Downstream Offshoring and Firm-level Employment

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Abstract

When engaging in offshoring, firms do not only import intermediates they used to produce in-house, but also intermediates previously sourced from non-affiliated domestic suppliers. This leads to a negative demand shock for the latter. Prior empirical research has so far neglected this channel through which offshoring may affect employment. We label this demand shock 'downstream offshoring' and develop a novel measure capturing its extent for a firm in a given upstream industry. According to our estimations for a representative sample of Belgian manufacturing firms over 1997-2007, downstream offshoring has a robust negative effect on employment.

Keywords: Offshoring, supply chain, employment

JEL Classification: F2

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1 Introduction

Over the last couple of decades, the spread of global value chains has contributed to the deepening of global economic integration. Within global value chains, production processes have been reorganised through fragmentation and foreign sourcing. As emphasized in Baldwin (2011), this has been fostered by the fall in coordination costs through information and communication technology developments. The theoretical model of global sourcing in Antras and Helpman (2004) confirms the role played by such cost reductions in raising the share of intermediate inputs that are imported. This share is nowadays generally referred to as offshoring in the literature. Its growing importance is illustrated among others in De Backer and Yamano (2012). In developed economies, offshoring raises fears of massive job losses. Most academic work, however, fails to find evidence that offshoring contributes to lowering employment. The basic conjecture in this paper is that offshoring may actually affect employment through a channel that has not yet been explored in the literature. Offshoring may have important consequences not only for the firm that engages into offshoring but also for other domestic firms that are part of the same value chain, in particular domestic upstream firms that are linked to downstream firms through deliveries of intermediates. When a downstream customer decides to replace domestically sourced intermediates by foreign sourced intermediates, this may have an effect on domestic employment. Indeed, switching from a domestic supplier to a foreign supplier generates a negative demand shock for the latter. This negative demand shock may in turn depress the demand for labour in domestic supplier or upstream firms.

The effect of offshoring on labour demand has received considerable attention in the academic literature. The main focus has been on the impact of offshoring on the composition of employment by skill category, occupation or types of tasks, while the effect on total employment has been less studied. In theoretical contributions, the effect of offshoring on total employment is generally assumed away through labour market clearing (Grossman and Rossi-Hansberg, 2008; Rodriguez-Clare, 2010; Baldwin and Robert-Nicoud, 2014). This is the standard assumption in the Ricardian or Hekscher-Ohlin framework that these theoretical models of offshoring are grounded on. It largely corresponds to a long-term perspective of perfect labour mobility across industries and adjustment through changes in relative wages. However, as emphasized in Strauss-Kahn (2003), in the short-run, wages may be sticky and adjustment in the wake of offshoring may affect employment levels, in particular in countries with a less flexible labour market. Mitra and Ranjan (2010) show that in a model with search frictions and imperfect interindustry labour mobility, offshoring may entail a rise in unemployment in the industry where the offshoring occurs.

The findings in the empirical literature on the impact of offshoring on employment mostly confirm the idea conveyed by the theoretical models. Offshoring is found to alter labour demand by skill category or occupation (Feenstra and Hanson, 1996 and 1999; Strauss-Kahn, 2003; Hijzen et al., 2005), but in most cases it does not affect the overall level of employment (Amiti and Wei, 2005 and 2006; Mion and Zhu, 2012). Only a few papers report evidence of a significant negative impact of offshoring on aggregate employment (Hijzen and Swaim, 2010; Lo Turco and Maggioni, 2012). Apart from confirming theory, several other arguments have been put forward to explain the dominant empirical finding that aggregate employment is not affected by offshoring. Most notably, jobs created through rising sales fostered by productivity gains from offshoring may offset direct job losses (Amiti and Wei, 2005) and the number of job losses due to offshoring is likely to be small compared to total labour market turnover (Bhagwati et al., 2006).

In this paper, we investigate a channel through which offshoring may affect aggregate employment. Prior empirical research has failed to recognise this channel, which we label 'downstream offshoring'. Rather than focusing on the commonly estimated 'within firm' or 'within industry' impact of offshoring, i.e. the effect of offshoring by a firm or industry on the employment in that same firm or industry, we analyse the impact of offshoring on firms that are linked to the offshoring firm through the value chain, i.e. we explicitly relate the impact of offshoring to the value chain. This is illustrated in Figure 1. The starting point

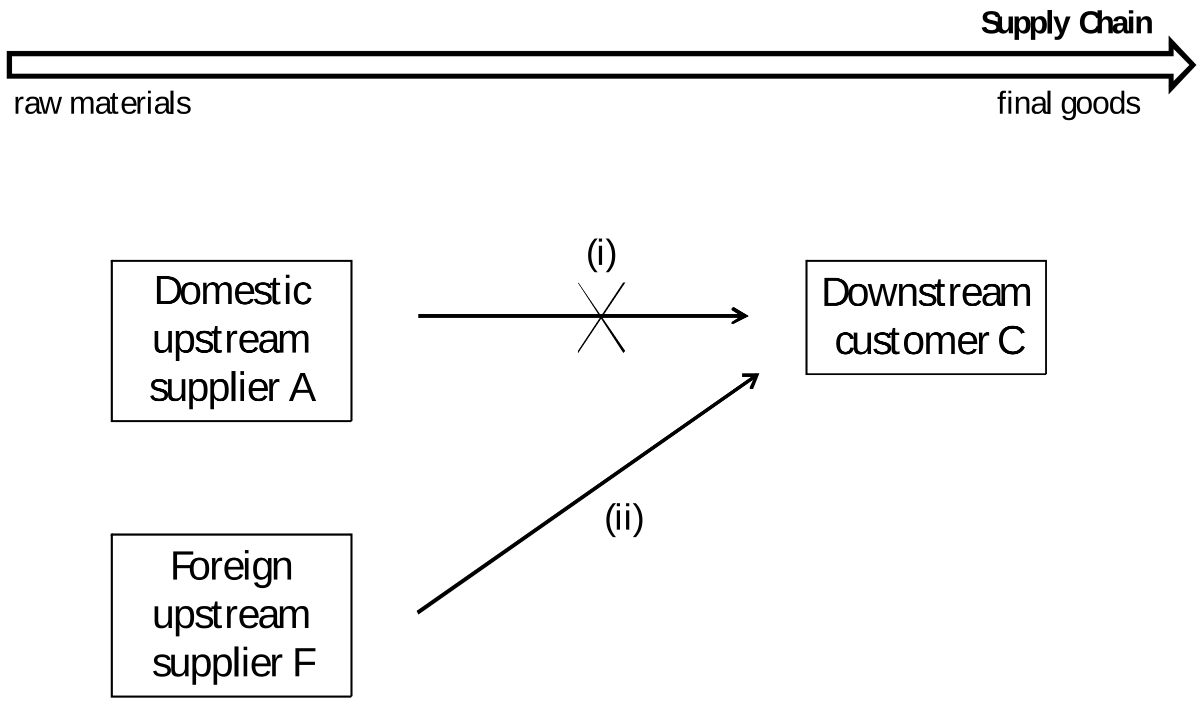

Figure 1: Upstream effect of offshoring by downstream firms

is the observation that firms may not only offshore intermediates they used to produce in house, but also intermediates they previously sourced from domestic suppliers. Firm A is a domestic upstream supplier and firm C is its downstream customer (relationship (i) in Figure 1). Suppose firm C decides to switch supplier and now prefers to source its intermediates from the foreign firm F (relationship (ii)) rather than from A. This implies a negative demand shock for A, which is very likely to negatively affect A's labour demand. We refer to this as downstream offshoring. Surprisingly, this intuitive channel for employment effects from offshoring has been neglected in the empirical literature, which has exclusively focused on within industry or within firm employment effects. We believe that this is at odds with the widely documented growing interdependence of firms within both domestic and, increasingly, cross-border value chains, and that there is considerable potential for employment effects of offshoring when domestic suppliers are replaced by foreign suppliers. Moreover, while the within firm employment losses due to offshoring may be offset by employment creation due to higher overall sales, there is no such compensation for downstream offshoring and its employment effect is therefore expected to be negative. Finally, this has the potential to reconcile the predominant empirical finding in the academic literature that aggregate employment is not affected by offshoring with the widely held perception that offshoring is responsible for job losses in developed economies.

The foremost empirical reason for this gap in the literature is the difficulty to disentangle whether foreign sourcing sourcing replaces in-house production or sourcing from domestic suppliers. We overcome this problem by defining a measure for downstream offshoring that relies on industry-level information with a separation of domestic from foreign sourcing. In practice, we estimate the employment effect of downstream offshoring using a sample of Belgian manufacturing firms over the period 1997-2007. For this estimation, we introduce a measure for the extent of downstream offshoring faced by a given firm into a standard labour demand framework. The measure is calculated based on information from a set of detailed constant price supply-and-use and input-output tables for the period 1995-2007, in which imports of intermediates are reported separately from domestically produced intermediates. Downstream offshoring depends on the share of foreign sourcing in downstream industries of the goods produced by the firm as well as on the relative size of purchases of these goods by downstream industries. Compared to the classical offshoring intensity defined by Feenstra and Hanson (1996) as the industry-level share of imported intermediates in total non-energy intermediates that is focused on what happens in terms of offshoring within the industry, our measure captures to what extent the substitution of imported intermediates for domestic intermediates in downstream industries matters for upstream suppliers. Our measure combines the underlying idea of the intensity measure defined by Feenstra and Hanson (1996) with insights from Javorcik (2004) to capture inter-industry or vertical links. Moreover, our approach is different from that of prior papers that look at the employment effect of traditional broadbased import competition indicators (Bernard et al., 2006) as it is specifically focussed import competition for domestic suppliers through imports of intermediates and participation in global value chains.

The results of the labour demand estimations show that downstream offshoring has a robust and highly significant negative impact on firm level employment. In the basic specification, a one standard deviation increase in downstream offshoring results in a decrease of employment of about 2%. We calculate that increases in downstream offshoring directly account for a job loss totaling 9023 over the sample period, i.e. 3,2% of in-sample employment in 1997.

The remainder of the paper is organised as follows. In section 2, we introduce the measure of downstream offshoring and compare it to the traditional offshoring measures found in the literature. Section 3 presents the empirical framework. Results are reported and discussed in section 4, and section 5 concludes.

2 Traditional and downstream offshoring intensities

2.1 Definition of the measures

Regarding empirical investigations of the employment effect of offshoring, the seminal contributions by Feenstra and Hanson (1996, 1999) have fixed matters in terms of the measurement of offshoring as the share of imported intermediates in total non-energy intermediates. This reflects the sourcing of intermediates from abroad. Initially, it was restricted to materials, i.e. manufactured goods.[1] In line with increasing trade in business services, Amiti and Wei (2005) have introduced the calculation of a similar offshoring measure for business services. Hence, the traditional industry-level offshoring intensity measure is split into materials and business services offshoring according to the type of intermediates sourced from abroad. For

[1] Feenstra and Hanson (1996) considered imported intermediate inputs of all manufactured goods by US manufacturing industries. This is also referred to as broad offshoring. Feenstra and Hanson (1999) added a further restriction by considering only imported intermediate inputs from the same industry and called this narrow offshoring. Here, we focus exclusively on broad offshoring.

industry j at time t (1) defines materials offshoring and (2) defines services offshoring.

$$off_{jt}^{m} = \frac{X_{jt}^{f,m}}{X_{jt}^{ne}} \quad (1)$$

$$off_{jt}^{s} = \frac{X_{jt}^{f,s}}{X_{jt}^{ne}} \quad (2)$$

Offshoring at the industry-level is thus the share of imported intermediates (X^f) in total non-energy intermediates (X^{ne}) and is defined separately for materials or manufactured goods (m) and business services (s). These intensities are usually computed with detailed data on purchases of intermediates from input-output tables (IO-tables). We do so for Belgium relying on a time series of constant price supply-and-use tables (SU-tables) produced by the Federal Planning Bureau (Avonds et al., 2012). These tables provide information on output and intermediate inputs by product category for each industry. As opposed to IO-tables, they are not necessarily symmetric, i.e. the number of product categories may exceed the number of industries, and industries in SU-tables are not necessarily homogenous, i.e. industries may have secondary output. The tables used here cover the period 1995–2007 and have been harmonised so as to respect a common national accounts vintage (2010). In terms of industry and product breakdown, the tables contain data on 120 industries of which 58 manufacturing industries (listed in Table A.1 in the Appendix) and 320 product categories This provides us with richer detail in vertical relationships than the more commonly used IO-tables at Nace rev.1.1 2-digit level. Use tables are split into use tables for domestic production and use tables for imports based on the methodology developed in Van den Cruyce (2004), which relies on a firm-level comparison of imports and intermediate uses by product category. Finally, the tables are deflated row-wise with separate price indices for imports and domestic production for each product category.

Several authors have used a standard labour demand framework to investigate the impact of these measures on industry-level employment in individual countries (Amiti and Wei, 2005 and 2006; Cadarso *et al.*, 2008; Michel and Rycx, 2012) finding only little evidence of a negative employment effect of either materials or business services offshoring. This may indicate that theory is indeed right in predicting that offshoring alters the skill or occupational composition of employment while leaving the aggregate employment level unchanged. Alternative explanations put forward by the literature are: *i*) the extent of offshoring is actually underestimated by the standard measures (OECD, 2007), *ii*) productivity gains from offshoring may raise sales and give rise to job creation that compensates for direct job losses due to offshoring (Amiti and Wei, 2005), and *iii*) the magnitude of job losses due to offshoring is small compared to total labour market turnover (Bhagwati *et al.*, 2006). However, the estimations in Hijzen and Swaim (2010) for a panel of OECD countries provide some evidence that materials offshoring significantly lowers industry-level employment and also raises the industry-level wage elasticity of labour demand. The latter finding is confirmed with US data by Senses (2010).

These measures are suitable for detemining the effect of offshoring on employment within the same industry. In order to extend the scope of employment effects to firms belonging to other industries, we define a comparable industry-level measure that reflects the impact of *downstream* offshoring on the demand for the output of upstream suppliers, i.e. reflects between-industry effects rather than within-industry effects. The indicator is computed with data from the SU-tables. It brings together two elements: the links between domestic industries through intermediate input purchases and offshoring in downstream industries that specifically affects firms in upstream industries. We first define the latter for upstream industry j and downstream industry k. Let G be the set of all products g indexed by $n = 1, ..., N$.

$$G = \left(g^1, g^2, ..., g^N\right) \tag{3}$$

From the supply table, we retrieve the output product mix $G_j^S \subset G$ of (firms in) industry j, and from the use table, we retrieve the product mix of intermediate input purchases $G_k^U \subset G$ by the downstream or customer industry k. The intersection between the two sets of products $G_{jk} = G_j^S \cap G_k^U$ contains all products g^n produced by industry j and purchased as intermediates by industry k. Given the data we use, G_{jk} may contain more than one element. Indeed, in our SU-tables, industries may have secondary output[2] and there is a greater number of product categories (320) than industries (120), i.e. industries may have more than one main product. For any product required in their production process, firms in downstream industry k have the choice between domestic and foreign sourcing, i.e. between purchasing intermediate product g^n domestically or importing it. If industry k increasingly imports product $g^n \in G_{jk}$, then this represents a negative demand shock for firms in upstream industry j. Since the SU-tables contain both domestic and imported use tables, we have for each product $g^n \in G_{jk}$ the share s_{kn} that is imported by firms in industry k. For our combination of industries -downstream industry k and upstream industry j- we are able to calculate Φ_{jk} which reflects to what extent imports of intermediates by industry k affect industry j. Due to the non-symmetric structure of our SU-tables with non-homogenous industries, Φ_{jk} is constructed as a weighted average of s_{kn} over all products $g^n \in G_{jk}$: $\Phi_{jk} = \sum_{g^n \in G_{kj}} \delta_{jn} s_{kn}$. The weights δ_{jn} are the shares of products in industry j's output mix G_j^S. These weights are computed as $\delta_{jn} = Y_{jn} / \sum_{g^n \in G_j^S} Y_{jn}$. Such weighting is not necessary when using symmetric IO-tables with homogenous industries, i.e. without secondary production, for calculating Φ_{jk}. In that case, G_{jk} is a set with a single element, which is the product category that corresponds to industry j's output. Industry k's import share of that product is then s_{kj} and Φ_{jk} equals s_{kj}.

The indicator Φ_{jk} is a relative measure that takes into account industry j's product mix and industry k's offshoring behaviour. We use it to calculate an aggregate measure of downstream offshoring for industry j. Because Φ_{jk} is only defined for a specific downstream industry k, we calculate a weighted average of Φ_{jk}'s with weights reflecting the relative importance of industries k as customers of j to obtain an industry-level indicator. Hence, we use technical coefficients for domestic uses, θ_{jk}, as weights. They represent the share of j's output supplied to respective downstream industries k and are derived from industry-

[2]This secondary output is eliminated in the conversion to symmetric IO-tables.

by-industry IO-tables.[3] Since they refer to domestic supply only, weights will over time be affected by offshoring in downstream industries. Therefore, in order to avoid a distortion of relative magnitudes over time and across industries of our measure, we use fixed weights of the year 1995 (θ_{jk}^{95}) for the entire sample period.[4] Doing so off_{jt}^{down} will accurately reflect the change in offshoring behaviour by downstream industries k as measured by Φ_{jkt} without offsetting effects due to the impact of offshoring on θ_{jk}. This preserves Φ_{jkt} as the crucial source of variation across time and industries where identification comes from.

$$off_{jt}^{down} = \sum_{k \neq j} \theta_{jk}^{95} \Phi_{jkt} \tag{4}$$

This is the baseline definition of downstream offshoring for testing the impact on firm-level employment. Elements on the 'diagonal', i.e. θ_{jk} with $j = k$ are excluded in (4) to avoid double counting with respect to the traditional offshoring measure off^m, i.e. to obtain an unambiguous identification of the effects of downstream offshoring. In the results section we investigate the sensitivity of our results by including the $j = k$ case. Finally, note that off^{down} is inherently a relative measure that is interpretable in the same way as the Feenstra–Hanson measure: (firms in) industries with a larger value for off^{down} are those that are faced with relatively more downstream offshoring.

2.2 Trends for Belgium

The figures and tables in this subsection aim to give a flavour of developments in our downstream offshoring measure for Belgium over time and across industries. In the first place, it is noteworthy that offshoring stands at high levels for Belgium in comparison with other Western European countries. This is consistent with the traditional perception of Belgium

[3] These are derived from the SUT based on a fixed industry sales structure hypothesis (Eurostat, 2008). Equivalently, we could have computed the technical coefficients directly from the SUT as $\theta_{jk} = \frac{1}{\sum_n Y_{jn}} \sum_n \left(\frac{Y_{jn}}{\sum_k Y_{kn}} X_{kn}^d \right)$ where Y stands for output and X^d stands for domestic intermediate inputs.

[4] The year 1995 is the first observation in our time series of SUT.

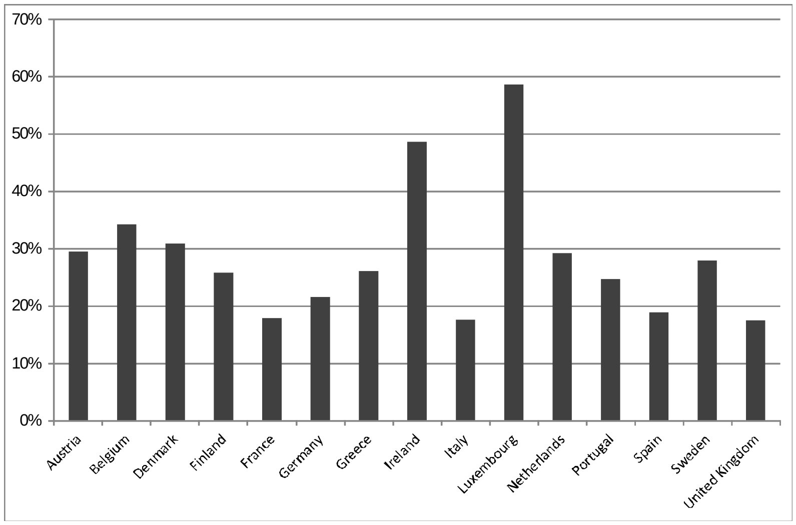

Figure 2: Total offshoring (materials and services) in 2005 - source: OECD (2010)

as a small open economy located at the center of the regional trading block of EU countries. Figure 2 shows that among the 15 old EU member states, Belgium is one of the countries with highest value for the OECD's offshoring indicator after Luxemburg and Ireland.[5]

Panel A of Table 1 reports summary statistics for our offshoring measures as defined in (1), (2), and (4), and an indicator of final demand import competition that will be discussed in the next section. These summary statistics are derived from a sample that covers the period 1995-2007 for 58 Belgian manufacturing industries.[6] The offshoring intensity for materials stands at a much higher level than for business services. Figure 3 presents boxplots for annual observations of off^{down} by industry. It shows an upward trend in downstream offshoring over the period with quite some heterogeneity across industries. This heterogeneity can also be seen from figure 4. It corresponds to what may be expected, e.g. a comparison of downstream offshoring faced by firms in industries *34A* and *34B* yields intuitive results. Industry *34A, manufacture of motor vehicles*, is one of the industries confronted with the lowest downstream offshoring intensity, whereas industry *34B*, *manufacture of bodies (coachwork) for motor*

[5]The comparison in Figure 2 is based on current price data from the OECD input-output database. Our calculations of offshoring measures for Belgium rely on constant price SUT.

[6]The industry classification used is the one used in the workformat of supply-and-use tables (SUT) for Belgium. Table A.1 in appendix links the SUT classification to the NACE Rev. 1.1 classification.

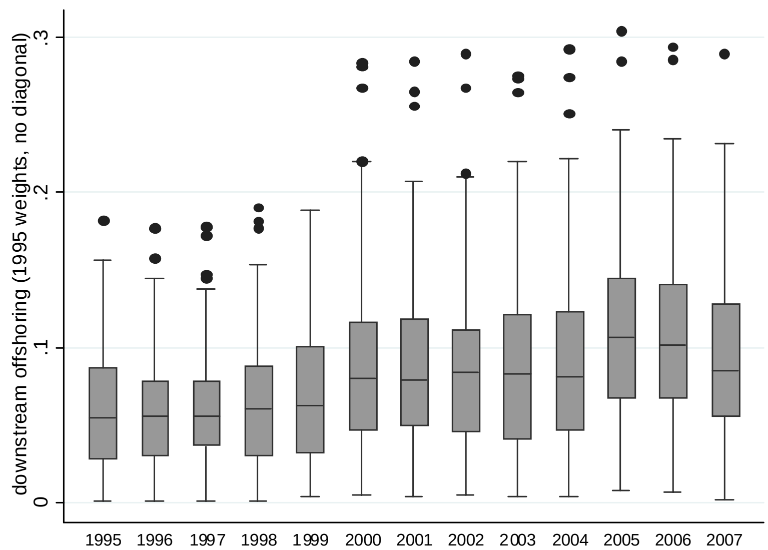

Figure 3: Boxplot of downstream offshoring for 58 manufacturing industries 1995-2007

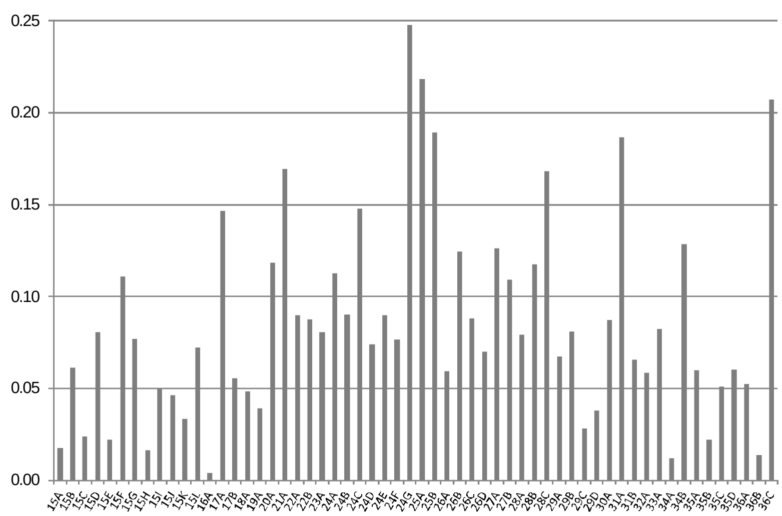

Figure 4: Downstream offshoring (baseline definition (4)) by SUT-industry (see appendix for industry-code details)

Table 1: Offshoring and import competition indicators - summary statistics and correlations

Panel A - Summary statistics

	Obs	Mean	Median	Std. Dev.	Min	Max
downstream offshoring	754	0.085	0.072	0.060	0.001	0.304
within industry materials offshoring	754	0.383	0.383	0.162	0.017	0.952
within industry services offshoring	754	0.016	0.011	0.018	0.000	0.180
final demand import competition	754	0.730	0.288	1.269	0.000	11.716

Panel B - Correlation matrix

	within industry materials offshoring	*within industry services offshoring*	*final demand import competition*
downstream offshoring	0.147	0.134	-0.096
within industry materials offshoring		-0.080	0.162
within industry services offshoring			0.008

vehicles, of trailers and parts and accessories for motor vehicles, is one of the industries confronted with the highest downstream offshoring intensity. The two industries facing the highest downstream offshoring intensities are *24G* and *25A*. These industries manufacture "*man-made fibres*" and "*rubber products*", i.e. products that are intuitively likely to be imported by downstream firms. Manufacturing of man-made fibres also experienced the largest increase in downstream offshoring between 1995 and 2007. Panel B of Table 1 suggests there is only a limited correlation between our four measures of internationalisation. This is a clear indication that downstream offshoring is a different channel of internationalisation than within-industry offshoring or final demand import competition.

3 Empirical framework

In order to estimate the impact of our downstream offshoring measure on firm-level employment in upstream industries, we largely follow previous work on the impact of traditional offshoring measures on employment (Amiti and Wei, 2005; Hijzen and Swaim, 2010). We derive a standard conditional labour demand equation from firm-level profit maximisation with a linear homogenous production function including labour as a variable factor and our downstream offshoring measure as an exogenous demand shifter. This is more easily expressed in terms of the dual of cost minimisation for a given level of output (Hamermesh, 1993). Production cost of firm i is then $C_i(W_i, Y_i, Z_i)$, a function of the wage rate, W, a vector of quantities of fixed input factors and output, Y, and a vector of exogenous demand shifters, Z. According to Shephard's lemma, the partial derivative of the cost function at the optimum with respect to the wage rate yields an expression for labour demand:

$$L_i = C_i^w(W_i, Y_i, Z_i) \tag{5}$$

where L is labour. As is common in the literature, capital is treated as a quasi-fixed factor (Berman *et al.*, 1994). The downstream offshoring measure is introduced as an exogenous demand shifter as it represents an exogenous change in the demand for the firm's output that may affect its labour demand. Industry-level materials offshoring (off^m) and business services offshoring (off^s) and an indicator of final demand import competition ($impcomp^{fd}$) are further controls that we introduce as exogenous demand shifters. The latter indicator is calculated with SU-table data as the share of imported final demand in total output for each industry.[7] Since downstream offshoring represents a demand shock for firms in upstream industries, we exclude output Y from the equation to be estimated. Indeed, controlling for output would not be appropriate when trying to measure the impact of downstream offshoring on labour demand in upstream firms. Hence, our starting point is an unconditional labour demand equation as in Hijzen and Swaim (2010)[8]. Since labour is an input in the production process that can be adjusted flexibly, we also introduce firm-level productivity in

[7] To be entirely accurate, this is final demand import competition for the main product of each industry. For the calculation, we aggregate product categories in our SU-tables such that they match the industry breakdown. Then, we compute the share of imported final demand in domestic output for each aggregated product category and take this to represent final demand import competition for the corresponding industry. The value of this indicator may be higher than one if imports largely exceed domestic output. This is the case for eleven industries in our sample.

[8] We have also tested a specification that includes the industry-level output price as in Amiti and Wei (2005, 2006). This does not affect our results for downstream offshoring (see Table 4). The same holds for the inclusion of industry-level prices for materials inputs (also Table 4), i.e. introducing materials as an extra variable factor does not alter the results.

the equation. Indeed, it is precisely the correlation between unobserved productivity shocks and variable inputs, such as labour, that has spurred the literature on the estimation of firm-level production functions.[9] We therefore control for total factor productivity (TFP), which we obtain from a production function estimated using the Wooldridge (2009) implementation of the Levinsohn and Petrin (2003) estimator.[10]

Log-linearising (5), denoting variables in logs by lower case letters and replacing Z by the offshoring indicators and the TFP measure defined above we obtain (6) as specification to estimate for firm i in industry j. The advantage of the log-linearisation of this generalised cost function is that coefficients can be interpreted as elasticities. The offshoring and import competition indicators are not expressed in logs, therefore β_3, β_4, β_5 and β_6 are semi-elasticities. *comp* is a control for within-industry competition. It is measured by a Herfindahl index. Time dummies, δ_t, and a set of firm-level fixed effects δ_i are added.

$$\begin{aligned} l_{ijt} &= \beta_1 w_{ijt} + \beta_2 k_{ijt} + \beta_3 off_{jt}^{down} \\ &\quad + \beta_4 off_{jt}^{m} + \beta_5 off_{jt}^{s} + \beta_6 impcomp_{jt}^{fd} \\ &\quad + \beta_7 tfp_{ijt} + \beta_8 comp_{jt} + \delta_i + \delta_t + \varepsilon_{ijt} \end{aligned} \tag{6}$$

Our basic model (7) is an 'augmented' first-differenced version of (6) where we additionally introduce the firm-level controls *age* and *exit* in levels and a set of industry dummies δ_j. Time differencing eliminates the firm specific effects. According to the line of reasoning developed above, the effect of the downstream offshoring intensity on firm-level employment should be negative, i.e. $\beta_3' < 0$.

[9] See e.g. Olley and Pakes (1996), Levinsohn and Petrin (2003), Ackerberg et al. (2006), and Wooldridge (2009).

[10] The Wooldridge (2009) generalised method of moments (GMM) implementation accounts for the points of critique formulated by Ackerberg et al. (2006) with respect to the estimators developed in Levinsohn and Petrin (2003) and Olley and Pakes (1996). The Stata code used is from Petrin and Levinsohn (2011) and is available from A. Petrin's website. Note that we use double deflated value added (real sales minus real material costs, both deflated by industry level price indicators).

Table 2: Firm level summary statistics

	Obs	Mean	Median	Std. Dev.	Min	Max
number of employees	25133	137	50	381	1	10283
log real capital	25133	14.06	14.20	1.91	2.92	20.56
log real wage	25132	10.69	10.69	0.62	2.88	14.32
log TFP W-LP	25133	3.46	3.32	0.90	-3.58	10.51
age	25133	27.9	23.0	19.2	2	126
Herfindahl	25133	1054.4	767.0	941.3	129.7	9842.9

$$\begin{aligned}\Delta l_{ijt} &= \beta_1'\Delta w_{ijt} + \beta_2'\Delta k_{ijt} + \beta_3'\Delta off_{jt}^{down} \\ &+\beta_4'\Delta off_{jt}^{m} + \beta_5'\Delta off_{jt}^{s} + \beta_6'\Delta impcomp_{jt}^{fd} \\ &+\beta_7'\Delta tfp_{ijt} + \beta_8'\Delta comp_{jt} + \beta_9' age_{ijt} + \beta_{10}' exit_{ijt} + \delta_t^{'} + \delta_j^{'} + \varepsilon_{ijt}^{'} \qquad (7)\end{aligned}$$

This basic model is estimated using firm-level data from the Amadeus database by Bureau Van Dijk Electronic Publishing. Amadeus is a pan-European database of financial information on public and private companies that has been widely used for research. We focus on a sample of Belgian manufacturing firms that file unconsolidated accounts and report the number of employees, the total wage bill, tangible fixed assets, sales, their industry classification, and their date of incorporation. Every month Bureau Van Dijk issues a new (hard-copy DVD) version of the database with updated information. However, a single version only contains the latest information on ownership and firms that go out of business are dropped from the database fairly rapidly. Furthermore, because Bureau Van Dijk updates individual ownership links between legal entities rather than the full ownership structure of a given firm, the ownership information on a specific issue of the database often consists of a number of ownership links with different dates, referring to the last verification of a specific link. To construct our dataset with entry and exit, we therefore employed a series of different issues of the database. Thereby we have obtained consistent data for all firm-level variables in the model for the period 1997-2007. The dataset is fairly representative.

It covers -averaged over industry-year combinations- 46% of firms, 79% of employment, 72% of output, and 79% of the wage bill in the Structural Business Statistics (SBS) provided by Eurostat.

Labor L is expressed as the number of employees. Real wages W are defined as the total wage bill divided by the total number of full time equivalent employees deflated by the producer price indices from the Belgian national accounts for the corresponding 2-digit industry in the European standard industry classification NACE Rev. 1.1. Real capital K is measured as fixed assets, deflated by a capital goods deflator that is computed as a weighted average of producer price indices for capital goods producing industries. Table 2 presents summary statistics for these variables. The final estimation sample, i.e. those firm-year observations with no missing values for all variables needed to estimate specification (7) and to compute the TFP measure contains between 1,873 and 2,303 firms per year. On average over industries and years, these firms still account for 48.9% of total SBS employment in manufacturing. In the dataset we observe both entry[11] and exit. Firms employ on average more than 100 employees, but the median firm has only 50 employees, i.e. the sample also contains smaller firms.

Estimation at the firm-level tackles another problem that has been put forward for explaining the absence of an employment effect from offshoring in most of the industry-level analyses. Indeed, their insufficient level of disaggregation is frequently blamed for the failure to detect an employment effect. A few recent papers address this issue using plant or firm-level data. Görg and Hanley (2005) estimate a plant-level labour demand specification for the electronics sector in Ireland and include the typical offshoring intensities at the plant level as regressors. Their results show that both materials and service offshoring significantly lower employment in their sample of plants. Lo Turco and Maggioni (2012) do a similar exercise for a sample of Italian manufacturing firms. They define offshoring as the share of firm-level imports in firm-level sales and separate between imports from high-wage and

[11] Due to the use of lags and first differences, the minimum age in the sample used for estimation is 3.

low-wage countries. According to their results, offshoring to low-wage countries significantly reduces employment in traditional manufacturing industries. However, these result are not confirmed by Mion and Zhu (2013) using firm-level data for Belgium. These authors measure two types of offshoring: offshoring of final goods as the share in turnover of firm-level imports of goods that correspond to the firm's main activity, and offshoring of intermediate goods as the share in turnover of all other firm-level imports of goods. They also split their measures by country of origin of the imports. According to their estimations for the manufacturing sector, the effect of both offshoring measures on total firm-level employment is rarely significant and the signs of the effect varies by country of origin. The authors do find a negative impact of offshoring on low-skilled labour, in particular for offshoring to China.[12]

Regarding econometric issues, the key identifying assumption for the estimation of the first differenced labour demand equation (7) would be that labour supply is perfectly elastic at the level of the firm, i.e. that the wage rate is exogenous. Although the assumption that firms face a perfectly elastic labour supply seems acceptable in most cases, we make a weaker assumption by using an IV approach for estimating (7) where wages are treated as endogenous and instrumented by their one-year and two-year lags. The tables with the results contain several test statistics on instrument validity.[13] First, we present an underidentification test, i.e. a test of whether the excluded instruments are correlated with the endogenous regressors. The "*Kleibergen-Paap rk LM*" statistic is used here because standard errors are clustered (*cf.infra*). A rejection of the null indicates that the instruments are not underidentified. Furthermore, we report a test for the presence of weak instruments ("weak identification"), i.e. instruments that are only weakly correlated with the endogenous variables. The null hypothesis of the test is that instruments are weak. Given the use of clustered standard errors we report the "*Kleibergen-Paap Wald rk F*" statistic and use the Staiger and Stock (1997) "rule of thumb" that the F statistic should be at least 10 for

[12] Wagner (2011) applies propensity score matching as an alternative methodological approach, but also fails to find a significant employment effect of offshoring.

[13] See Baum et al. (2007) for a full discussion of the IVREG2 routine in Stata.

weak identification not to be considered a problem. Third, to test whether the instrumental variables are independent from the unobservable error process, we use the heteroskedasticity-robust version of the Hansen J statistic. Non-rejection of the null hypothesis indicates that the instruments satisfy the orthogonality condition. Finally, since our offshoring indicators and several control variables are defined at the industry level, standard errors in the firm level estimations need to be adjusted (Moulton, 1990). They are therefore clustered for all observations in the same industry.

4 Results

Table 3 presents results for the first-differenced model estimated for our sample of manufacturing firms for Belgium. Estimation results for a labour-demand equation without exogenous demand shifters are reported in column 1. The wage elasticity amounts to 0.236, which falls within the reference interval established by Hamermesh (1993) stretching over [0.15;0.75]. It is somewhat lower than previous wage-elasticity estimation results with firm-level data for Belgium in Konings and Roodhooft (1997) and very close to the industry-level results for Belgium in Michel and Rycx (2012). Firms facing a productivity shock (the change in log TFP) significantly increase their demand for labour. The estimated elasticity is about 0.15. This implies that a one standard deviation increase in TFP results in an increase in employment by 13.6%. The test statistics at the bottom of the table show that instruments are relevant and that instrument weakness can be rejected. The Hansen J statistic indicates that the instruments satisfy the orthogonality condition. Throughout the other specifications in Table 3, the test statistics yield similar conclusions. In column 2 we add the downstream offshoring indicator calculated according to the basic definition (1995 weights, no diagonal, *cf. supra*). The estimated coefficient is statistically significant at the one percent level. The coefficient value of -0.331 implies that a one standard deviation increase in off^{down} results in a decrease in employment of 1.99%. In columns 3 and 4 we

Table 3: Basic results on downstream offshoring

	(1) *first dif model*	(2) *first dif model*	(3) *first dif model*	(4) *first dif model*	(5) *first dif model*	(6) *first dif model*
real wage	-0.236***	-0.234***	-0.226***	-0.227***	-0.229***	-0.227***
	[0.035]	[0.035]	[0.033]	[0.033]	[0.033]	[0.033]
real capital	0.180***	0.178***	0.174***	0.175***	0.176***	0.175***
	[0.022]	[0.022]	[0.021]	[0.021]	[0.021]	[0.021]
productivity shock	0.154***	0.153***	0.149***	0.150***	0.151***	0.150***
	[0.028]	[0.028]	[0.027]	[0.027]	[0.027]	[0.027]
exit	-0.500***	-0.500***	-0.509***	-0.509***	-0.509***	-0.510***
	[0.079]	[0.079]	[0.080]	[0.080]	[0.080]	[0.080]
age	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Herfindahl	0.008**	0.008*	0.007*	0.007*	0.008*	0.007
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
downstream offshoring		-0.331***	-0.360***	-0.357***		-0.345***
		[0.079]	[0.081]	[0.079]		[0.081]
downstream offshoring (t-1)						0.079
						[0.101]
final demand import comp			0.078	0.086	0.071	0.092
			[0.054]	[0.053]	[0.055]	[0.053]
final demand import comp (t-1)						-0.011
						[0.045]
materials offshoring				-0.050	-0.047	-0.037
				[0.039]	[0.040]	[0.038]
materials offshoring (t-1)						0.068*
						[0.036]
services offshoring				0.440	0.489*	0.403
				[0.279]	[0.290]	[0.282]
services offshoring (t-1)						-0.160
						[0.229]
Time dummies	Y	Y	Y	Y	Y	Y
Industry dummies	Y	Y	Y	Y	Y	Y
Observations	21,849	21,849	21,227	21,227	21,227	21,227
R-squared	0.208	0.208	0.204	0.204	0.204	0.205
Underidentification	228.6***	229.4***	224.0***	223.9***	223.2***	224.1***
Weak identification	84.69	84.95	83.13	83.09	82.87	83.16
Hansen J statistic	0.565	0.553	1.269	1.271	1.281	1.211
p-value (Hansen)	0.45	0.46	0.26	0.26	0.26	0.27

Specification estimated in first differences. Dependent variable is the change in log employment at the firm-level. Wage, capital, and Herfindahl are in first-differenced logs. All offshoring and import competition variables are first-differenced (no logs). Exit is a dummy that is set to 1 if the firm exits the following year. Exit and age are not first-differenced. See the text for the exact definitions and data sources. Standard errors in brackets are clustered at the SUT-industry level; *** p<0.01, ** p<0.05, * p<0.1. "Underidentification" refers to the Kleibergen-Paap rk LM test statistic, where a rejection of the null indicates that the instruments are not underidentified. "Weak identification" refers to the Kleibergen-Paap Wald rk F statistic test for the presence of weak instruments. The statistic should be at least 10 for weak identification not to be considered a problem (Stock and Staiger, 1997). The Hansen J statistic tests whether the instrumenst satisfy the orthogonality condition, with orthogonality satisfied as null hypothesis.

add measures of final demand import competition and materials and services offshoring. The estimated impact of the downstream offshoring variable is very robust to the inclusion of these additional control variables. This actually confirms expectations based on the correlogram for the three offshoring measures and final demand import competition, which reveals low correlations between all these variables (Panel B of Table 1). Within industry materials offshoring affects employment negatively, while services offshoring and final demand import competition have a positive impact. None of these effects is statistically significant, however. This also holds when dropping the downstream offshoring indicator (column 5). Though the services offshoring indicator becomes significant at the 10%-level, it is not a robust result (*cf. infra*). Our results shed further light on the employment effect of import competition reported in prior papers (Bernard et al., 2006, Biscourp and Kramarz, 2007, Mion and Zhu, 2012). It is import competition for domestic suppliers through imports of intermediates that affects employment rather than import competition for deliveries to final consumers. As offshoring contemporaneously replaces domestic supply of intermediates, we expect the impact of downstream offshoring on the variable input factor labour to occur at time t. This is confirmed by the result in column 6, which includes all offshoring variables and their one-period lagged values simultaneously. The lagged variables are not significant and do not affect the impact of the current values of our offshoring variables. The only exception is lagged materials offshoring that is positive and statistically significant at the 10%-level. Based on the point estimate in column 4 of Table 3 a one standard deviation increase in off^{down} decreases employment by 2.14%. Using the same specification we predict the number of jobs lost at the firm-level.[14] We find that annual changes in downstream offshoring over the period 1997-2007 have accounted for a total net loss of 3507 jobs, which is 1,25% of the total number of employees in the estimation sample in 1998. Overall, these results suggest a statistically and economically significant impact of downstream offshoring.

[14]For each firm in the estimation sample we multiply the coefficient on downstream offshoring with the change in downstream offshoring in a given year faced by the firm. The result is the precentage change in employment due to the change in downstream offshoring. This is then multiplied by the level of employment in the previous year to obtain the change in the number of jobs over the current year for a given firm.

A first set of robustness checks is presented in Table 4. Globally, the results for downstream offshoring pass all robustness checks, whereas the impact of materials and services offshoring is insignificant throughout the robustness checks. Final demand import competition is positive and significant in some specifications. In column 1, we re-introduce firm fixed effects in the first differenced specifications to control for time-invariant factors affecting employment growth at the firm level. In column 2, we estimate the basic first-differenced specification (7) using OLS rather than IV. The downstream offshoring variable is again found to have a significant negative impact on employment, whereas neither manufacturing nor services offshoring is significant. Column 3 shows results for a test for differences between foreign and domestic firms. Although employment in both domestic and foreign firms is negatively affected by downstream offshoring, the impact is stronger for foreign firms, though not significantly. This is consistent with the fact that foreign firms are more likely to be part of cross-border value chains and therefore tend to be more exposed and reactive to demand shocks generated by offshoring in downstream industries. The results in columns 4 and 5 illustrate that including in the estimated equation the industry-level output price to control for firms potentially being price takers in their industry or the industry-level materials input price to allow for materials as a second variable input factor does not alter our result for downstream offshoring. In column 6, we show results controlling for lagged firm size. Smaller firms typically grow at faster rates because of a smaller base. Therefore, our results could be driven by smaller firms being concentrated in industries facing more downstrean offshoring. According to results in column 6, this is not the case. Downstream offshoring is still negative and significant at the 1%-level. The point estimate is very similar to our baseline estimate in column 4 of table 3. Finally, in column 7, we allow for an asymmetry between the effect of an increase and a decrease in downstream offshoring by splitting the downstream offshoring variable in two subcomponents (increases account for about 60% of industry-year first differenced observations). The results indicate a negative employment effect for industries in which firms face an increase in downstream offshoring. We do not find evidence of a symmet-

Table 4: The impact of alternative specifications and alternative estimation techniques

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
	FE first dif model	*OLS first dif model*	*foreign inter-action*	*output price control*	*material price control*	*firm size control*	*increase*	*decrease*
real wage	-0.221***	-0.345***	-0.228***	-0.227***	-0.228***	-0.229***	-0.227***	
	[0.031]	[0.020]	[0.033]	[0.033]	[0.033]	[0.033]	[0.033]	
real capital	0.161***	0.246***	0.175***	0.175***	0.175***	0.176***	0.174***	
	[0.021]	[0.014]	[0.021]	[0.021]	[0.021]	[0.021]	[0.021]	
productivity shock	0.150***	0.232***	0.150***	0.150***	0.150***	0.151***	0.150***	
	[0.025]	[0.018]	[0.027]	[0.027]	[0.027]	[0.027]	[0.027]	
exit	-0.447***	-0.460***	-0.509***	-0.509***	-0.509***	-0.517***	-0.509***	
	[0.088]	[0.077]	[0.080]	[0.080]	[0.080]	[0.080]	[0.080]	
age	-0.009**	-0.001***	-0.001***	-0.001***	-0.001***	-0.000***	-0.001***	
	[0.004]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	
Herfindahl	0.008*	0.008*	0.007*	0.007*	0.007*	0.007*	0.008*	
	[0.004]	[0.005]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	
downstream offshoring	-0.344***	-0.383***	-0.306***	-0.357***	-0.323***	-0.355***	-0.448***	-0.145
	[0.093]	[0.078]	[0.083]	[0.080]	[0.081]	[0.079]	[0.116]	[0.144]
final demand import competition	0.115*	0.093*	0.085	0.086	0.089*	0.085	0.085	
	[0.064]	[0.055]	[0.053]	[0.053]	[0.053]	[0.053]	[0.053]	
materials offshoring	-0.055	-0.049	-0.051	-0.051	-0.046	-0.051	-0.048	
	[0.041]	[0.039]	[0.039]	[0.039]	[0.040]	[0.039]	[0.039]	
services offshoring	0.284	0.457	0.442	0.440	0.455	0.443	0.436	
	[0.210]	[0.293]	[0.277]	[0.279]	[0.281]	[0.281]	[0.278]	
downstream offshoring*foreign			-0.234					
			[0.158]					
output price				0.002				
				[0.038]				
material input price					-0.065*			
					[0.035]			
lagged firm size						-0.009***		
						[0.001]		
Time dummies	Y	Y	Y	Y	Y	Y	Y	
Firm dummies	Y	-	-	-	-	-	-	
Industry dummies	-	Y	Y	Y	Y	Y	Y	
Observations	20,970	21,227	21,227	21,227	21,227	21,227	21,227	
R-squared	0.16	0.22	0.21	0.20	0.21	0.21	0.204	
Underidentification	166.9	-	223.7	224.0	221.5	225.1	223.9	
Weak identification	45.0	-	83.1	83.0	82.2	83.5	83.11	
Hansen J statistic	0.215	-	1.275	1.271	1.312	1.377	1.265	
p-value (Hansen)	0.64	-	0.26	0.26	0.25	0.24	0.261	

With the exception of age and exit, both the dependent variable, log employment, and the explanatory variables are either in first differences as indicated by column headings. Wage, capital, and Herfindahl are in logs. Exit is a dummy that is set to 1 if the firm exits the following year. Firms are defined as foreign if a single foreign investor owns at least 10% of shares. See the text for the exact definitions and data sources. Standard errors in brackets are clustered at the SUT-industry level; *** p<0.01, ** p<0.05, * p<0.1. "Underidentification" refers to the Kleibergen-Paap rk LM test statistic, where a rejection of the null indicates that the instruments are not underidentified. "Weak identification" refers to the Kleibergen-Paap Wald rk F statistic test for the presence of weak instruments. The statistic should be at least 10 for weak identification not to be considered a problem (Stock and Staiger, 1997). The Hansen J statistic tests whether the instrumenst satisfy the orthogonality condition, with orthogonality satisfied as null hypothesis.

Table 5: The sensitivity of downstream offshoring effects to alternative sample configurations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	sample				*balanced*	*non-exit*	*exit*	*exiter*
	starts 1999	*starts2001*	*ends 2003*	*ends 2005*	*sample*	*sample*	*interaction*	*interaction*
real wage	-0.193***	-0.086	-0.250***	-0.222***	-0.228***	-0.231***	-0.228***	-0.246***
	[0.073]	[0.132]	[0.048]	[0.039]	[0.036]	[0.034]	[0.033]	[0.033]
real capital	0.154***	0.167***	0.198***	0.174***	0.170***	0.174***	0.175***	0.188***
	[0.033]	[0.017]	[0.033]	[0.026]	[0.023]	[0.022]	[0.021]	[0.021]
productivity shock	0.128***	0.154***	0.148***	0.134***	0.154***	0.154***	0.150***	0.164***
	[0.041]	[0.024]	[0.038]	[0.031]	[0.030]	[0.028]	[0.027]	[0.027]
age	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Herfindahl	0.008*	0.003	0.005	0.007	0.006	0.004	0.007*	0.007
	[0.004]	[0.006]	[0.005]	[0.005]	[0.004]	[0.004]	[0.004]	[0.004]
exit	-0.537***	-0.529***	-0.499***	-0.538***			-0.498***	
	[0.086]	[0.083]	[0.136]	[0.102]			[0.079]	
exiter								-0.103***
								[0.016]
downstream offshoring	-0.325***	-0.348***	-0.381***	-0.387***	-0.303***	-0.308***	-0.341***	-0.349***
	[0.082]	[0.112]	[0.103]	[0.089]	[0.075]	[0.073]	[0.077]	[0.077]
downstream offshoring*exit(er)							-3.265	-0.708
							[3.793]	[0.856]
final demand import competition	0.060	0.055	0.127	0.097*	0.132***	0.091*	0.086	0.093*
	[0.054]	[0.063]	[0.080]	[0.059]	[0.049]	[0.053]	[0.053]	[0.054]
materials offshoring	-0.027	-0.019	-0.102**	-0.058	-0.038	-0.025	-0.051	-0.042
	[0.037]	[0.060]	[0.049]	[0.040]	[0.035]	[0.034]	[0.039]	[0.039]
services offshoring	0.459*	0.122	0.827***	0.389	0.384	0.368	0.433	0.428
	[0.276]	[0.294]	[0.295]	[0.296]	[0.272]	[0.274]	[0.279]	[0.279]
Time dummies	Y	Y	Y	Y	Y	Y	Y	Y
Industry dummies	Y	Y	Y	Y	Y	Y	Y	Y
Observations	19,354	15,322	12,199	16,650	19,288	20,377	21,227	21,227
R-squared	0.194	0.163	0.215	0.201	0.16	0.17	0.21	0.19
Underidentification	31.94***	64.03***	134.6***	183.2***	200.6***	212.0***	223.8***	224.2***
Weak identification	16.2	10.8	55.8	71.3	72.5	75.5	83.1	84.0
Hansen J statistic	3.16	0.278	0.604	0.819	1.23	1.19	1.252	0.751
p-value (Hansen)	0.08	0.60	0.44	0.37	0.27	0.28	0.26	0.39

Specification estimated in first differences. Dependent variable is the change in log employment at the firm-level. Wage, capital, and Herfindahl are in first-differenced logs. All offshoring and import competition variables are first-differenced (no logs). Exit is a dummy that is set to 1 if the firm exits the following year. Exiter is a dummy variable that is set to 1 for all observations of a firm that at some point exits the sample. Exit, exiter, and age are not first-differenced. See the text for the exact definitions and data sources. Standard errors in brackets are clustered at the SUT-industry level; *** p<0.01, ** p<0.05, * p<0.1. "Underidentification" refers to the Kleibergen-Paap rk LM test statistic, where a rejection of the null indicates that the instruments are not underidentified. "Weak identification" refers to the Kleibergen-Paap Wald rk F statistic test for the presence of weak instruments. The statistic should be at least 10 for weak identification not to be considered a problem (Stock and Staiger, 1997). The Hansen J statistic tests whether the instrumenst satisfy the orthogonality condition, with orthogonality satisfied as null hypothesis.

ric positive impact, i.e. an increase in employment for firms in industries confronted with a decrease in downstream offshoring. If we use this result to predict the number of jobs lost due to increases in downstream offshoring (*cf. supra*), we end up with a total of 9023 jobs which have been lost between 1997 and 2007. This amounts to 3.2% of the total number of employees in the estimation sample in 1997.

Table 5 explores whether results differ between subperiods of the sample period (1997-2007). For this purpose, we estimate our basic specification for four different subperiods in columns 1 to 4: 1999-2007, 2001-2007, 1997-2005, and 1997-2003. The negative employment impact of downstream offshoring holds in all subperiods and standard errors suggest that differences are not statistically significant. Columns 5 to 8 of Table 5 investigate the impact of exit (and entry) on our results. In column 5, we use a balanced sample without entry and exit and find that our result on downstream offshoring is not driven by market dynamics.[15] This is confirmed in column 6 where we use a non-exit sample, i.e. entry is allowed for, to test whether the exiting firms are driving results for downstream offshoring. In both cases, the point estimate is somewhat smaller than in our standard sample, but the impact is still significant and non-negligeable. Column 7 again uses the full sample but introduces an interaction effect of the exit variable and the measure of downstream offshoring. The interaction is not significant, but both variables remain individually significant. Although we control for exit by means of a dummy variable that takes the value 1 if a firm exits the following year, the firm could already have started to reduce employment in the years before exit. Therefore, column 8 replaces the exit dummy with an 'exiter' dummy and its interaction with off^{down}, the difference being that the 'exiter' dummy takes the value 1 if the firm exits from the sample at some point rather than only in the following year. Again, our conclusion is unaffected. Overall, the negative impact of downstream offshoring on employment is driven neither by a specific sample period nor by firm exit.

[15] The coefficient of final demand import competition is positive and statistically significant at the 1% level in this specification. This suggests that the employment performance of incumbent survivors, i.e. firms active throughout the 1997-2007 period, is better in industries facing more final demand import competition.

Table 6: The impact of alternative calculations of the downstream offshoring measure

	(1)	(2)	(3)
	within-industry intermediates excluded	*within-industry intermediates included*	*within-industry intermediates excluded, adjustment for final use*
1995 weights	-0.357***	-0.315***	-0.090***
	[0.079]	[0.073]	[0.030]
1997 weights	-0.328***	-0.294***	-0.088***
	[0.071]	[0.067]	[0.029]
average weights (95-07)	-0.409***	-0.338***	-0.075**
	[0.117]	[0.099]	[0.032]
time varying weights	-0.337**	-0.237**	-0.054*
	[0.138]	[0.110]	[0.033]
2007 weights	-0.255**	-0.200**	-0.045
	[0.129]	[0.097]	[0.028]

Downstream offshoring coefficients based on a specification estimated in first differences. Rows refer to different weighting schemes, columns refer to alternative calculations of technical coefficients that are used to construct our measure of downstream offshoring. See the text for full details. Clustered standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Finally, in Table 6, the impact of variations in the construction of the downstream offshoring measure is illustrated. Only results for the coefficient of the downstream offshoring variable are shown.[16] These are obtained by estimating a specification similar to column 4 in Table 3 for alternative definitions of the downstream offshoring measure. Recall that our preferred definition above makes use of fixed weights of the year 1995 (θ_{jk}^{95} in (4)), i.e. the starting year of our series of SU-tables. Results using 1995 fixed weights are reported in the first row in Table 6. The other rows in Table 6 refer to alternative reference years for the weights. We consider 1997 weights, i.e. the first year of our firm-level data, in the second row (in (4) θ_{jk}^{95} is replaced by θ_{jk}^{97}). The third row shows results where the downstream offshoring measure has been constructed using weights averaged over the entire period for which we have SU-tables (1995-2007). Row four refers to time varying weights, and finally,

[16] The results on the other variables are unaffected by changes in the definition of off^{down}.

the last row in Table 6 uses 2007 weights - the last year for which SU-tables are available. As argued above, we believe that the downstream offshoring measures computed with 1995 (or 1997) weights are to be preferred since these weights are not affected by offshoring behaviour during the 1997-2007 period. The different columns of Table 6 explore another aspect of the off^{down} measure. Column 1 refers to the measure that excludes within-industry intermediate input purchases (i.e. $\theta_{jk} = 0$ for $j = k$), while column 2 refers to a measure including these purchases. In column 3, the weights are based on technical coefficients calculated using only total intermediate use rather than the sum of total intermediate and final use. The upper left cell in Table 6 corresponds to the result for downstream offshoring in column 4 of Table 3.

Results are fairly stable across columns and qualitatively largely unaffected by including within-industry intermediate input purchases or by omitting final use. Point estimates differ but averages and standard deviations of the alternative measures suggest a similar impact on employment. For both 1995 or 1997 weights, we obtain a significant negative impact of downstream offshoring with similar point estimates and significance levels. For average weights, the level of significance is still at the 1%-level, but the estimate is less precise. For both the time-varying and 2007 weights, point estimates are still negative but their magnitude in absolute value and level of significance are lower, in particular for the measure where final use has been excluded. These findings are in line with the idea that increases in offshoring by sourcing industries entail an offsetting fall in the weights used for the calculation of the downstream offshoring measure and therefore make estimates less precise. Initial period fixed weights are to be preferred because they do not disturb the key source of variation in off^{down}, i.e. changes in the share of imported intermediates.

5 Conclusions

In the ongoing debate on the aggregate employment effects of offshoring, most empirical analyses fail to find evidence of a significant employment effect. Up to now, the focus in these analyses has been exlusively on within-industry or within firm effects. However, inter-industry effects may arise from offshoring that consists in replacing domestic suppliers by foreign suppliers. We have called this downstream offshoring. It entails a negative demand shock for upstream firms that may depress their labour demand. Such effects have been neglected in this literature so far. To fill this gap in the literature, we develop a novel indicator to measure the extent of downstream offshoring that firms are confronted with. To compute the measure, we use data from supply-and-use and input-output tables on domestic and imported intermediate goods. It results in an industry-level measure that can be interpreted as a weighted average of offshoring in linked downstream industries where more important client industries are given a higher weight.

Estimations of the impact of downstream offshoring on employment in upstream manufacturing firms show that downstream offshoring has a robust negative impact on upstream employment. Results from our standard specification suggest that a one standard deviation increase in downstream offshoring results in a decrease of employment of about 1.74%. Increases in downstream offshoring directly account for a job loss totaling 9023 over the sample period, which corresponds to 3,2% of in-sample employment in 1997. The negative impact of downstream offshoring on employment in upstream manufacturing firms is robust to the use of alternative estimation techniques and we are able to show that it is not driven by exit. The negative employment effect of downstream offshoring holds in various subperiods of the sample period. Our results contrast with the dominant finding in prior empirical analyses that offshoring does not affect home-country employment. Nevertheless, it must be emphasized that, even if the employment effect of downstream offshoring turns out to be negative, this does not preclude overall welfare gains from offshoring through other channels.

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Table 7: Correspondance table for NACE Revision 1.1 codes and SUT-codes

SUT	NACE Rev. 1.1	Description
15A	15.1	Production, processing and preserving of meat and meat products
15B	15.2	Processing and preserving of fish and fish products
15C	15.3	Processing and preserving of fruit and vegetables
15D	15.4	Manufacture of vegetable and animal oils and fats
15E	15.5	Manufacture of dairy products
15F	15.6	Manufacture of grain mill products, starches and starch products
15G	15.7	Manufacture of prepared animal feeds
15H	15.81 - 15.82	Manufacture of bread, fresh pastry goods, rusks and biscuits
15I	15.83 - 15.84	Manufacture of sugar, chocolate and sugar confectionery
15J	15.85 - 15.89	Manufacture of noodles and similar farinaceous products, processing of tea, coffee and food products n.e.c.
15K	15.91 - 15.97	Manufacture of beverages except mineral waters and soft drinks
15L	15.98	Production of mineral waters and soft drinks
16A	16.0	Manufacture of tobacco products
17A	17.1 - 17.3	Preparation and spinning of textile fibres, weaving and finishing of textiles
17B	17.4 - 17.7	Manufacture of made-up textile articles, except apparel, other textiles, and knitted and crocheted fabrics
18A	18.1 - 18.3	Manufacture of wearing apparel; dressing and dyeing of fur
19A	19.1 - 19.3	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20A	20.1 - 20.5	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw
21A	21.1 - 21.2	Manufacture of pulp, paper and paper products
22A	22.1	Publishing
22B	22.2 - 22.3	Printing and service activities related to printing, reproduction of recorded media
23A	23.1 - 23.3	Manufacture of coke, refined petroleum products and nuclear fuel
24A	24.1	Manufacture of basic chemicals
24B	24.2	Manufacture of pesticides and other agro-chemical products
24C	24.3	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
24D	24.4	Manufacture of pharmaceuticals, medicinal chemicals and botanical products
24E	24.5	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations
24F	24.6	Manufacture of other chemical products
24G	24.7	Manufacture of man-made fibres
25A	25.1	Manufacture of rubber products
25B	25.2	Manufacture of plastic products
26A	26.1	Manufacture of glass and glass products
26B	26.2 - 26.4	Manufacture of ceramic products
26C	26.5	Manufacture of cement, lime and plaster
26D	26.6 - 26.8	Manufacture of articles of concrete, plaster and cement; cutting, shaping and finishing of stone; manufacture of other non-metallic mineral products
27A	27.1 - 27.2	Manufacture of basic iron and steel and of ferro-alloys and tubes
27B	27.3 - 27.5	Other first processing of iron and steel; manufacture of non-ferrous metals; casting of metals
28A	28.1 - 28.4	Manufacture of structural metal products, tanks, reservoirs, containers of metal, central heating radiators, boilers and steam generators; forging, pressing, stamping and roll forming of metal
28B	28.5	Treatment and coating of metals; general mechanical engineering
28C	28.6 - 28.7	Manufacture of cutlery, tools, general hardware and other fabricated metal products
29A	29.1	Manufacture of machinery for the production and use of mechanical power, except aircraft and vehicle engines
29B	29.2	Manufacture of other general purpose machinery
29C	29.3 - 29.6	Manufacture of agricultural and forestry machinery and of machine tools
29D	29.7	Manufacture of domestic appliances
30A	30.0	Manufacture of office machinery and computers
31A	31.1 - 31.3	Manufacture of electric motors, generators and transformers, of electricity distribution and control apparatus, and of insulated wire and cable
31B	31.4 - 31.6	Manufacture of accumulators, batteries, lamps, lighting equipment and electrical equipment
32A	32.1 - 32.3	Manufacture of radio, television and communication equipment and apparatus
33A	33.1 - 33.5	Manufacture of medical, precision and optical instruments, watches and clocks
34A	34.1	Manufacture of motor vehicles
34B	34.2 - 34.3	Manufacture of bodies (coachwork) for motor vehicles, of trailers and parts and accessories for motor vehicles
35A	35.1	Building and repairing of ships and boats
35B	35.2	Manufacture of locomotives and rolling stock
35C	35.3	Manufacture of aircraft
35D	35.4 - 35.5	Manufacture of motorcycles and bicycles and other transport equipment n.e.c.
36A	36.1	Manufacture of furniture
36B	36.2	Manufacture of jewellery and related articles
36C	36.3 - 36.6	Manufacture of musical instruments, sports goods, games and toys; miscellaneous manufacturing