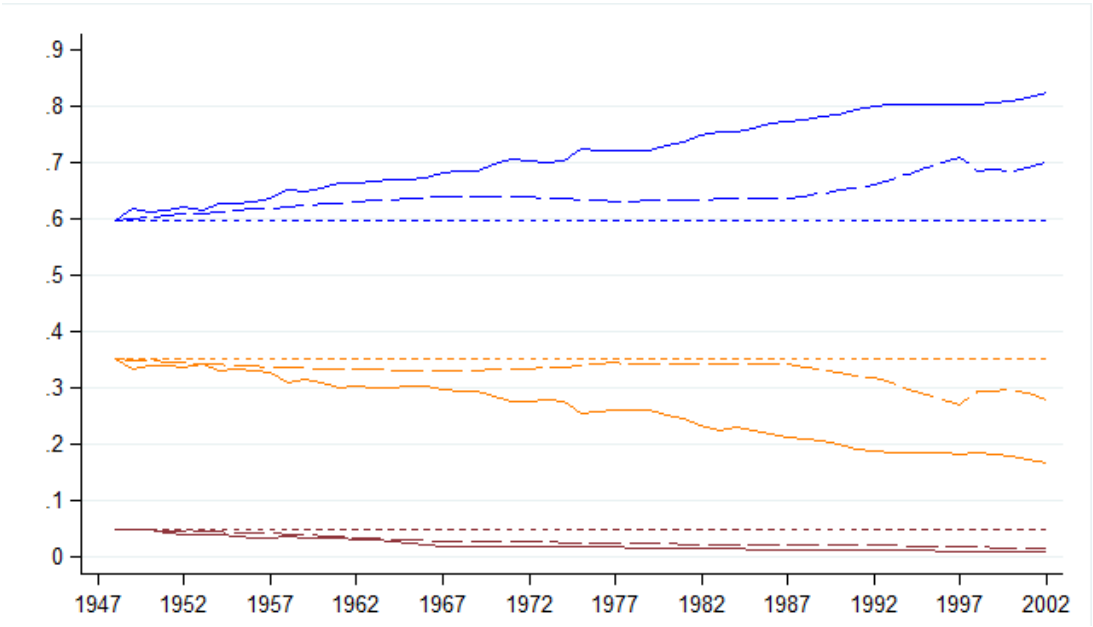
(b) No Auxiliaries



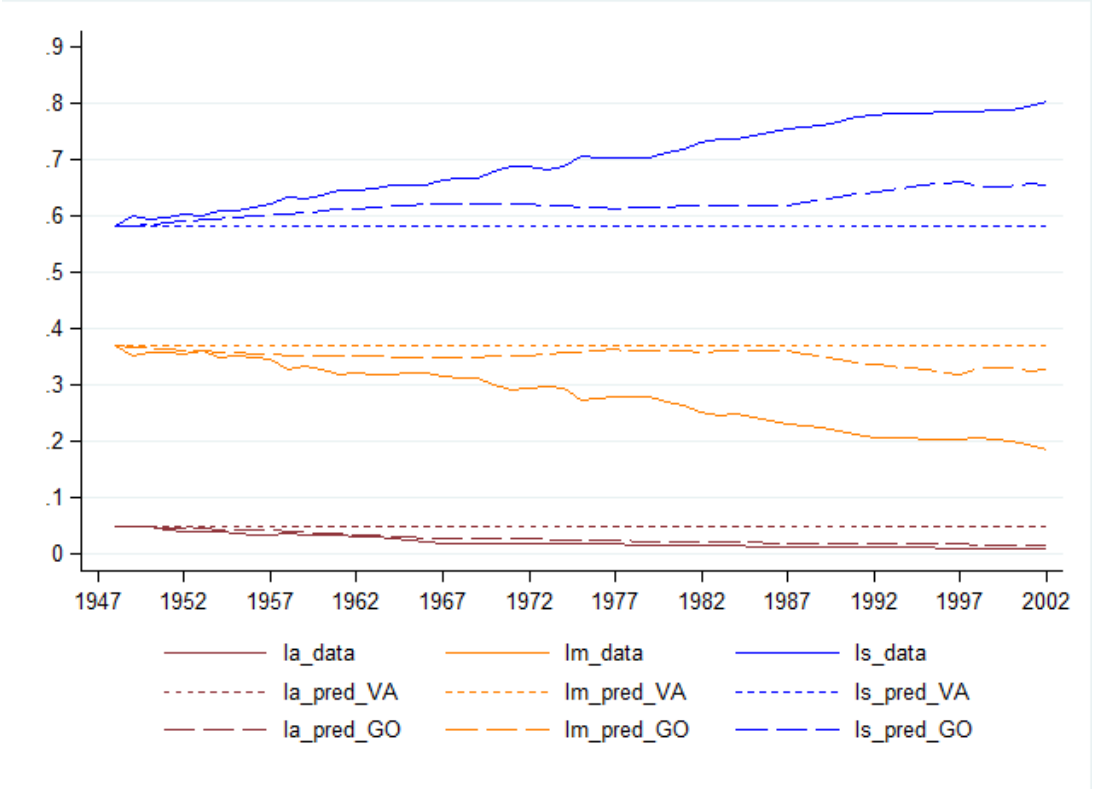
Source: BEA Annual Industry Accounts, release: December 2010.
Note: Professional and Business Services under the 1987 SIC classification include: Business Services (73); Miscellaneous Repair Services (76); Legal Services (81); Other Services (84, 87, 89). The series is not entirely consistent over time; before 1987 the 1972 SIC classification is used, the two coincide apart from Other Services that is named Miscellaneous Professional Services and the corresponding 1972 codes are 84 and 89. Under NAICS Professional and Business Services include: Professional, Scientific, and Technical Services (54); Management of Companies and Enterprises (55); Administrative and Waste Management Services (56). Management of Companies and Enterprises (55) mostly coincide with the so-called auxiliary units under the SIC classification and it has been excluded from the data of panel 4b.

Figure 5: Predicted vs. Actual Employment Shares in the U.S.

(a) Published I-O Tables

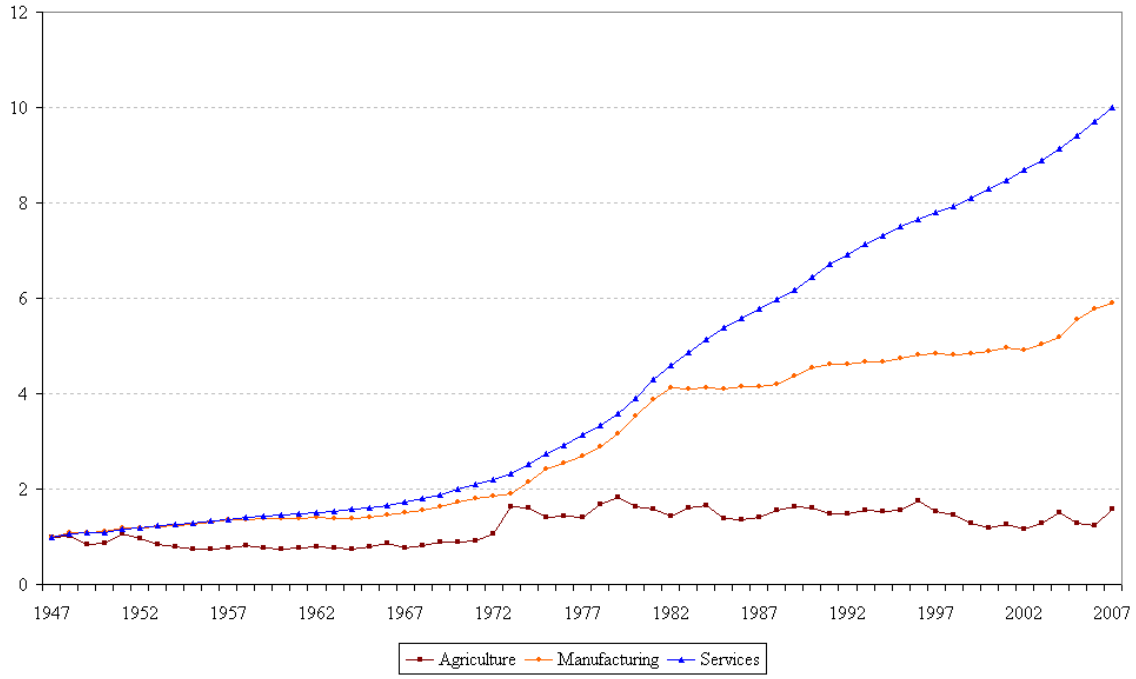


(b) No Auxiliaries



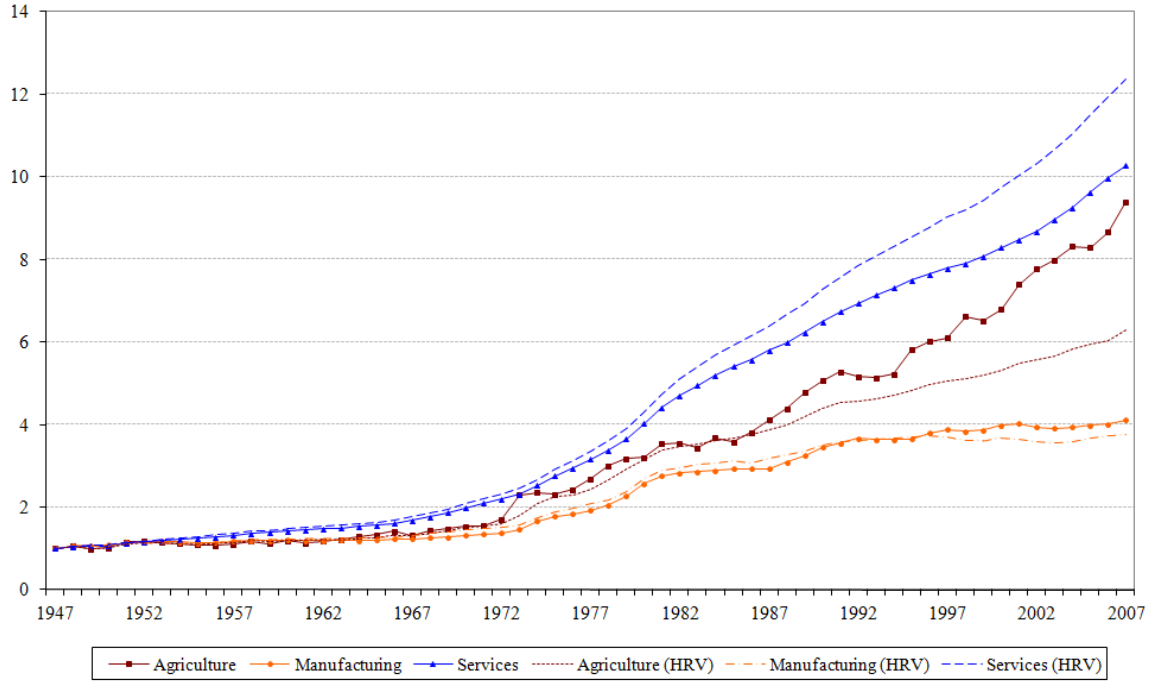
Source: BEA Benchmark and Annual Industry Accounts (release: December 2010) and author's calculations.
Note: Period: 1948-2002. The first panel shows data and predictions obtained using the published I-O tables; the second panel instead is obtained after the re-classification of auxiliary units, PBS and publishing performed in Section 4.2.3. The predicted changes in labor shares for agriculture (la), manufacturing (lm) and services (ls) are obtained using the proposed Gross Output framework. A traditional Value Added model predicts no change because final uses are kept constant.

Figure 6: Value Added Price Indexes (1947=1)



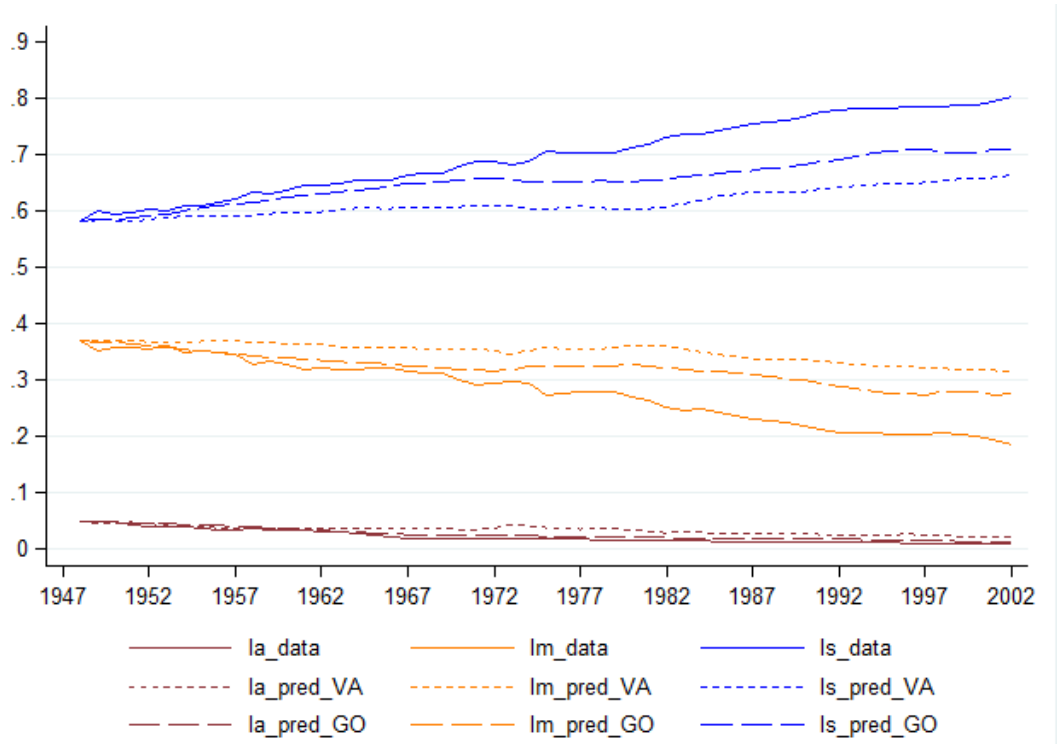
Source: BEA Annual Industry Accounts (release: December 2010) and author's calculations.

Figure 7: Final Uses Price Indexes (1947=1)



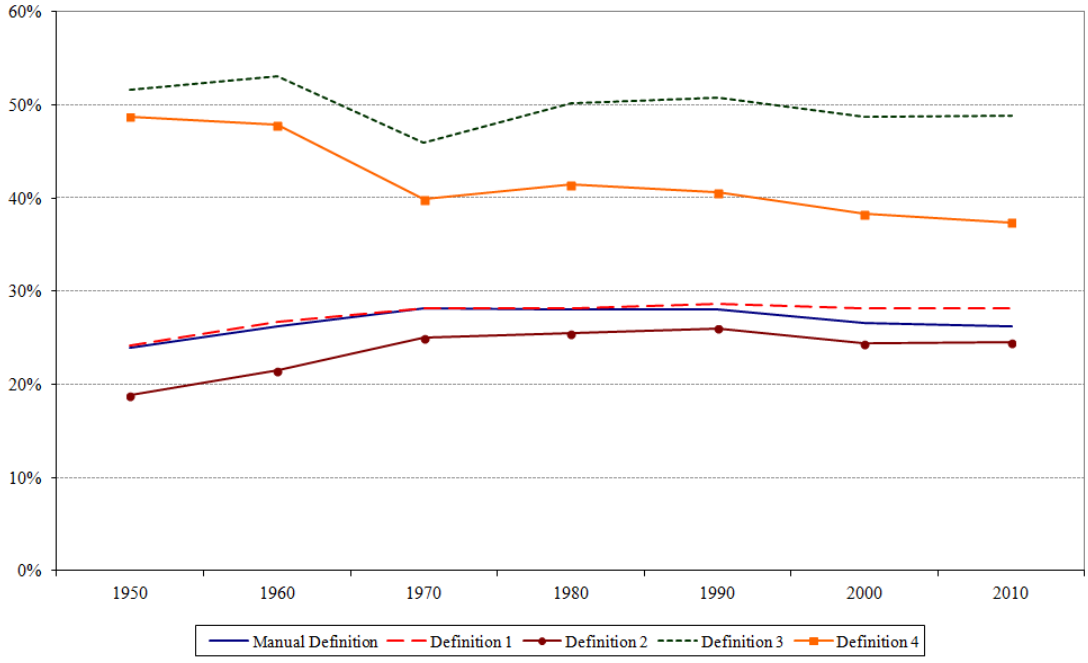
Source: BEA NIPA Tables and author's calculations.

Figure 8: Predicted vs. Actual Employment Shares in the U.S.



Source: BEA Benchmark and Annual Industry Accounts (release: December 2010) and author's calculations.
Note: Period: 1948-2002. The predicted changes in labor shares for agriculture (la), manufacturing (lm) and services (ls) are obtained using both the proposed Gross Output framework and the Value Added benchmark model. The elasticity of substitution $\epsilon = 0.5$.

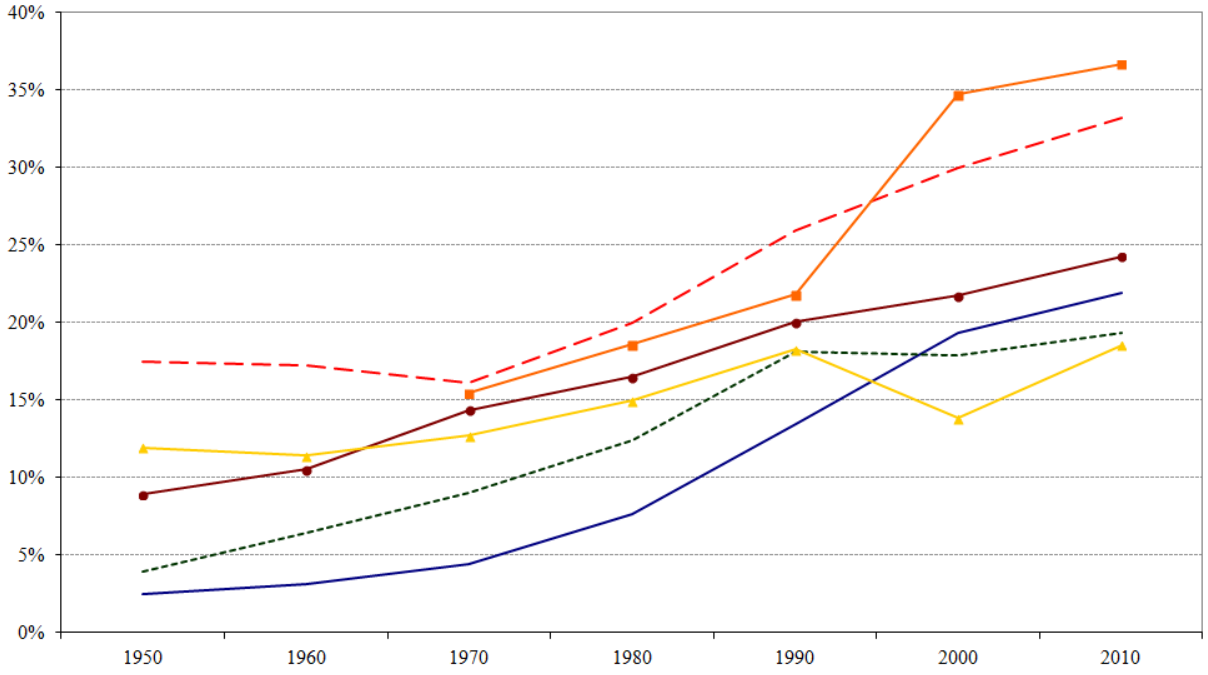
Figure 9: Share of PBS Occupations in Total Employment



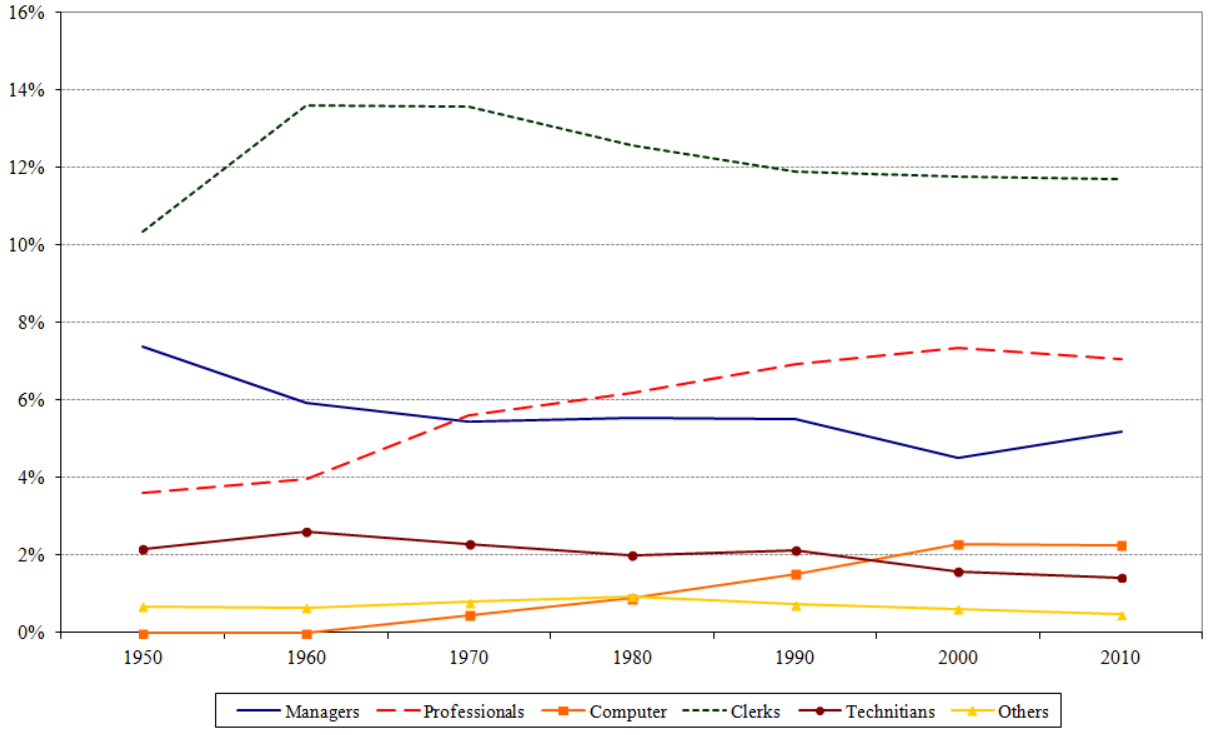
Source: IPUMS-USA.
Note: PBS Occupations are selected according to five definitions, as described in the main text.

Figure 10: Main Categories of PBS Occupations

(a) Participation in PBS (Within component)

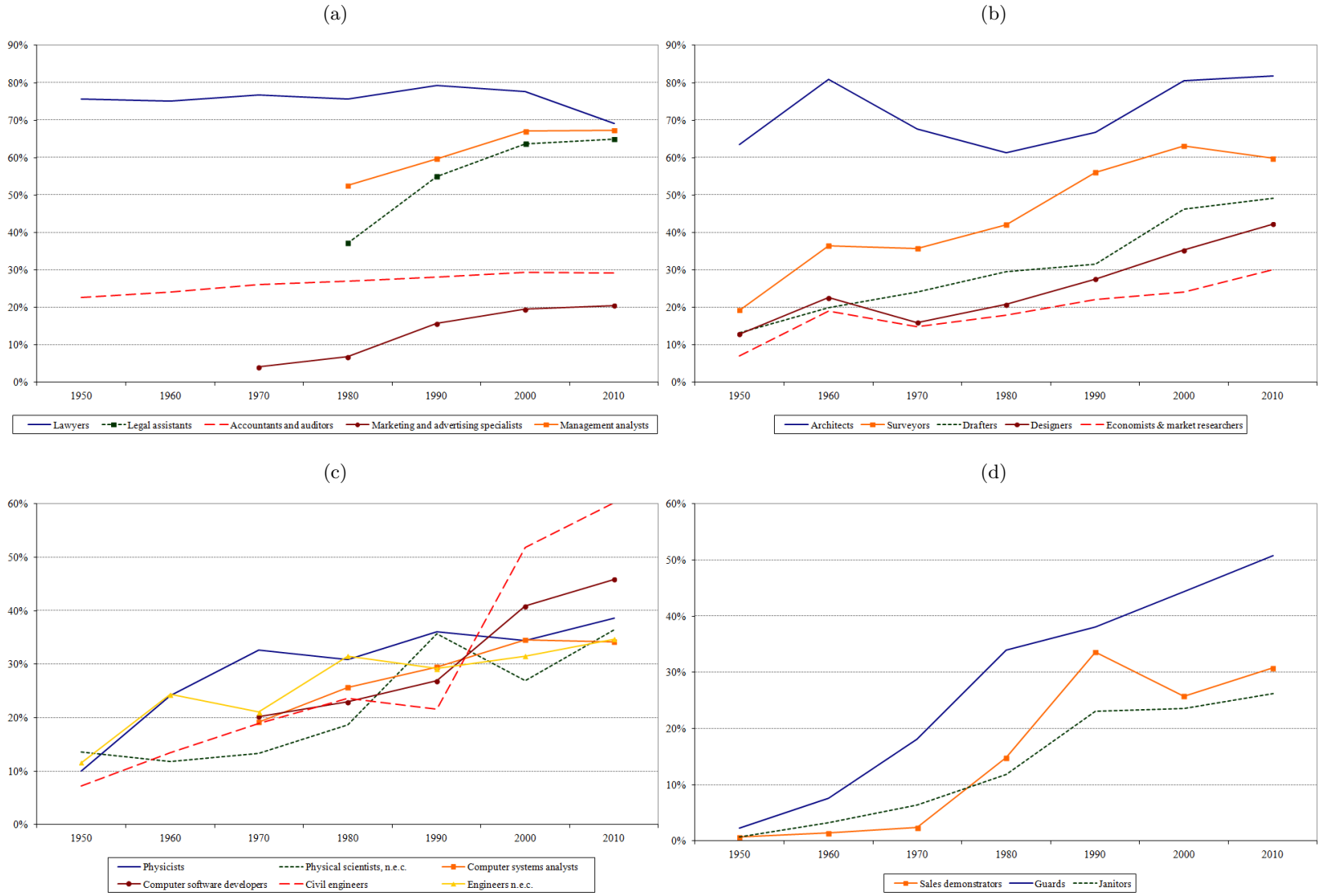


(b) Share in Total Employment (Between component)



Source: IPUMS-USA.
Note: PBS Occupations are selected according to Definition 1. Panel (a) plots, within each main category, the share of workers that are employed in the PBS industry. Panel (b) plots the share of the main categories in total employment.

Figure 11: Selected Occupations - Participation in PBS



Source: IPUMS-USA.

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