From Selling Goods to Selling Services: Investigating a New Channel of Firm Response to Import Competition DRAFT

Holger Breinlich*, Anson Soderbery† and Greg C. Wright‡

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Abstract

In the face of increased import competition domestic firms are often forced out of the market, whereas others adapt and survive. In this paper we focus on a new channel of adaptation, namely the shift toward increased provision of services in lieu of goods production. Using firm-level data for the U.K. we explore the link between import competition in goods and the firm's tradeoff between goods production and the provision of services. We exploit variation in EU trade policy in order to identify the impact of goods imports in the firm's decision. We find that the degree of import competition faced by firms in the goods market is strongly associated with a shift to greater services provision. Additionally, we find that the firm's stock of R&D is strongly associated with a successful transition.

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*Breinlich: University of Essex

†Soderbery: Purdue University

‡Wright: University of California, Merced

In the face of increased import competition domestic firms are often forced out of the market, whereas others adapt and survive. Those who survive do so in several ways – recent work has shown that firms respond by increasing their innovation efforts (Bloom, Draca and Van Reenen, 2011; Teshima, 2010), by increasing the quality of their products (Khandelwal, 2010), by refocusing their product scope on core competencies (Mayer, Melitz and Ottaviano, 2013; Liu, 2010), or by decentralizing their management heirarchy (Bloom, Sadun and Van Reenen, 2010). In this paper we focus on a new channel of adjustment, namely the shift toward increased provision of services in lieu of goods production.

The share of services in global production and trade is substantial, with services accounting for 64 percent of global output and 21 percent of global trade in 2012. For the U.K. these figures are even more striking, with services accounting for 78 percent of GDP and 25 percent of total trade. This has been the outcome of sustained growth in services provision in recent years, which has averaged around one percent per year since 1997 (World Bank, 2013), and in 2011 the country overtook Germany as the world's second largest services trader. In this paper the focus will be on firms whose primary activity is goods production and their contribution to these trends. As it turns out, their contribution has been significant: over 1997-2007 the manufacturing sector accounted for 16 percent of the total increase in U.K. services provision, a contribution that added nearly one percentage point annually to U.K. GDP. Had the manufacturing sector *not* undergone this transition toward increased services provision its share of total output would have been 10 percent in 2007, rather than the 13 percent that it represented. Thus, to the extent that manufacturing has remained a relevant source of growth for the U.K., this suggests it has done so in part by becoming more services-oriented.

A closer look at the data suggests that import competition in goods may be an important force behind these trends. First, U.K. consumption of both goods and services rose significantly over this period; however, as Figure 1(b) indicates, the corresponding supply-side growth was different in the two markets. Whereas the increased demand for services by U.K. consumers was largely met via increased provision of services by U.K. firms, the growth in demand for goods was overwhelmingly met via an increase in imports – in fact, domestic production of goods fell slightly over the period (see Figure 1). The U.K. manufacturing sector thus experienced an aggregate shift away from goods production and toward services provision during a period

in which aggregate consumption of both grew, with an important role for goods imports in meeting demand. Furthermore, this was not simply a composition effect: of the 373 4-digit manufacturing industries, 282 saw goods production fall and 338 saw an increase in services provision, suggesting a common industrial trend.

The firm-level evidence also points to a substantial shift toward services provision, and away from goods production. Specifically, using U.K. firm-level data, a simple regression of the log of goods revenues on the log of services revenues, along with firm fixed effects, produces a coefficient on services equal to -0.35, significant at the one percent level. Thus, within the firm goods and services output was inversely related over the period. Considered in light of the aggregate trends, existing U.K. firms have been, on average, re-orienting production toward services *at the expense of* goods.

Using firm-level data for the U.K. we explore the link between import competition in goods and the firm's tradeoff between goods production and the domestic provision of "non-industrial" services, a category that can be broadly considered as sales of knowledge-intensive services.[1] We exploit variation in E.U. trade barriers faced by goods exporters to the U.K. in order to identify the impact of increased goods market competition on the firm's production decision. We find that the degree of import competition in goods is strongly associated with a shift to greater domestic services provision.

We motivate the empirics with a simple model of import competition. In the model, the firm allocates its (scarce) stock of accumulated industry expertise in order to augment the productivity of its goods and services production. The firm's expertise is both confined to the firm and rivalrous in its use across goods and services production. We show that one implication of this is that the greater the aggregate stock of industry expertise the easier it is for the firm to adjust its production strategy in the face of changing market conditions. In light of the model, we augment our regression specification in order to explore the firm-level determinants of the magnitude of the response to import competition. In other words, we ask: why are some firms able to alter their production strategies in the face of import competition while others are not? Following the prediction of the model we focus on the role of the firm's accumulated expertise, as embodied by the firm's stock of research and development. The empirical results suggest an important role

[1] See Appendix A for the services types included in this group.

for this proxy for expertise in facilitating the transition to more intensive services provision in the face of goods market competition.

The paper is organized as follows. Section 1 presents a simple model; Section 2 describes the data; Section 3 implements an empirical strategy; and Section 4 concludes.

1. An Illustrative Model

The descriptive evidence above suggests that firms face a tension between goods and services production. There are several ways in which this tension could be modeled, as there are several potential determinants of the tradeoff that the firm faces. One mechanism has been proposed by Bloom, Romer and Van Reenen (2012), who suggest that in "good times" the opportunity cost of reallocating inputs away from the goods market is relatively high, and so the current production structure is maintained. During "bad times" however, reallocation is relatively attractive and shifts in production occur. One problem that this formulation presents is that it is very difficult to observe input reallocation within firms.

In light of this we take a somewhat different approach, abstracting from business cycle considerations and suggesting that rather than facing a choice about input allocation across production activities, firms face a choice regarding the relative productivity of their inputs across production activities. More specifically, firms allocate their accumulated knowledge resources – what we will refer to as "expertise" – across activities within the firm – resources that perhaps take the form of managerial focus or technical know-how (we discuss this further below). We take this firm-specific knowledge as exogenous in the model and explore its content in the empirics. As we will see, the primary results from the model suggest, first, ambiguity regarding the firm's response to changing market conditions (for instance due to import competition) and, second, a key role for the firm's level of accumulated expertise once the response has been pinned down.

In the following partial equilibrium model firms produce multiple output types – goods and services – and must decide how to allocate their accumulated expertise across the production of each. The scarce nature of the expertise, and its confinement to the firm, induces a tradeoff in goods and services production and generates predictions regarding how firms adjust production in the face of changing market conditions, such as increased import competition.

1.1. Demand

We consider a continuum of industries in which a representative agent consumes industry-specific goods and services. The agent's preferences over total industry output are Cobb-Douglas such that the share of aggregate expenditure spent on industry j is κ_j, where $\int_0^1 \kappa_j dj = 1$. Furthermore, the share of industry j expenditure that is spent on services output from that industry is ν_j. We therefore denote by $E_{jS} \equiv \kappa_j \nu_j E$ and $E_{jG} \equiv \kappa_j (1 - \nu_j) E$ the expenditure on services and goods output, respectively, from industry j, where E is total expenditure in the economy.

We assume that preferences for goods and services are separable and within an industry are given by independent Constant Elasticity of Substitution (CES) utility functions. For reasons described below, all firms will produce both a good and a service variety. The CES demand for the variety of good and the variety of service produced by firm $i = 1, ..., N_j$ in industry j can be written separately as:

$$q_{ijG} = p_{ijG}^{-\sigma} P_{jG}^{\sigma} E_{jG} \tag{1}$$

$$q_{ijS} = p_{ijS}^{-\gamma} P_{jS}^{\gamma} E_{jS} \tag{2}$$

where $\sigma > 1$ denotes the elasticity of substitution across varieties of goods and $\gamma > 1$ denotes the elasticity of substitution across services varieties. In addition, the industry price indices can be written as $P_{jG} = \left[\int_{i=1}^{N_j} (p_{ijG})^{1-\sigma} + \int_{i=1}^{N_j^*} (p_{ijG}^* \tau_{jG})^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$ and $P_{jS} = \left[\int_{i=1}^{N_j} (p_{ijS})^{1-\sigma} + \int_{i=1}^{N_j^*} (p_{ijS}^* \tau_{jS})^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$, where * denotes foreign values and τ_{jG} and τ_{jS} are industry-specific goods and services trade costs, respectively.

1.2. Production

We assume that the firm's production functions for goods and services take the following general form:

$$Y_{ijG} = \Lambda_{ijG} T_{ijG} L_{ijG} \tag{3}$$

$$Y_{ijS} = \Lambda_{ijS} T_{ijS} L_{ijS} \tag{4}$$

where $\Lambda_{ijl} T_{ijl}$ is a firm-specific productivity term that is comprised of a fixed, exogenously determined component, Λ_{ijl}, and an endogenously chosen component, T_{ijl}, where $l \in (G, S)$. The

firm's labor input is L_{ijl}.

The key feature of the model is our interpretation of T_{ijl} which, motivated by the stylized facts and discussion above, we assume to reflect the extent to which the firm's accumulated industry-specific expertise is directed toward one output type or the other. Over time firms both passively and actively accumulate knowledge (expertise) about the products they are selling and the markets they are selling to. Since this knowledge is, to some extent, embodied in workers and managers whose time is limited, it must be apportioned efficiently within the firm. Formally, we assume that the stock of expertise is both fixed within the firm and rivalrous in its use across output types in the sense that increased use of expertise in producing one output type reduces the expertise available in producing the other output type. We model the degree of rivalry in expertise across goods and services production in the following reduced-form way:

$$T_{ij} = \left((T_{ijG})^t + (T_{ijS})^t\right)^{1/t} \tag{5}$$

where we assume that $t \in [1, \infty)$ and governs the extent of rivalry in the use of expertise across output types.

Given this setup, the profit maximization problem of the firm is:

$$\max_{\mathbf{p}_{ijG}, \mathbf{p}_{ijS}, T_{ijG}, T_{ijS}} \pi_{ij} = \sum_{j=1}^{J} \left[p_{ijG} Y_{ijG} + p_{ijS} Y_{ijS} - w_{ij} \left(\tau_j^G L_{ijG} + \tau_j^S L_{ijS} \right) \right] \quad s.t. \;\; T_{ij} = \left((T_{ijG})^t + (T_{ijS})^t\right)^{1/t}$$

which, substituting in (1)−(5), is equivalent to:

$$\max_{\mathbf{p}_{ijG}, \mathbf{p}_{ijS}, T_{ijG}, T_{ijS}} \pi_{ij} = \sum_{j=1}^{J} \left(p_{ijG}^{1-\sigma} P_{jG}^{\sigma-1} E_{jG} + p_{ijS}^{1-\gamma} P_{jS}^{\gamma-1} E_{jS} \right) - w_{ij} \left(\frac{\sum_{j=1}^{J} \tau_j^G p_{ijG}^{-\sigma} P_{jG}^{\sigma-1} E_{jG}}{\Lambda_{ijG} T_{ijG}} + \frac{\sum_{j=1}^{J} \tau_j^S p_{ijS}^{-\gamma} P_{jS}^{\gamma-1} E_{jS}}{\Lambda_{ijS} \left((T_{ij})^t - (T_{ijG})^t \right)^{1/t}} \right)$$

The solutions for the firm's optimal prices for each industry in each destination are then given by:

$$p_{ijG} = \frac{\sigma}{\sigma - 1} \frac{\tau_j^G w_{ij}}{\Lambda_{ijG} T_{ijG}} \tag{6}$$

$$p_{ijS} = \frac{\gamma}{\gamma - 1} \frac{\tau_j^S w_{ij}}{\Lambda_{ijS} \left((T_{ij})^t - (T_{ijG})^t \right)^{1/t}} \tag{7}$$

The firm faces a clear tradeoff. For instance, by directing more expertise toward goods production, increasing T_{ijG}, the firm is able to lower its output price for goods and improve its competitiveness in the goods market, thus yielding greater production of goods at the expense of services. Ultimately, the firm's optimal allocation will depend on the relative marginal profitability of goods versus services across all markets. Solving for this optimal allocation decision, and substituting in the optimal prices (6) and (7), the equilibrium expertise directed toward goods production can be written (services is symmetric):

$$T_{ijG}^{\frac{\sigma-\gamma}{t}} \left(\left(\frac{T_{ij}}{T_{ijG}} \right)^t - 1 \right)^{\frac{1+t-\gamma}{t}} = \frac{\frac{\sigma}{\sigma-1}\mu_{ijG}}{\frac{\gamma}{\gamma-1}\mu_{ijS}} RMA_j \tag{8}$$

where $\mu_{ijG} \equiv \left(\frac{\sigma}{\sigma-1} \frac{w_{ij}}{\Lambda_{ijG}} \right)^{\sigma-1}$ is the markup over the efficiency wage for goods (services is symmetric) and $RMA_j \equiv \frac{\sum_{j=1}^J \tau_{jS}^{1-\gamma} P_{jS}^{\gamma-1} E_{jS}}{\sum_{j=1}^J \tau_{jG}^{1-\sigma} P_{jG}^{\sigma-1} E_{jG}}$ is the effective "relative market access" associated with each output type. The allocation decision is therefore a function of relative market conditions (RMA), the firm's aggregate stock of expertise (T_{ij}), the elasticity parameters associated with goods and services markets (σ, γ), and the degree of rivalry in the use of expertise within the firm (t).

We can also derive the (partial equilibrium) goods and services revenues that the firm receives in each market, which are given by:

$$R_{ijG} = \left(\frac{\sigma}{\sigma - 1} \right)^{1-\sigma} \left(\frac{\tau_j^G w_{ij}}{\Lambda_{ijG} T_{ijG}} \right)^{1-\sigma} (P_{jG})^{\sigma} E_{jG} \tag{9}$$

$$R_{ijS} = \left(\frac{\gamma}{\gamma - 1} \right)^{1-\gamma} \left(\frac{\tau_j^S w_{ij}}{\Lambda_{ijS} T_{ijS}} \right)^{1-\gamma} (P_{jS})^{\gamma} E_{jS} \tag{10}$$

where the optimal allocation of T_{ijS} is given by (8) and its services counterpart.

1.2.1. Comparative Statics

The focus of the empirics will be on the extent to which firms alter their production strategies in the face of increased competition in the goods market, reflected in the model as a decline in relative domestic market access. More specifically, as import tariffs on goods fall, the result is a decline in the goods price index, P_{jG}, and thus a corresponding decline in relative domestic market access for goods as the domestic market becomes more competitive. Reiterating the results from above, condition (8) indicates that the firm's response to this will depend on its aggregate stock of expertise, T_{ij}, the demand parameters σ and γ, along with the extent to which expertise is "freely available" within the firm, governed by the rivalry parameter t.

The result is an ambiguous response on the part of firms due to the increased import competition in the goods market. To see this, we can differentiate the equilibrium condition (8) with respect to the goods price index, P_{jG}. This leads to sufficient conditions under which the firm will respond by reallocating expertise toward services provision. The flip side are conditions under which the firm will respond by increasing the expertise allocated to goods production.

Proposition 1. *Given equilibrium condition (8) and its services counterpart, the following sufficient conditions hold:*

- *When* $1 + t < \gamma < \sigma$, *then* $\frac{\partial T_G}{\partial P_G} > 0$ *and* $\frac{\partial T_S}{\partial P_G} < 0$
- *In contrast, when* $\sigma < \gamma < 1 + t$, *then* $\frac{\partial T_G}{\partial P_G} < 0$ *and* $\frac{\partial T_S}{\partial P_G} > 0$

See Appendix A for proof.

The intuition is the following: when, for example, the goods elasticity, σ, is large relative to the services elasticity, γ, the marginal increase in profits associated with a small increase in the allocation of expertise toward goods production exceeds the increase from allocating additional expertise toward services provision, an effect that is ultimately due to the fact that expertise enhances the productivity of the firm in producing each output type. In short, the firm faces a "flee" or "fight" decision. In this case the firm will find it more profitable to fend off import competition in goods – i.e., to fight – rather than to switch toward increased services provision – i.e., to flee.

In addition, from (5) we can see that for a given stock of expertise, T_{ij}, both T_{ijG} and T_{ijS} are decreasing in t. This is because for larger t (more rivalrous expertise) there is less "shared"

expertise in the production of each output type. For fixed elasticities in goods and services, a larger t therefore constrains the transfer of expertise toward goods production in the face of increased competition in the goods market. This leads to an additional implication of the first result in Proposition 1: when t is too large then it will not be profitable for the firm to respond to increased competition by fighting (when $\sigma > \gamma$). The second result in Proposition 1 then indicates that the opposite holds as well: the firm will only reorient toward services, or flee, when expertise is sufficiently mobile within the firm.

Finally, whether the firm will flee or fight will depend on the firm's capacity to do so. Specifically, for given values of the parameters, σ, γ and t, the size of the aggregate stock of expertise matters for the extent of reallocation. Formally:

Proposition 2. *The sign of* $\frac{\partial^2 T_k}{\partial P_G \partial T}$ *is the same as the sign of* $\frac{\partial T_k}{\partial P_G}$ *for* $k \in (G, S)$.

See Appendix B for proof.

Having a larger stock of expertise magnifies the extent of reallocation in the face of import competition. In other words, the more expertise a firm has accumulated, the easier it will be to reorganize production to fend off import competition (to fight) or, alternatively, to re-orient the firm toward increased services provision (to flee), depending on which condition holds in Proposition 1. As we will see, this result allows for a formal test of the role that firm inputs play in the response to shocks to the domestic market and, crucially, it does so without the need to observe shifts in the allocation of inputs across production within the firm which, as noted, can be difficult.

To sum up, we motivated the structure of our model in large part by pointing to the parallel growth in import competition in the U.K. goods market and sales of services by domestic goods producers. In addition, we find a strong negative correlation between goods and services revenues within U.K. firms, suggesting a tradeoff in production over the period. The simple structure of our model led straightforwardly to Propositions 1 and 2 which predict: 1. It is unclear whether firms will "fight" or "flee" in the face of increased goods market competition, with the response depending on demand conditions in the two sectors and 2. Having a larger stock of expertise magnifies the extent of reallocation in the face of import competition, whatever its direction. We next describe the data we use to determine and evaluate the empirically relevant cases.

2. Data and Empirical Measures

2.1. Firm Data

The primary dataset used is the U.K. Annual Census of Production Respondent's Database (ARD), which contains the relevant firm variables over the period 1997-2007. The ARD is drawn from an underlying register of the universe of U.K. businesses and is the U.K. equivalent of the U.S. Longitudinal Respondents Database. The data consist of the full population of large businesses (those with more than 100 or 250 employees depending on the year) as well as a random sample of smaller businesses.[2] We then combine these data with information on the annual research and development (R&D) investments by firms, drawn from the Business Expenditure on Research and Development (BERD) dataset. We construct the R&D stock for each firm using the perpetual inventory method applied to the BERD flows, adopting an economic depreciation rate of 30 percent.[3] Figure 5 illustrates the distribution of R&D as a share of total industry output across major manufacturing industries. Our final dataset contains between 6,441 and 38,617 individual firms depending on the specification[4], covering 243 4-digit manufacturing industries over 1997-2007.

The ARD includes many establishment-level variables and, for our purposes, the most relevant will be the total value of industrial services provided by the establishment, the total value of non-industrial services provided by the establishment, and the total value of goods of own production produced. Appendix E provides the exact survey questions asked in constructing the ARD for the primary variables used in our empirical section. As suggested by these variables we will distinguish between industrial and non-industrial services. Since industrial services are comprised primarily of repair and maintenance services, we set these aside in the empirical analysis. The provision of these services is highly correlated with goods production and so variation in their provision does not provide much additional information or insight. The focus of the empirical analysis is therefore on firms' output of non-industrial services. Figures 3 and 4 show how

[2]For a comprehensive description of this dataset see Criscuolo, Haskel and Martin (2003) or for a summary see Breinlich and Criscuolo (2010).

[3]We choose this value following the convention in the literature – see, for instance, Bloom, Griffith and Van Reenen (2002). However, our results are virtually unchanged for values near this.

[4]In specifications that include the R&D variables the number of firms is reduced to the smaller of these numbers due the smaller sample of firms drawn for the BERD. In both cases the samples are representative.

services output is distributed both across, and within industries in the manufacturing sector. It's clear that both the Chemicals and Vehicles industries play an outsized role in manufacturing's contribution to services provision.

While the exact composition of non-industrial service types produced by firms is unavailable (though Appendix C lists the possible service types), we can gain some sense of the specific services being provided by firms by looking at the services that they export. The International Trade in Services (ITIS) dataset contains this information at the firm level and, though it is a survey, it has wide coverage of the U.K. firms most likely to engage in export activity. It can also be merged with the ARD allowing us to gain a good descriptive sense of the relationship between services producers and their exports.

The estimation strategy will be motivated by the revenue function, (10), and so we want to be careful to address its implications. Firstly, the revenue function indicates the need for firm-level controls for input prices, given by w_{ij}, as well as controls for services-specific productivity shocks at the firm level, Λ_{ijS}. To this end, we control directly for the average wage bill of the firm and also include a measure of investments in plant and machinery as a proxy for the variation in productivity that is driven by new technologies. Finally, in our most restrictive specifications we include two-digit industry time trends to jointly control for productivity trends as well as trends in aggregate expenditure on each industry's output, which in the model are given by the terms E_{jS} and E_{jG}.

2.2. Trade Barriers

In all specifications we will control for both the direct and indirect effects of variation in all four trade barriers: import and export barriers associated with both goods and services. Again from (10), the direct effects are those operating directly through the export barriers, τ_j^G and τ_j^S, and through the import barriers, which are embodied by the price indices, P_{jG} and P_{jS}. In addition, variation in each of these variables will affect revenues through the optimal allocation of expertise, T_{ijS} and T_{ijG}, as both of these firm choice variables are a function of all four trade barriers. These are what we consider the indirect effects, and they are reflected in the partial derivatives of (8) with respect to one of the trade barriers. Note again that Proposition 1 indicates that the sign of the partial derivative is ambiguous without further information regarding the

relative magnitudes of σ, γ and t.

Throughout the analysis the source of variation we will be most interested in will be due to variation in E.U. import tariffs on goods. In particular, the focus of the empirics will be on the effect of variation in goods import tariffs on services revenues, which from (10) operates via the indirect effect – i.e., a reallocation of expertise. We collect goods import tariffs from the World Trade Organization Tariff Database and note that they include both Most Favoured Nation tariffs as well as Regional Tariff Agreements signed during the period, which we list in Appendix D. Figure 2 illustrates the variation in these tariffs that we exploit in the regressions. Goods export tariffs come from John Romalis[5] and we aggregate these up to the U.K. SIC industry level as a trade-weighted sum across countries and destinations.

For measures of services trade barriers we rely on an index constructed for OECD countries and published by the OECD. Since our empirical analysis will take place at the U.K. SIC industry level, while the trade barrier index is classified by service type, we need to determine the services types that correspond to each SIC industry. To do this, we focus on the service types that are imported and exported by firms in a particular SIC industry, obtained from the ITIS, which we use to construct import and export trade barrier indices at the SIC industry level as a simple trade-weighted sum of the OECD service type measures for each industry. Importantly, all of these trade barriers are likely to be largely exogenous to U.K. industrial trends due to the fact that their values are set in Brussels.

3. Empirics

As noted, our primary empirical specification is motivated by the revenue function (10). Since this function is multiplicative it suggests running a regression that is non-linear in its parameters. In addition, there are many zeroes for the value of services revenue – i.e., there are many firms who provide no services. Most importantly, given the highly skewed distribution of revenues across firms it is unlikely that the unexplained variation in either specification will be homoskedastic. As Santos-Silva and Tenreyo (2006) point out, the log of the error term is then likely to be correlated with the regressors, due to the mechanical correlation between the mean and variance of a logged variable. The combination of these facts then suggests that we follow

[5]University of Sydney

the suggestion of Santos-Silva and Tenreyo (2006) in adopting the Poisson Pseudo-Maximum Likelihood (PPML) estimator.

We focus narrowly on *domestic* services revenues as the dependent variable in order to cleanly identify the relevant effect. In other words, we remove variation in firm-level services exports since any omitted variable that is correlated with the trade barriers (the regressors of interest) will likely be correlated with the services exports of U.K. firms. The baseline empirical model we wish to estimate is the following:

$$R_{ijtS} = exp\left[\eta_{ij} + \theta_t + \beta_1 \tau^{M}_{jtG} + \beta_2 \tau^{X}_{jtG} + \beta_3 \tau^{M}_{jtS} + \beta_4 \tau^{M}_{jtS} + \beta_5 \ln \bar{w}_{ijt} + \beta_6 \ln \psi_{ijS} + \rho_{mt}\right] + \epsilon_{ijt} \quad (11)$$

where R_{ijtS} represents domestic firm revenues in services, the τs represent import and export barriers for goods and services associated with industry j, η_{ij} and θ_t are firm and year fixed effects, respectively, ψ_{ijS} is a measure of investment in plant and machinery, and ρ_{mt} is a 2-digit industry time trend. We cluster standard errors at the 4-digit industry level, the level of variation of our regressor of interest.

3.1. Firm Response to Import Competition

The first results are presented in Table 1, in which the primary regressor of interest is the E.U. goods import tariff and columns (2) and (3) are progressively more restrictive. Note that the dependent variable is *domestic* services revenues, as opposed to total services revenues, a choice that allows us to carefully focus on the effect due to increased domestic competition, rather than any confounding effects due to correlations between services exports and the trade barrier variables.

From Table 1 we see that a fall in the goods import tariff has a negative and significant effect on domestic services revenues, implying that increased goods market competition has shifted firms' production strategies toward services. In terms of economic magnitudes, a one percentage point reduction in the goods import tariffs – over a period in which these tariffs declined by 3 percentage points on average – has led to an approximately 4 percent increase in domestic services revenues. Importantly, the economic magnitude is significant: over the period this import competition-induced rise in services revenues was equal to 24 percent of the total rise

in domestic services revenues.

3.2. Determinants of Firms' Response to Import Competition

We next run a regression in which firm-level domestic services revenues are the dependent variable and the goods import tariff is now interacted with additional regressors – i.e., we allow for firm heterogeneity in the response to trade liberalization. We interpret this as an exploration of the relevant proxies for what we term "expertise" in the model, given by T. To reiterate the theoretical result that we are interested in, Proposition 2 states that when firms possess a greater stock of the rival input, they will be unambiguously more responsive to import competition. As discussed above, we are interested in particular in the role of knowledge inputs, as proxies by the stock of R&D.

We also examine heterogeneity with respect to firm labor productivity and capital investment since these may be proxies for firm capabilities more generally, and may therefore affect firm responsiveness to import competition. Formally, we estimate the following specification:

$$R_{ijtS} = exp\Bigg[\eta_{ij} + \theta_t + \alpha_1(\ln R\&D_{ijt} \times \tau^{M}_{jtG}) + \alpha_2(\ln CapInv_{ijt} \times \tau^{M}_{jtG}) + \alpha_3(\ln LabProd_{ijt} \times \tau^{M}_{jtG}) + \\ + \alpha_4(R\&D_{ijt}) + \alpha_5(CapInv_{ijt}) + \alpha_6(LabProd_{ijt}) + \alpha_7\tau^{M}_{jtG} + \alpha_8\tau^{X}_{jtG} + \alpha_9\tau^{M}_{jtS} + \alpha_{10}\tau^{M}_{jtS} + \\ + \alpha_{11}\ln\bar{w}_{ijt} + \alpha_{12}\ln\psi_{ijS} + \rho_{mt}\Bigg] + \epsilon_{ijt} \quad (12)$$

where we are interested in particular on the coefficients α_1, α_2 and α_3.

Table 2 reports the results. Again columns (2) and (3) are more restrictive, adding wages and capital controls in (2) and 2-digit time trends in (3). The results indicate a strong role for R&D in promoting the firm's response to import competition, as well as a mitigating role for capital intensity. Taken together with the results from Table 1 the results suggest that, on average, import competition in the goods market leads firms to flee toward services provision, and that the most knowledge-intensive, and least capital-intensive, firms are the most responsive.

4. Additional Empirical Results

It is possible that the pattern observed in the regression results above may be due to an increase in geographic specialization on the part of multinationals. In other words, U.K. firms may simply be moving their goods production overseas while increasingly focusing their activities on headquarters services. Note that this possibility does not undermine the goal of this paper, which is simply to estimate the causal relationship between import competition in goods and increased services provision on the part of U.K. firms, independent of the firm's motivations for the transition. It does, however, potentially add nuance to the story, as it addresses whether firms are simply ceasing goods production in the face of competition, or are relocating goods production.

We can test for evidence of this mechanism by simply repeating regression (11) but, rather than using domestic services revenues as the dependent variable, we instead use the total volume of "affilate services" trade associated with each firm. This service type is one of the categories within the ITIS dataset, and should be associated with increasing production fragmentation within the firm.

Table 3 (Note: this regression has not been done yet) reports the results of this regression, and we can see that X

5. Concluding Remarks

References

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Feenstra, R., J. Romalis and P. Schott (2002) "U.S. Imports, Exports and Tariff Data, 1989-2001", NBER Working Paper No. 9387.

A Proof of Proposition 1

We begin by totally differentiating (8) with respect to the goods price index, P_G. This yields:

$$\frac{\partial T_G}{\partial P_x} = \frac{\frac{\partial RMA_{SG}}{\partial P_x}}{RMA_{SG}} \frac{T_G}{\Omega} \tag{13}$$

where $\Omega \equiv \frac{\sigma-\gamma}{t} + (\gamma - 1 - t)\left(\frac{T}{T_S}\right)^t$.

The sign is therefore determined by the ambiguous term, Ω, that takes into account the relative use of T in each output type and its relation to the elasticities of substitution in each sector. The sufficient conditions in Proposition 1 can be derived simply by noting that Ω will be positive when both $\sigma > \gamma$ and $\gamma > 1 + t$. Similarly, it will be negative under the reverse conditions.

Finally, the signs of $\frac{\partial T_S}{\partial P_G}$ follow directly from the imperfect substitution implied by the CES structure in (5). ■

B Proof of Proposition 2

Differentiating (13) with respect to T yields:

$$\frac{\frac{\partial RMA_{SG}}{\partial P_x}}{RMA_{SG}}\left(\frac{\frac{\partial T_G}{\partial T}}{\Omega}-\frac{t(\gamma-1-t)\frac{T_G}{T_S}\left(\frac{T}{T_S}\right)^{t-1}\left(1-\frac{T}{T_S}\frac{\partial T_S}{\partial T}\right)}{\Omega^2}\right)$$

where Ω is defined as above. The sign of this derivative depends once again on the relative values of the substitution parameters (γ, σ, and t). However, under the sufficient conditions from Propositions 1 and 2, we can pin down the direction of the second derivative. We have two cases:

1. When $1+t<\gamma<\sigma$, Proposition 1 holds since $\Omega>0$. Since $\frac{\partial T_G}{\partial T}>0$, $\frac{\partial^2 T_G}{\partial P_x \partial T}$ will be the same sign as $\frac{\partial T_G}{\partial P_x}$ when $1-\frac{T}{T_S}\frac{\partial T_S}{\partial T}<0$.

2. When $\sigma<\gamma<1+t$, Proposition 2 holds since $\Omega<0$. Again, since $\frac{\partial T_G}{\partial T}>0$, $\frac{\partial^2 T_G}{\partial P_x \partial T}$ will be the same sign as $\frac{\partial T_G}{\partial P_x}$ when $1-\frac{T}{T_S}\frac{\partial T_S}{\partial T}<0$.

From (5) we know that $\frac{\partial T_S}{\partial T}>0$, and since $\frac{T}{T_S}$ is always greater than 1, it is therefore always true that $1-\frac{T}{T_S}\frac{\partial T_S}{\partial T}<0$. Thus, $\frac{\partial^2 T_G}{\partial P_x \partial T}$ will always be the same sign as $\frac{\partial T_G}{\partial P_x}$.

■

C Service Types in the ITIS

Aggregate Service Types (10)	*Disaggregated Service Types (38)*
Business Services	Legal services
	Accounting and auditing
	Management consulting and public relations
	Advertising
	Market research and polling
	Property management
	Procurement
	Publishing services
	Recruitment and training
	Other business services
	Operational leasing
R&D	Research and development
Financial Services	Insurance: Premiums
	Insurance: Claims
	Financial services
	Auxiliary services
Affiliated	Management charges
Telecommunication Services	Telephone services
	Postal services
	Computer services
	Information services
Technical Services	Architectural
	Engineering
	Surveying
	Agricultural services
	Mining services
	Other technical services
	Waste treatment and depollution
	Other on-site maintenance
Construction	Construction services
Cultural Services	TV and radio related services
	Other cultural and recreational services
	Health services
Royalties and Licences	Payments/Receipts for the use of intangible assets
	Payments/Receipts for the outright purchase or sale of intangible assets
Trade Related Services	Merchanting
	Earnings from trading in commodities
	Any other trade in services not shown elsewhere

D Variable Definitions

We list here the directions provided to respondents in the ARD survey regarding the definitions of different output types.

Value of Sales of Goods of Own Production (R_{iG})

- Sales of goods made by you or for you by others from materials supplied by you;
- Sales of waste products, residues and scrap.

Value of Industrial Services Provided By You (R^I_{iS})

- Payments received for entry, exit, system and infrastructure charges;
- Option fees and net amounts receivable under contracts for differences;
- Any repairs, maintenance and installation provided by you to customers.

Value of Non-Industrial Services Provided By You (R^{NI}_{iG})

- Management Fees;
- Income derived from the renting of property;
- Services provided to other organisations such as amounts charged for hiring out plant, machinery and other goods, the provision of transport, computer processing, technical research and studies;
- Amounts received for the right to use patents, trademarks, copyrights, etc., manufacturing rights, technical know-how and advertising revenue;
- Royalty payments received;
- Use of system charges;
- Transport and delivery charges where possible.

E EU Regional Trade Agreements, 1997-2007

The following are regional trade agreements that entered into force during the period we cover. These negotiated tariffs are included along with MFN tariffs in our analysis.

EU-Chile Association Agreement

- Entered into force on interim basis on 1 February, 2003
- Entered fully into force on 1 March, 2005

EU-Mexico Economic Partnership, Political Cooperation and Cooperation Agreement

- Free trade area entered into force in 2000

EU-South Africa Trade, Development and Co-operation Agreement

- Entered into force on a provisional basis since 2000, in full force in 2004.
- Progressively introduced a free trade area.

EU-Gulf Co-operation Council (GCC) Free Trade Agreement

- GCC countries include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates
- Introduced a free trade area that entered into force in 2003

Table 1. Domestic Services Output & Goods Import Competition, 1997-2007

Dependent Variable: Domestic Services Revenues

	(1)	(2)	(3)
Goods Import Tariff	-0.046***	-0.042***	-0.045**
	(0.015)	(0.016)	(0.019)
Goods Export Tariff	-0.111	-0.102	-0.104
	(0.072)	(0.066)	(0.068)
Services Import Barrier	0.061	0.076	0.076
	(0.242)	(0.234)	(0.264)
Services Export Barrier	0.001	0.001	-0.001
	(0.001)	(0.001)	(0.001)
Plant & Machinery Investment		0.006	0.007
		(0.039)	(0.038)
Firm Average Wage		0.459***	0.451***
		(0.166)	(0.164)
2-Digit Industry Trend	**No**	**No**	**Yes**
Number of Observations	38617	30226	30226

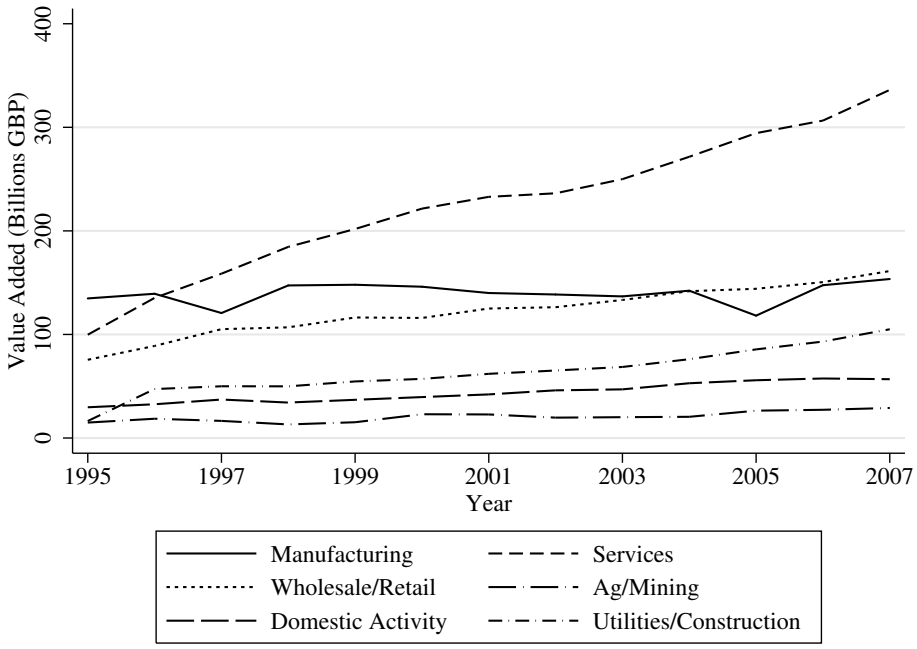
Note: The reported estimates are the outcome of a Poisson regression. All regressions include firm and year fixed effects and robust standard errors are clustered at the firm level. Plant and Machinery Investment and the Firm Average Wage are in logs, while the other regressors are in levels and vary between 0 and 1. ***, **,*: significant at 1%, 5%, 10%.

Table 2. Correlates of the Transition to Services Provision, 1997-2007

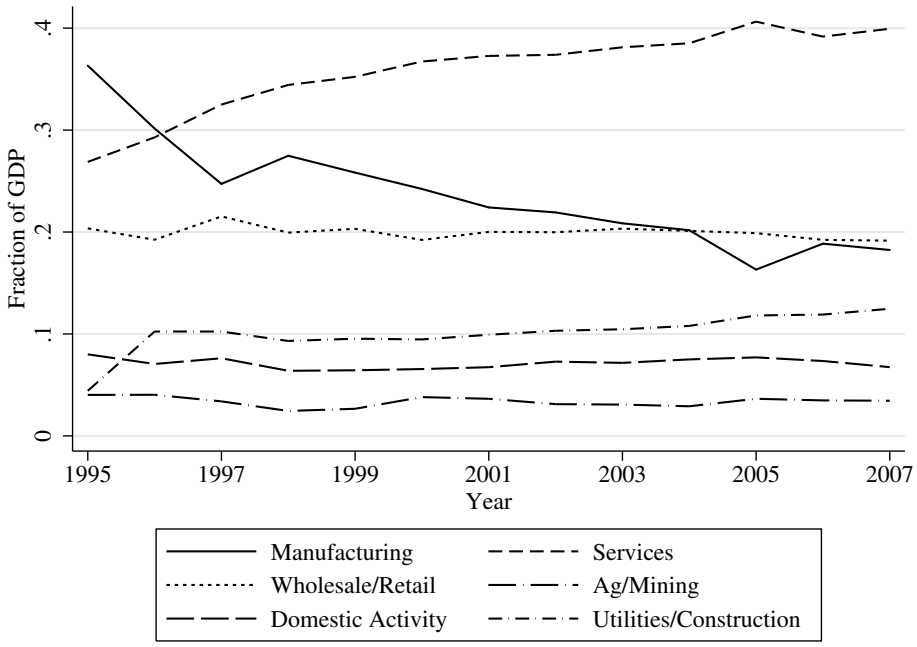
Dependent Variable: Domestic Services Revenues

	(1)	(2)	(3)
Goods Import Tariff x R&D Investment	-0.020**	-0.023**	-0.023**
	(0.009)	(0.011)	(0.011)
Goods Import Tariff x P&M Investment	0.036*	0.031*	0.032*
	(0.018)	(0.016)	(0.017)
Goods Import Tariff x Labor Productivity	-0.182	-0.162	-0.170
	(0.247)	(0.263)	(0.266)
R&D Investment	0.311***	0.262***	0.259***
	(0.084)	(0.072)	(0.072)
Plant & Machinery Investment	-0.179*	-0.244**	-0.249**
	(0.102)	(0.109)	(0.109)
Labor Productivity	-0.518	-0.092	-0.070
	(1.597)	(1.011)	(0.965)
Goods Import Tariff	0.047	0.061	0.062
	(0.099)	(0.098)	(0.099)
Goods Export Tariff	-0.129	-0.153	-0.142
	(0.126)	(0.126)	(0.125)
Services Import Barrier	0.254	0.556	0.657
	(0.648)	(0.556)	(0.585)
Services Export Barrier	-0.017	-0.052	-0.051
	(0.031)	(0.168)	(0.166)
Plant & Machinery Investment		0.031	0.035
		(0.096)	(0.095)
Firm Average Wage		1.32***	1.31***
		(0.377)	(0.376)
2-Digit Industry Trend	**No**	**No**	**Yes**
Number of Observations	7403	6441	6441

Note: The reported estimates are the outcome of a Poisson regression. All regressions include firm and year fixed effects and robust standard errors are clustered at the firm level. Plant and Machinery Investment and the Firm Average Wage are in logs, while the other regressors are in levels and vary between 0 and 1. ***, **,*: significant at 1%, 5%, 10%.



(a) Total Value Added



(b) Fraction of UK Economy

Figure 1: U.K. GDP by Sector

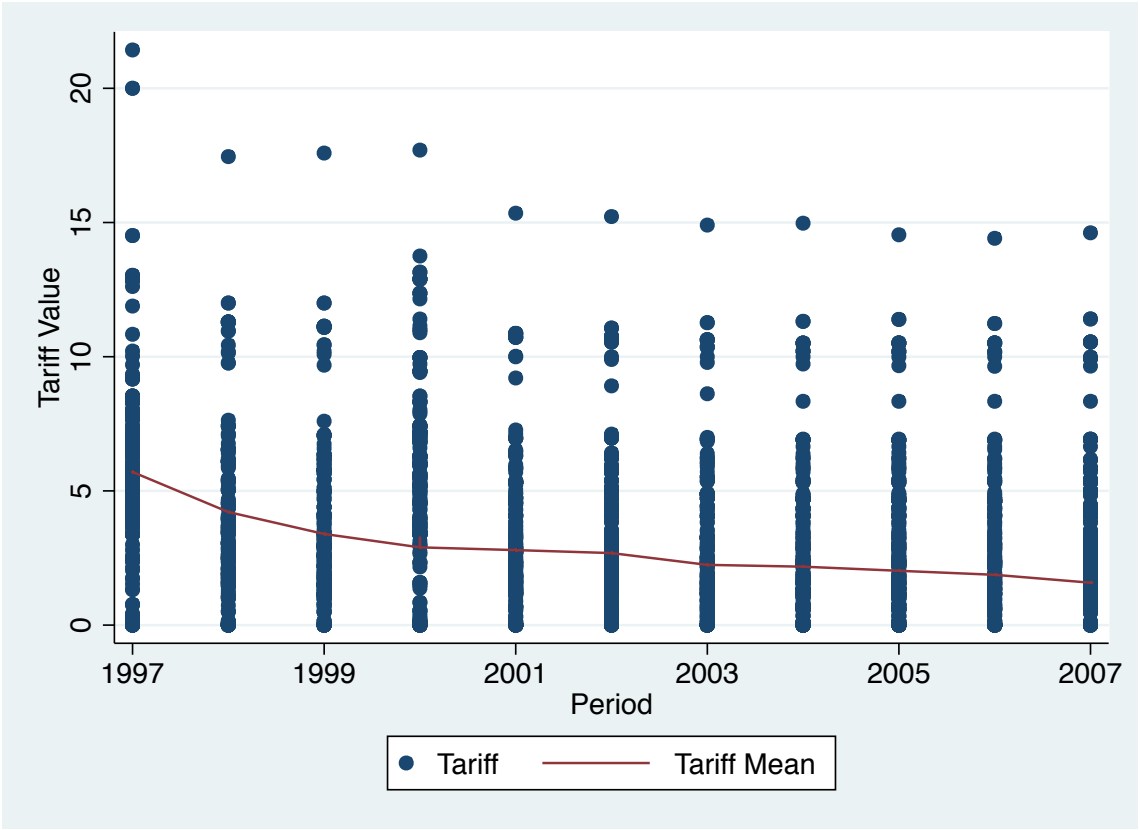


Figure 2: Tariffs, 1997-2007

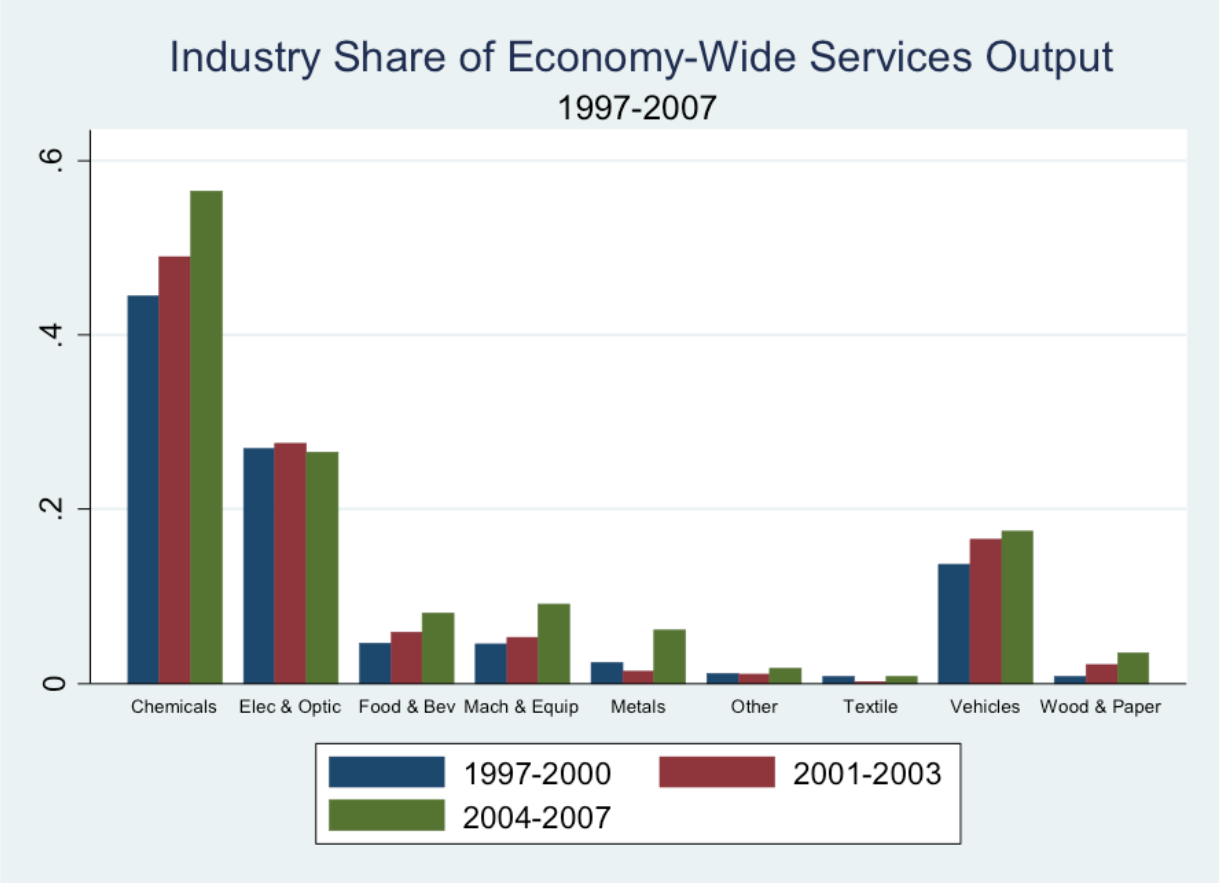


Figure 3: Industry Share of Manufacturing-Wide Services Output

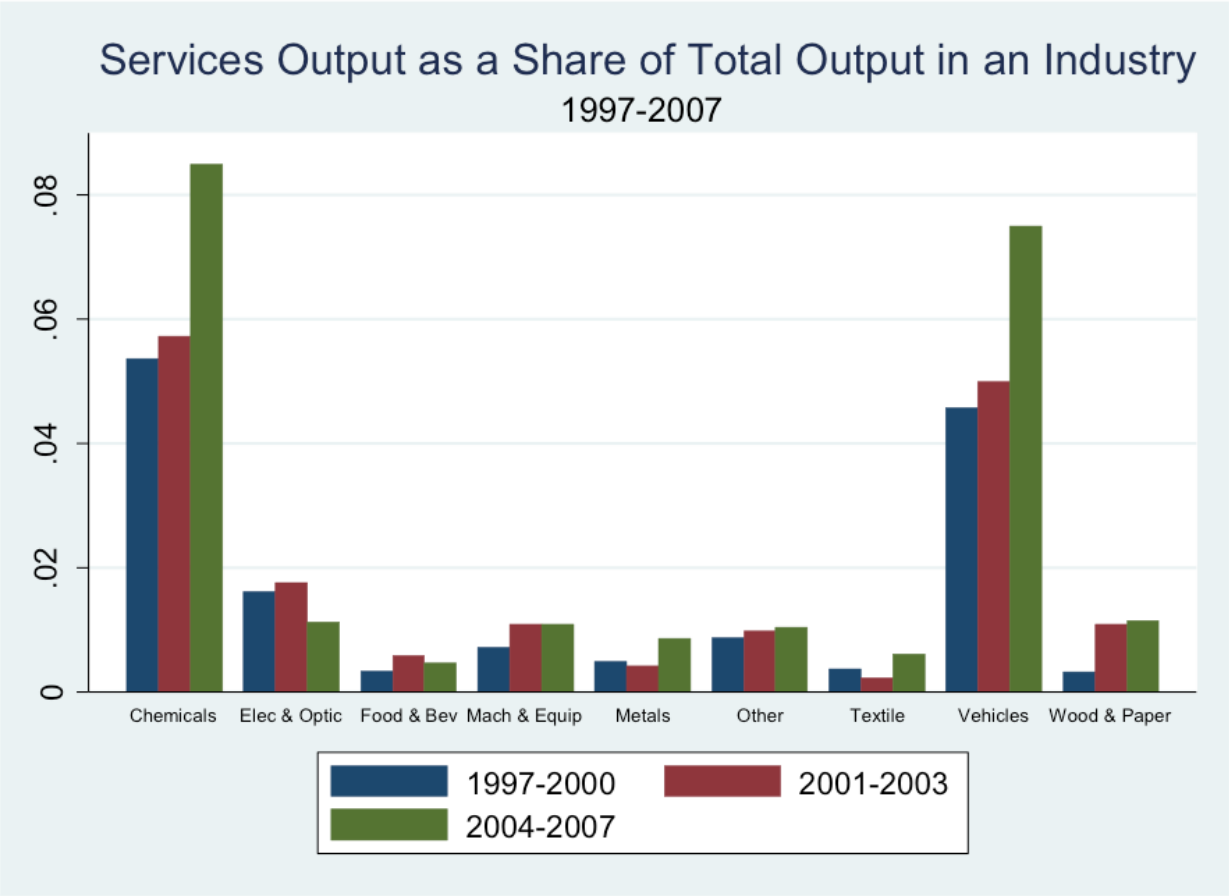


Figure 4: Services Output as a Share of Total Output in an Industry

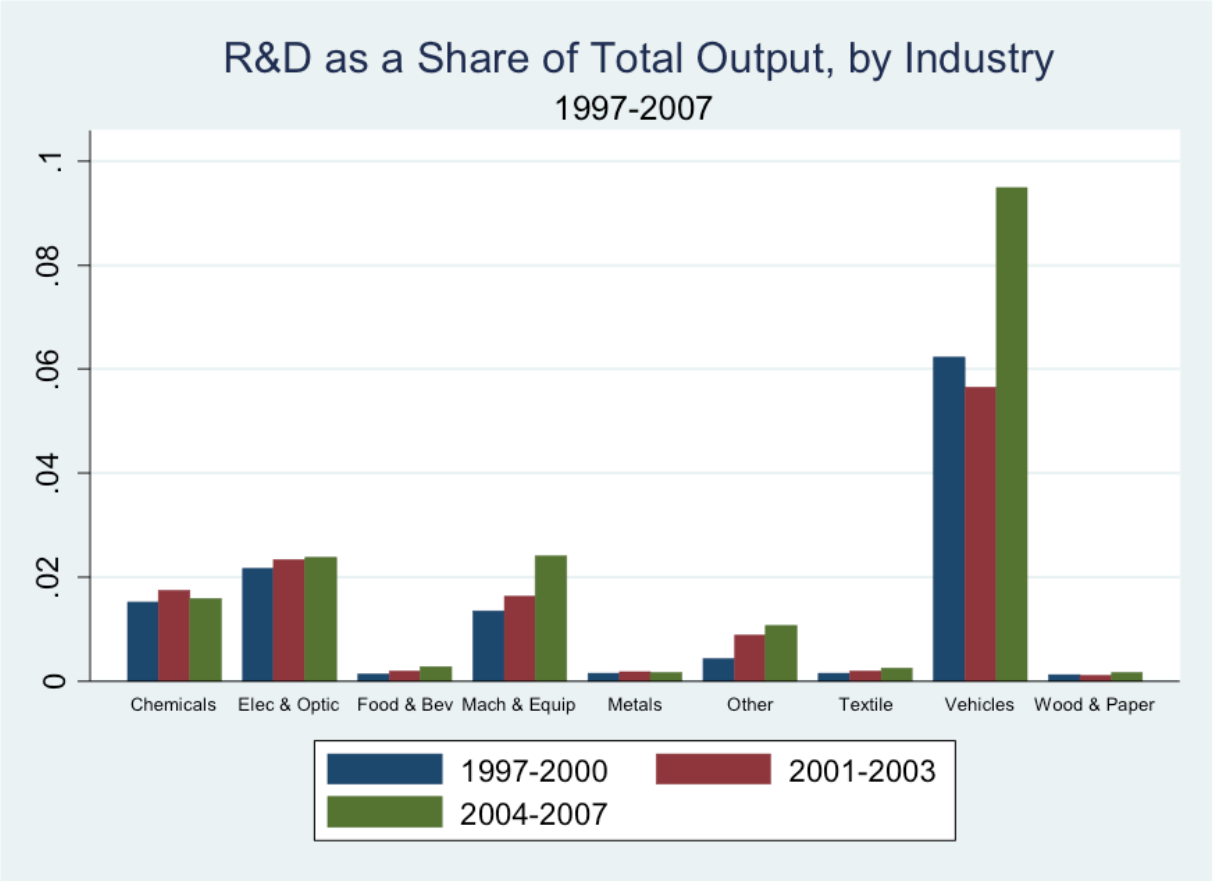


Figure 5: R&D as a Share of Total Output, by Industry