

**Demand- and Supply-Driven Externalities in
OECD Countries: A Dynamic Panel Approach***

by

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Abstract

This paper provides empirical evidence of the relevance of supply- and demand-driven externalities in determining sectoral employment growth for 18 industrial sectors on a set of OECD countries. The paper improves over the existing literature in two ways. First, we use dynamic panel estimation technique. This allows us to utilise lagged variables as natural instruments and to take account of possible dynamic externalities. Second, we look for evidence of externalities by relating activity in sector i to a weighted sums of downstream and upstream activity – thanks to input-output tables. This allows us to distinguish between demand- and supply-driven externalities.

Keywords: Business Cycle, Input-Output Linkages, sectoral growth.

JEL classification: C23, E32, O41.

I. Introduction

Research on the extent and nature of externalities has pervaded many fields of economics. Models where increasing returns derive from learning by doing or technological spillovers have generated a new stream of literature on economic growth (Romer, 1986). Models with internal increasing returns and pecuniary externalities have been part of the building block of the new Keynesian economics (Waitzman, 1982; Blanchard and Kyotaki, 1987) and they have been an important explanation for the lack of take off in development economics (Ciccone and Matsuyama, 1996). More recently, pecuniary externalities have also been at the source of the dynamic linkages that characterize the new economic geography literature (Krugman, 1991) and its interaction with regional growth (Baldwin, Martin and Ottaviano, 2001).

The purpose of this paper is to provide empirical evidence on the importance of two types of externalities on sectoral employment growth. A new stream of empirical literature to which this paper more closely relates – and that is reviewed in the next section – has started with Caballero and Lyons (1990, 1992) and has developed with major contributions by Bertelsman Caballero and Lyons (1994), Basu and Fernald (1995), Burnside (1996), Oulton (1996) and Lindström (2000). A common feature of this literature (with the exception of Bertelsman et al. 1994) is that external economies are revealed by the statistical relationship between economic activity in anyone sector and aggregate economic activity in all other sectors. Our approach is slightly different. We make use of input-output tables to consider explicitly the inter industry linkages. In this way we are able to distinguish between externalities driven by demand linkages and externalities driven by supply linkages. In our approach externalities are revealed by the relationship between economic activity in anyone sector and a weighted measure of economic activity in upstream or downstream industries. For instance, if an externality is transmitted via intermediate inputs, the appropriate measure of aggregate economic activity relevant for sector i is a weighted sum of activities in other sectors where the weights are shares of the inputs received from the other sectors. We use this supply-weighted measure of economic activity to capture externalities driven by supply linkages. Alternatively, if an externality is transmitted via demand, the appropriate measure of aggregate activity in other sectors is a weighted sum where the weights are shares of output sent to those sectors. We use this demand-weighted measure of aggregate activity to capture externalities driven by demand linkages. In this way we are able to distinguish between supply- and demand-driven externalities. Some externalities may be transmitted in both ways. This is why we also look at a mixed case where we use a weighted sum of upstream and downstream activities.

While Bertelsman et al. use input output tables for the United States, to our knowledge the present paper is the first study that makes use of weighted sums using input-output tables for a set of OECD countries using a dynamic panel data approach. One of our results shows that the Caballero-Lyons approach based on un-weighted sums tends to underestimate the importance of externalities.

II. Relationship to the literature

A number of important empirical contributions have shed light on the impact of externalities on sectoral growth. Two influential contributions by Caballero and Lyons (1990, 1992) have paved the way to a new interesting stream. Caballero and Lyons (1990) analyse the existence of external economies in productivity for a set of two digits industries and a set of European countries over the period 1960-1986. They base their analysis on a production function that includes external economies and a productivity index as described in Hall (1988). They find that the estimated coefficient associated with the changes in total inputs is almost never larger than one, thus showing evidence of lack of internal increasing returns. Conversely, the coefficient associated with aggregate inputs growth is always positive and significant, thus showing evidence of the presence of external economies. Caballero and Lyons (1992) find similar results for the US. These results, however, have not gone unchallenged. Basu and Fernald (1995) argue that the Caballero-Lyons result is compatible with pecuniary externalities and indeed suggests the presence of pecuniary externalities once gross output data is utilized instead of value-added data. They show that with imperfect competition, the use of value-added data instead of gross output leads to spurious findings of large apparent externalities. Oulton (1996) follows Basu and Fernald (1995) in using aggregate output data instead of value-added for a dataset of 124 UK manufacturing industries for 1954-1986. His OLS regressions show evidence of positive external effects arising from the expansion of manufacturing as a whole and no evidence of increasing returns internal to the industry. A recent contribution is due to Lindström (2000) who has applied the Caballero-Lyons approach to Swedish manufacturing. He uses a panel firm-level dataset including information on output and factor inputs of eight thousands Swedish firms from 1979 to 1994. He estimates various specifications of the model using OLS with instrumental variables. He finds that an extended model with high-frequency shocks in technology statistically outperforms the Caballero-Lyons specification. This is interestingly because it seems to suggest that economy wide fluctuations in technologies are more important than external economies in explaining short run output fluctuations.

As pointed out by Burnside (1996), one common feature of this literature is that it struggles with choice of instrumental variables. He argues that the difference in the results obtained in the various papers may be explained in large part by the sensitivity of the estimates to the choice of instrumental variables. To demonstrate this point he tests the robustness of the results obtained in Caballero-Lyons (1992) and Basu-Fernald (1995). Using their data he shows that the results are indeed very sensitive to the choice of instruments and that when this is taken into account the conclusions are not so clear-cut.

We contribute to the advancements of this literature in two ways. First, by utilising a more appropriate estimation technique. We exploit the dynamic properties of panel data testing equation that include lagged values of the dependent as well as the explanatory variables. In this way we circumvent the problem of the choice of instruments and we also take account of possible dynamic externalities.¹ More specifically, we use the estimation technique developed by Arellano and Bond (1991) and first difference our series in order to get rid of individual specific effects. The lagged level of the dependent variable and first difference of strictly exogenous variables then constitute the natural instruments to be utilized. Second, we distinguishing between demand- and supply-driven externalities and look for empirical evidence of each of them separately. As in Bartelsman et al. (1994), we make use of input-output tables to construct our variable representing the demand- and supply-weighted aggregate activity. Our dataset, however, allows us to improve in at least three ways over Bartelsman et al. (1994). First we use a series of input-output tables for the period 1975-95 instead of one year only. This is important because it allows us to use the dynamic panel approach and thus to overcome the problems related to the choice of instruments. Second, our study estimates demand and supply linkages for a set of OECD countries instead of US alone. Third, unlike their dataset, our input output tables include the sub-table of gross fixed capital formation instead of consumption flows only. This is particularly useful since input-output linkages due to fix capital formation account for a large part of the total linkages in investment-goods industries.

Our results show evidence that both demand- and supply-driven externalities are important determinant of sectoral employment growth. In the various specifications we have tried they are always statistically significant. Further, the magnitude of the estimated coefficients indicates that they are the third most important determinant of sectoral employment growth after sectoral

¹ The literature reviewed does not take into account possible dynamic externalities. Bartelsman et al. (1994) is the closest one to do it by considering the *within* (that emphasizes the short-run relationship) and *between* estimates (for the long-run). Their analysis is not dynamic strictly speaking, however, since different lags of the demand and supply externalities variables are not considered together in the same equation.

output and real wage. Finally, we provide an informative ranking of the magnitude of estimated coefficients of demand- and supply-driven externalities by sector. These coefficients show the sensitivity of each sector to each source of externality.

The rest of the paper is organized as follows. Section III provides a description of the data used together with descriptive statistics. Section IV presents the equation tested and the way demand-supply linkages are determined. Section V describes the econometric methodology and the results obtained. Our main results are summarized and conclusion is drawn in section VI.

III. Data and descriptive statistics

We use Stan database and the new version of Stan available from the OECD to get series for the period 1975-95 on employment, wages, capital and production for seven countries: Canada, France, Germany, Japan, the Netherlands, the United Kingdom and the United States. The main advantage of the Stan database lies in its comparability with the OECD input-output database also available from OECD for the period 1975-90, although at a five-year interval. In fact other countries were initially available in Stan but data limitations in the input-output database precluded their inclusion (further information on both databases is in the appendix). The version of Stan database used here classifies activities according to the nomenclature ISIC rev.2 which is compatible with the input-output database and provides us with 18 manufacturing branches as described in Table 1. Stan database contains complete panel for employment and wages for the countries mentioned above; except the United Kingdom, where 1975 is missing for the Aircraft industry, and Japan, where the same industry is missing between 1975 and 1983. Both production and value added series are complete while capital has some missing observations as indicated by table A.1 in appendix. All monetary variables are expressed in constant national currency using sectoral industrial price indexes. Those indexes were obtained using sectoral value added series at constant (the base year being 1990) and current prices from OECD. The missing observation for employment caused special concern since our measure of demand and supply-weighted aggregate activity is only supported when all sectors are available, as we will discuss in the next section. For this reason, when series were missing for a particular country-industry, we treated as missing all branches for this country and the corresponding years.

Table 1 provides summary statistics for employment growth by sector. The general evolution is a fall in most of sectors over the period, especially for activities like textiles, iron and steel and shipbuilding & repairing. Other

activities like, rubber and plastic products, office and computing machinery and aircraft have experienced the highest growth rate. Table 2 provides details at the country-sector level. On average, the United Kingdom has experienced the most important fall in manufacturing employment with an average annual growth rate of -1.89%. The fastest growing country has been Japan but at a still low average rate of 0.32%, masking important disparities among sectors in this country: for example employment in sectors like shipbuilding and repairing, wood products and furniture has decreased at an average rate of -2.23% and -5.23% respectively, while other activities like rubber and plastic products and office and computing machinery have seen their employment increase in average by 2.25% and 3.22% respectively. The next section describes the estimated equation and the computation of demand- and supply-weighted aggregated activity.

IV. Estimated equation

We estimate the determinants of employment growth using a variant of the equation normally utilized in the literature (see Hamermesh, 1993 for a the theoretical foundations). Equation (1) describes the estimated specification we utilise. This specification relates sectoral employment growth $l_{i,k}(t)$ to past employment growth $l_{i,k}(t-z)$ and to a set of non-labour explanatory variables that we shall explain in detail below. Before this, note that this specification is close to the ones used by Layard and Nickell (1986) and Arellano and Bond (1991) but differs from theirs and from other specifications in two respects. First, it is specified at the industry-level and, second, it is augmented with a measure of demand- and supply-weighted aggregate activity as represented by the third and fourth terms on the right hand-side.

$$l_{i,k}(t) = \lambda + \sum_{z=0}^p \alpha_z q_{i,k}(t-z) + \sum_{h=1}^p \beta_h l_{i,k}(t-h) + \sum_{g=0}^p d_g G_k l_k(t-g) + \sum_{g=0}^p s_g F_k l_k(t-g) + \mu(t) + v_{i,k} + \varepsilon_{i,k}(t) \quad (1)$$

The dependent variable $l_{i,k}(t)$ represents the growth rate of employment in sector i and country k taking the first difference of the natural logarithm of the employment level between time (t) and $(t-1)$. The parameters α , β , d , s and the constant term λ are to be estimated. In the first term on the right hand-side $q_{i,k}(t-z)$ represents a set of non-labour explanatory variables at time $t-z$, where t is the current time and z the length of the lag. This set of non-labour explanatory variables is represented by x , the gross output growth, w , the real wage per employee growth and m , capital stock growth, between t and $(t-1)$. In the second term, $l_{i,k}(t-h)$ represents the influence of past employment fluctuations on current employment.

Initially we do not impose any restriction in the structure of the lags with z being the number of lags of the non-labour explanatory variables and h the number of lags of the dependent variable (p is the maximum length of the lag). The lags in the employment growth are introduced in order to consider adjustment issues in employment and may capture some intra-industry externalities. The term $v_{i,k}$ represents the random effects that we assume to be independent and identically distributed (*i.i.d.*) over the individuals with variance σ_v^2 . The term $\mu(t)$ is a set of time dummies in order to capture the influence of annual shocks common to all country-sector pairs. The last term $\varepsilon_{i,k}(t)$ is an *i.i.d.* over the whole sample with variance σ_ε^2 . Finally, the third and fourth terms capture the demand- and supply-driven externalities represented by the demand- and supply-weighted aggregate activities in other sectors, which we now discuss in detail. The third term is the demand-weighted measure of aggregated activity and it is constructed as follows. The vector $l_k(t)$ has dimension $(18.t \times 1)$ and represents the employment growth of all sectors i , $i=1\dots 18$ in country k . We pre-multiply it by the matrix of domestic linkages G_k of dimensions $(18.t \times 18.t)$. The matrix G_k is a block triangular matrix of domestic intermediate linkages between sectors in country k of the form:

$$G_k = \begin{bmatrix} A_k(t_0) & 0 & 0 & 0 \\ 0 & . & 0 & 0 \\ 0 & 0 & . & 0 \\ 0 & 0 & 0 & A_k(t_T) \end{bmatrix} \text{ with } t = t_0 \dots t_T \quad (2)$$

That is, G_k has matrices $A_k(t)$ representing the input-output linkage for a particular year t . Each matrix $A_k(t)$ is of dimension (18×18) and has elements $a_{i,j,k}(t)$ defined as follows²:

$$a_{i,j,k} = \frac{n_{i,j,k}}{X_{j,k}} \cdot \frac{L_{i,k}}{X_{i,k}} \quad (3)$$

The term $n_{i,j,k}$ represents the sum of intermediate and investment product flows from sector i to sectors j . Note that this term includes both the flows of intermediate inputs *and* the flows of investment goods. In order to get the usual technical coefficient used in input-output analysis, we divide $n_{i,j,k}$ by the level of gross output in sector j (X_j) and then multiply the ratio $\frac{n_{i,j,k}}{X_{j,k}}$ by a labour-input ratio $\frac{L_{i,k}}{X_{i,k}}$, where L_i and X_i are employment and gross output in sector i respectively. These weights can be assimilated to the employment multipliers

² Expression (3) is standard in input-output analysis, see Blair and Miller (1985).

generally used in input-output analysis.³ Each row of $A_k(t)$, whose elements are $[a_{i,2,k}, \dots, a_{i,18,k}]$, provides the weights for the demand linkages relevant for sector i .⁴ Accordingly, at any time t , for each country and sector we obtain a weighted average of employment growth in all other sectors within the same country. For example, by expanding the third term on the right hand-side of equation (1) in correspondence of sector $i=I$ in a particular country k at time t the weighted average of employment growth in all other sectors j is:

$$a_{I,2,k}(t).l_{2,k}(t) + a_{I,3,k}(t).l_{3,k}(t) + \dots + a_{I,18,k}(t).l_{18,k}(t) \quad (4)$$

The weights for the supply-weighted aggregate activity are then obtained analogously by switching i with j in equation (3). The coefficients d_g and s_g of equation (1) represent respectively the demand- and supply-driven externalities at time $t-g$. To economize notation we will use D and S to refer to the demand-driven and supply-driven externality respectively. We will use DS to refer to their combined effect. Ideally we would need an input-output matrix for each year and each country in order to estimate (1). Unfortunately, we have to cope with the fact that the OECD publishes input-output tables only every five years. For this reason we consider growth rate by computing the fifth difference of the natural logarithms of employment levels and pre-multiply these by the input-output matrix at the corresponding base year. For example, for the employment growth in 1990 we take the difference in the levels of employment between 1990 and 1985 and construct the demand- and supply-weighted sums by using the input-output matrix for 1985. By doing this, we will consider the potential changes in the input-output structure of the manufacturing industry. In fact, a detailed inspection of the coefficients computed according to (3) reveals few changes in the input-output structure. We test equation (1) by using the one-year growth rate in employment. In this case we use as weights the one given by the average of the 1975 to 1990 matrices. Comparison between the five-years and the one-year versions of equation (1) will tell us whether the changes in the input-output structures may influence our measure of the weighted aggregate activity. Finally, in order to be able to compare the impact of demand- and supply-driven externalities among industries, we divided each series by its standard deviation.

³ Note that we assume the labor-requirement in the production function to be fixed. This assumption is exactly the one made for the construction of the input-output matrices and will be relaxed when considering different input-output coefficients across time.

⁴ Since we exclude intra-industry linkages, each matrix $A_k(t)$ has zeros on its diagonal. To get a comparable measure of these linkages across sectors we normalize the row-sum to be one.

V. Econometric methodology and results

Using the dynamic panel approach makes the estimation more complicated especially because the lagged dependent variable is correlated with the disturbance term. In order to consider these issues, one should rely on the Generalized Method of Moments (GMM) see Greene (2000, p.583). In this case both the first differences and the lagged levels of the dependent variable represent natural instrument to be used. The methodology we utilize is directly taken from Arellano and Bond (1991) using the Ox version of the Dynamic Panel Data (DPD) program presented in Doornik et al (2001). Arellano and Bond developed estimators together with appropriate tests for dynamic panel analysis or equations like our equation (1). First differencing (1) removes the individual effects v_{ik} and produces an equation that is estimable by instrumental variables. Arellano and Bond (1991) derived a GMM estimator for the parameters to be estimated using lagged levels of the dependent variable and first differences of strictly exogenous variables. The consistency of such estimators lies on the assumption of absence of first order serial correlation. If the disturbances are not serially correlated, there should be evidence of significant negative first order serial correlation in the differenced residuals but no evidence of second order serial correlation. To check the consistency of these hypothesis Arellano and Bond have developed a test for first and second order autocorrelation based on two steps estimates, namely AR(1) and AR(2) tests as will be shown in the tables.

Given our specification for labour demand, all non-labour explanatory variables may be endogenous. Arellano and Bond (1991) show that first differencing allows for the use of suitably lagged endogenous as well as exogenous variables as instruments. With such method, the number of instrumental variables may become very large and the use of too many instruments may result in over fitting biases. Accordingly, when instrumenting the lagged dependent variable we chose unrestricted further lags of the dependent variable level as instruments (i.e. from lags (t-2) backward) while limiting the use of instruments up to three lags for the non-labour explanatory variables. A Sargan test providing some indication of the validity of the instruments is also reported. We use the Sargan test based on the two-step GMM estimator and the homoskedastic case as recommended by Arellano and Bond (1991).

As mentioned in the preceding section, our specification of demand- and supply-driven externalities for a particular sector i in a country k can be interpreted as a weighted average of employment growth in all other sectors j different from i in the same country. However, by considering highly aggregated sectors it is possible that the strongest input-output linkages are

within sector. In fact, one could argue that with a specification such as (1), the lagged values of the dependent variable also capture the within-sector lagged linkages in addition to the aforementioned sectoral adjustment process. Because we cannot disentangle the two elements, we focus our analysis on the *between-sectors* linkages and their significance as determinant of employment growth at the sector level⁵. Finally, in order to remove the influence of common shocks, we combine the restriction of a common coefficient for the demand-supply linkage to all sector-country pairs with the inclusion of time dummies. Alternatively, we will also test our equation separately for each sector as we shall describe below. Our main results are shown in Tables 5-8. We start however with Table 4 where we show some preliminary results and discuss some econometric issues.

Table 4. We start by studying the combined effect of demand- and supply-driven externalities (*DS*). Column 1 shows the results for the five years growth model where the lagged dependent variable only is treated as endogenous. All explanatory variables are highly significant and display the expected sign. The two largest coefficients are those of the lagged dependent variable (0.315) and of sectoral output growth (1.524). The coefficient on *DS* is equal to 0.185, meaning that a 10% increase in employment growth of all sectors, excluding sector *i*, increases employment growth in *i* by 1.85%. This coefficient is significant at 5%. Note that the AR(2) test on the five-years growth equation was not reported given the lack of observations available to compute this statistic. Columns 2 to 5 provide results for the one-year growth equation. In these cases the number of observations is reasonably large. Column 2 provides results for the unrestricted lag model. Explanatory variables generally display the expected sign and are highly significant except the second lag of the dependent variable, the gross output and the wage per head variables. This is also the case for the first lag of capital and the demand-supply linkages. More importantly, the demand-supply linkage variable exhibit a coefficient very similar to the one obtained for the five-years growth model suggesting that potential changes in input-output structure have not influenced the magnitude of

⁵ Note moreover that when considering different countries and industries, we make the assumption that all have similar labor demand function represented by equation (1) above. Three factors justify this assumption. First, equation (1) is fairly general and applying this to heterogeneous country-industry pairs should be not too restrictive. Second, since the panel of countries considered here is limited to countries with a similar level of industrial development, panel data techniques can be applied assuming the production technology is not too different across countries. Third, we use a single data source with homogenous accounting and classification criteria as described in section II. Related to the last point, Maddala (1999) while noticing that international databases suffer from less than perfect consideration of heterogeneity across counties, also notes that these criticisms lose their importance when considering a set of fairly similar countries.

the demand-supply linkage, at least when considering all sectors together⁶. The set of instrument used looks appropriate according to the Sargan test. Moreover, according to the AR(2) we cannot reject the null hypothesis of absence of second order autocorrelation, which is in line with the basic hypothesis of our model. In column 3 we re-estimate our equation by dropping the non-significant lagged dependent and explanatory variables. We get a coefficient for *DS* close to the preceding one, i.e, 0.182. The results shown in columns (1)-(3) might be influenced by the fact that the period covered, 1975-95, includes very different periods in the business cycle. The time span includes two major recessions, namely 1979-80 and 1993. This is why we re-estimated the equation by excluding those years. Column 4 shows the results of the re-estimation. The coefficient obtained for *DS* is now slightly higher, reaching a value of 0.203. As argued earlier, our non-labour explanatory variables may be endogenous. We then instrument those variables by using as instruments up to three lags of the non-labour explanatory variables. The results are shown in column (5) of Table 4 and in column (1) of Table 5 for easiness of comparison. Once again, the *DS* variable is significant and its point estimate is of 0.196,

Table 5. Column (1) is the same as column (5) of Table 4. Columns (2)-(3) of Table 5 show the results when demand- and supply-driven externalities are estimated separately. We obtain higher coefficients, equal to 0.254 and 0.28 for the demand- and supply-driven externalities respectively. Those coefficients are significant at 1%. Quite naturally, sectoral employment growth depends primarily on sectoral output growth and on real wages. Interestingly, however, we observe that the third most important factor of sector *i* employment growth is employment growth in downstream or upstream industries. This result testifies of the importance of externalities in employment growth. Finally both supply- and demand-demand driven externalities are found to be important, which suggests the presence of both technological and pecuniary externalities.

In order to gauge the usefulness of our weighted measure of aggregated activity, we re-estimated equation (1) using a non-weighted measure of employment growth represented by the variable *Y*. This variable is the non-weighted employment growth in the rest of the economy, excluding the sectors under scrutiny. This is what is typically done in the spirit of Caballero and Lyons (1990, 1992) type of studies. Results for this exercise are reported in column (4). We obtain a much lower coefficient for *Y* in comparison with *D*, *S* and *DS*, but still significant. The estimate for *Y* equal to 0.12, that is, less than twice the result obtained for the demand and supply externalities estimated

⁶ One could argue that the different countries considered here may be subject to common shocks biasing the results. In fact, as argued before, the use of time dummies and the restriction that the coefficients are the same across countries and sectors invalidates such view.

separately. This result suggests that the simple measure of aggregate economic activity in other sectors tends to underestimate the importance of externalities. Further, with the simple non-weighted measure it is not possible to distinguish between demand- and supply-driven externalities.

Tables 6-8. These tables rank sectors according to the absolute value of the coefficient obtained for the demand-supply linkages for the period 1975-95. Results can be compared to column 3 of table 4 since the methodology employed is the same and all series have been scaled by their standard deviation. First, not all demand and supply linkages display significant coefficients. Looking at table 6, the higher coefficient is obtained for the motor vehicle industry, which is more than twice higher than the coefficient obtained for the pooled regression in Table 4. This coefficient is also significant at 5%. Follows the other manufacturing industries sector with a coefficient equal to 0.44 and the petroleum & coal products with a coefficient equal to 0.41. The shipbuilding and repairing industry, the professional goods industry and the office & computing machinery also never exhibit significant coefficients. Other non-significant coefficients are obtained for some other sectors but not in all periods. The results concerning the motor vehicles industry and the petroleum & coal products are fairly intuitive and coincide with a common view about the importance of these sectors for the general economic activity. However, another usually important sector like chemicals exhibits a much lower coefficient, equal to 0.12 for the whole period although always statistically significant. The highly aggregated sectors used may be responsible for that result, the chemical industry may be strongly dependent on its own production, giving rise to strong intra-industry linkages. In fact, non-reported results show that the coefficient on the lagged dependent variable is around 0.20 for this sector, which is higher than the one obtained in the pooled regression and meaning that chemicals industry's employment mostly dependent on intra-industry fluctuations. This result needs to be taken with caution though since, as we argued earlier, most of the demand- and supply-driven externalities seem to occurs simultaneously (i.e. within the year) given the lack of significance of the lagged demand-supply linkages variable and also because the lagged dependent variable also hides adjustment process inherent in the function of demand for labour used. Comparing now the results obtained when we estimate demand- and supply-driven externalities separately as in Tables 7 and 8 reveals some differences. For example in the case of the motor vehicles industry, the estimates for the demand and supply linkages are equal to 0.31 and 0.30 respectively. This result is similar to the one obtained previously for in table 5 when estimating the demand- and supply-driven externalities separately.

VI. Conclusion

The major contribution of this paper is to provide empirical evidence of the importance of supply- and demand-driven externalities for 18 industrial sectors on a set of OECD countries by using a dynamic panel approach. Most of the previous literature looked for evidence of externalities by relating activity in sector i to the simple sum of activity in all other sectors. We instead use weighted sums of downstream and upstream activity to capture the importance of externalities. One of our results shows that the un-weighted approach tends to underestimate the importance of externalities. An advantage of the approach we followed is that it allows us to estimate the importance of demand- and supply-driven externalities separately. We have utilized a data set and chosen an econometric technique that has features that represent an improvement over the previous literature in two ways. First our input-output tables include the flows of fixed capital investment in addition to the flows of intermediate inputs. This is important since the former is a large part of total input-output flows. Second, we make use of dynamic panel data using GMM. This estimation technique allows us to use a proper set of instruments represented by lagged levels of the dependent variable (and of the explanatory variables suffering from potential endogeneity) and first differences of strictly exogenous variables as instruments. Sargan tests provide strong basis for the validity of our instruments. This methodology also allows us to consider dynamic issues in the existence of externalities between sectors. The existence of positive externalities is then shown to be fairly robust to the specification used while some differences appear between sectors.

Our results show evidence that both demand- and supply-driven externalities are important determinant of sectoral employment growth. In the various specifications that we have tried they always come up as statistically significant. Indeed in all the specification we have tried demand- and supply-drive externalities are the third most important explanatory variable (after gross output and real wages). The sectoral results, however, show that externalities are not equally important for all sectors. Finally we also show that the Caballero-Lyons approach previously utilized in the literature tends to underestimate the importance of externalities.

Coming to a possible limitation of our dataset is that the high level of aggregation may bias the results against the importance of externalities to the extent that they occur within sectors. This is why we have focused the analysis on the externalities *between* sectors. Our study, like the rest of this literature, does not provide an estimate of international-inter-industry externalities. Data limitations for this extension of research are particularly severe since detailed matrices of inputs imported and exported by country (with the detail of the

origin and destination of the products) are not available at the moment. We think this is an interesting direction for future research however.

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Tables

Table 1: Employment growth rate by sector, 1975-95 (%)

Sectors	Obs	Mean	Std. Dev.	Min	Max
1.Food, beverage & tobacco	140	-0.35	2.04	-6.37	8.20
2.Textiles, apparel & leather	140	-2.86	4.03	-13.96	10.61
3.Wood products & furniture	140	-0.52	4.42	-15.09	10.59
4.Paper, paper products & printing	140	0.15	2.40	-5.12	5.81
5.Chemicals	140	-0.61	2.25	-8.84	5.62
6.Petroleum & coal products	140	-1.66	5.51	-13.61	23.01
7.Rubber & plastic products	140	1.25	3.83	-10.54	12.93
8.Non-metallic mineral products	140	-1.46	3.90	-13.24	10.48
9.Iron, steel & non-ferrous metals	140	-2.40	4.16	-18.96	6.41
10.Metal products	140	-0.72	3.97	-11.73	8.95
11.Non-electrical machinery	140	-0.54	4.65	-14.28	12.89
12.Office & computing machinery	140	1.53	8.31	-26.21	23.84
13.Electric apparatus	140	-0.42	3.85	-9.95	10.00
14.Shipbuilding & repairing	140	-4.12	8.85	-37.89	38.77
15.Motor vehicles	140	0.42	6.06	-20.20	18.20
16.Aircraft	130	1.25	7.68	-20.21	23.00
17.Professional goods	140	-0.45	4.56	-15.35	9.77
18.Other manufacturing	140	-0.82	4.86	-13.43	17.09

Sources: OECD and authors' computations

Table 2 : Average growth rate of employment by branch & country, 1975-95

	ca	fr	ge	ja	ne	uk	us	tot. countries
1.Food, beverage & tobacco	-0.30	-0.28	-0.60	1.66	-1.31	-1.69	0.04	-0.35
2.Textiles, apparel & leather	-2.05	-4.22	-4.66	-0.81	-3.76	-3.20	-1.30	-2.86
3.Wood products & furniture	0.62	-1.55	-0.45	-2.23	-1.11	-0.22	1.34	-0.52
4.Paper, paper products & printing	0.18	-0.36	-0.42	0.98	-0.24	-0.54	1.48	0.15
5.Chemicals	-0.10	-0.79	-0.51	-0.02	-0.95	-1.71	-0.20	-0.61
6.Petroleum & coal products	-1.33	-2.35	-0.84	-0.66	-1.04	-4.25	-1.15	-1.66
7.Rubber & plastic products	1.66	-0.29	1.00	2.25	0.80	0.56	2.75	1.25
8.Non-metallic mineral products	-1.13	-2.63	-1.32	-1.08	-1.36	-2.09	-0.60	-1.46
9.Iron, steel & non-ferrous metals	-1.48	-3.13	-2.12	-0.56	-2.48	-4.91	-2.14	-2.40
10.Metal products	-0.06	-1.62	-0.58	0.06	-1.13	-1.76	0.07	-0.72
11.Non-electrical machinery	1.36	-1.96	-0.45	0.15	-0.74	-2.16	0.02	-0.54
12.Office & computing machinery	3.06	1.78	-0.98	3.22	0.39	2.43	0.78	1.53
13.Electric apparatus	-0.87	-1.06	-0.67	1.96	-1.74	-1.43	0.87	-0.42
14.Shipbuilding & repairing	-1.83	-5.56	-4.30	-5.23	-4.66	-6.35	-0.94	-4.12
15.Motor vehicles	2.01	-2.27	2.02	1.46	1.12	-2.76	1.38	0.42
16.Aircraft	3.85	1.09	2.96	1.69	1.14	-1.90	-0.05	1.25 ⁽¹⁾
17.Professional goods	0.63	-2.04	0.08	-1.02	-0.13	-1.02	0.32	-0.45
18.Other manufacturing	0.77	-1.05	-1.80	-0.72	-0.18	-2.85	0.12	-0.82
Tot. Manufacturing	-0.04	-1.65	-0.77	0.32 ⁽²⁾	-1.30	-1.89 ⁽³⁾	0.18	

Notes:

(1) For sector 16: Aircraft, average growth for all countries only refers to the period 1983-1995

(2) For Japan, average growth of total manufacturing refers to 1983-95

(3) For the UK , average growth of total manufacturing refers to 1977-95

Source: OECD and authors' computations.

Table 3: Summary statistics

Variables	Nobs	Mean	Std. Dev.	Min	Max
$l_{i,k}$	2358	-0.008	0.053	-0.476	0.328
x_{ik}	2520	0.087	0.167	-0.991	1.385
$k_{i,k}$	2412	0.089	0.288	-4.530	1.509
w_{ik}	2510	0.090	0.142	-0.945	1.173
$D_{i,k}$	2340	-0.008	0.033	-0.150	0.124
$S_{i,k}$	2340	-0.009	0.031	-0.163	0.076
$DS_{i,k}$	2340	-0.008	0.036	-0.234	0.176

Sources: OECD and authors' computations

Table 4: Estimating the Demand-Supply externalities together: preliminary results

	(1)	(2)	(3)	(4)	(5)
Sample	five years	one year	one year	one year	one year
$l_{i,k}(t-1)$	0.315 (0.103)	0.092 (0.044)	0.104 (0.024)	0.019 (0.026)	0.114 (0.02)
$l_{i,k}(t-2)$	-	-0.035 (0.034)	-	-	-
$x_{i,k}(t)$	1.524 (0.170)	0.909 (0.091)	0.883 (0.034)	0.887 (0.036)	0.868 (0.044)
$x_{i,k}(t-1)$	-	0.226 (0.064)	0.208 (0.041)	0.265 (0.044)	0.169 (0.04)
$x_{i,k}(t-2)$	-	0.110 (0.066)	-	-	-
$w_{i,k}(t)$	-1.071 (0.185)	-0.915 (0.103)	-0.878 (0.035)	-0.888 (0.037)	-0.952 (0.05)
$w_{i,k}(t-1)$	-	-0.241 (0.060)	-0.193 (0.041)	-0.247 (0.044)	-0.139 (0.04)
$w_{i,k}(t-2)$	-	-0.124 (0.057)	-	-	-
$k_{i,k}(t)$	0.230 (0.077)	0.160 (0.040)	0.145 (0.020)	0.151 (0.021)	0.185 (0.03)
$k_{i,k}(t-1)$	-	0.048 (0.026)	-	-	-
$k_{i,k}(t-2)$	-	-0.028 (0.033)	-	-	-
$DS_{i,k}(t)$	0.185 (0.084)	0.180 (0.038)	0.182 (0.023)	0.203 (0.024)	0.196 (0.025)
$DS_{i,k}(t-1)$	-	-0.017 (0.025)	-	-	-
Observations	168	1863	1991	1659	1991
Sargan Test	0.72 (0.69)	102.17 (1.00)	103.31 (1.00)	113.73 (1.00)	98.16 (1.00)
Wald test	18.37 (0.00)	3364.24 (0.00)	5795.43 (0.00)	4852.65 (0.00)	1968.01 (0.00)
AR(1) test	-2.50 (0.01)	-5.75 (0.00)	-5.89 (0.00)	-5.07 (0.00)	-5.69 (0.00)
AR(2) test	-	-0.54 (0.58)	-0.76 (0.44)	-1.52 (0.12)	-1.05 (0.291)

Notes

- (1) five years growth equation using 1975-80-85-90 input-output matrices
- (2) one-year growth equation using average of 1975-80-85-90 input-output matrices, unrestricted lags model
- (3) one-year growth equation using average of 1975-80-85-90 input-output matrices, restricted lags model
- (4) same as (3) excluding the years 1980-81 and 1993
- (5) same as (3) instrumenting x , k , w and DS

Heteroskedasticity consistent standard error in parentheses. Regressions include time dummies and a constant term. The Wald test is on the explanatory variables, excluding time dummies and constant term. Wald, Sargan, AR(1) and AR(2) tests are based on two-step estimates. Sargan test is based on homoskedastic case, AR and Wald tests are based on Heteroskedastic cases.

Table 5: Estimating the Demand- and Supply-driven externality separately
(dependent variable: one year growth in employment)

	(1)	(2)	(3)	(4)
$l_{i,k}(t-1)$	0.114 (0.02)	0.103 (0.02)	0.106 (0.02)	0.128 (0.04)
$x_{i,k}(t)$	0.868 (0.044)	0.838 (0.04)	0.815 (0.04)	0.929 (0.09)
$x_{i,k}(t-1)$	0.169 (0.04)	0.177 (0.04)	0.162 (0.03)	0.198 (0.07)
$w_{i,k}(t)$	-0.952 (0.05)	-0.911 (0.05)	-0.861 (0.05)	-0.933 (0.11)
$w_{i,k}(t-1)$	-0.139 (0.04)	-0.141 (0.04)	-0.121 (0.03)	-0.153 (0.06)
$k_{i,k}(t)$	0.185 (0.03)	0.168 (0.03)	0.163 (0.03)	0.177 (0.05)
$DS_{i,k}(t)$	0.196 (0.025)	-	-	-
$D_{i,k}(t)$	-	0.254 (0.02)	-	-
$S_{i,k}(t)$	-	-	0.280 (0.03)	-
$Y_{i,k}(t)$				0.12 (0.02)
Observations	1991	1991	1991	1991
Sargan Test	98.16 (1.00)	99.75 (0.00)	100.4 (1.00)	103.7 (1.00)
Wald test	1968.01 (0.00)	2385.84 (0.00)	3635.58 (0.00)	2308.0 (0.00)
AR(1) test	-5.69 (0.00)	-5.65 (0.00)	-5.87 (0.00)	-5.579 (0.00)
AR(2) test	-1.05 (0.291)	-0.96 (0.33)	-0.62 (0.535)	-0.94 (0.346)

Notes

- (1) results taken from table 4, column 5
- (2) demand linkages instrumenting x , k , w and D
- (3) supply linkages instrumenting x , k , w and S
- (4) employment growth in the rest of the economy instrumenting x , k , w and S

Heteroskedasticity consistent standard error in parentheses. Regressions include time dummies and a constant term. The Wald test is on the explanatory variables, excluding time dummies and constant term. Wald, Sargan, AR(1) and AR(2) tests are based on two-step estimates. Sargan test is based on homoskedastic case, AR and Wald tests are based on Heteroskedastic cases.

Table 6: Ranking of sectors according to the demand- and supply-driven externalities

Sectors	75-95	75-85	85-95
15.Motor vehicles	0.48	0.37	0.53
18.Other manufacturing	0.44	0.40	0.68
6.Petroleum & coal products	0.41	0.47	0.55
2.Textiles, apparel & leather	0.31	0.37	0.34
1.Food, beverage & tobacco	0.30	0.21	0.38
7.Rubber & plastic products	0.29	0.27	0.40
4.Paper, paper products & printing	0.26	0.20	0.37
8.Non-metallic mineral products	0.26	0.52	0.26
12.Office & computing machinery	0.24	0.22	0.33
16.Aircraft	0.22	0.07	0.57
10.Metal products	0.21	0.21	0.23
3.Wood products & furnitures	0.20	0.23	0.18
9.Iron, steel & non-ferrous metals	0.18	0.17	0.21
13.Electric apparatus	0.18	0.15	0.13
11.Non-electrical machinery	0.14	0.08	0.25
5.Chemicals	0.12	0.06	0.16
17.Professional goods	0.11	0.03	0.16
14.Shipbuilding & repairing	0.03	0.13	0.25

Note: Only coefficients of demand-supply linkages reported here. Results obtained as in table 4 column (3). Significant coefficients (95% confidence interval minimum) are in bold. Source: OECD and authors' computations

Table 7: Ranking of sectors according to the demand-driven externalities

sectors	75-95	75-85	85-95
6.Petroleum & coal products	0.39	0.41	0.51
9.Iron, steel & non-ferrous metals	0.36	0.35	0.39
15.Motor vehicles	0.31	0.25	0.34
7.Rubber & plastic products	0.29	0.27	0.41
10.Metal products	0.28	0.28	0.33
4.Paper, paper products & printing	0.27	0.23	0.36
2.Textiles, apparel & leather	0.23	0.27	0.24
18.Other manufacturing	0.21	0.21	0.36
13.Electric apparatus	0.19	0.12	0.14
11.Non-electrical machinery	0.18	0.10	0.30
5.Chemicals	0.18	0.10	0.23
8.Non-metallic mineral products	0.18	0.37	0.17
1.Food, beverage & tobacco	0.17	0.12	0.22
3.Wood products & furniture	0.11	0.13	0.11
12.Office & computing machinery	0.10	0.11	0.13
16.Aircraft	0.10	0.03	0.27
17.Professional goods	0.06	0.02	0.09
14.Shipbuilding & repairing	0.03	0.09	0.14

Note: Only coefficients of demand-supply linkages reported here. Results obtained as in table 4 column (3). Significant coefficients (95% confidence interval minimum) are in bold. Source: OECD and authors' computations

Table 8: Ranking of sectors according to their supply-driven externalities

sectors	75-95	75-85	85-95
9.Iron, steel & non-ferrous metals	0.45	0.55	0.46
6.Petroleum & coal products	0.38	0.36	0.43
13.Electric apparatus	0.36	0.45	0.43
15.Motor vehicles	0.30	0.19	0.33
2.Textiles, apparel & leather	0.27	0.40	0.29
18.Other manufacturing	0.27	0.25	0.32
11.Non-electrical machinery	0.26	0.12	0.50
12.Office & computing machinery	0.22	0.15	0.14
7.Rubber & plastic products	0.20	0.16	0.33
10.Metal products	0.18	0.19	0.22
8.Non-metallic mineral products	0.17	0.31	0.17
5.Chemicals	0.16	0.08	0.17
4.Paper, paper products & printing	0.16	0.13	0.23
3.Wood products & furniture	0.16	0.18	0.21
16.Aircraft	0.15	0.16	0.18
1.Food, beverage & tobacco	0.14	0.15	0.14
14.Shipbuilding & repairing	0.07	0.26	-0.05
17.Professional goods	0.03	-0.09	0.16

Note: Only coefficients of demand-supply linkages reported here. Results obtained as in table 4 column (3). Significant coefficients (95% confidence interval minimum) are in bold. Source: OECD and authors' computations

Data appendix

The two datasets used in this paper, Stan database and the OECD input-output tables database had some missing values, which required both completing the data whenever possible and grouping some sectors as shall be described below.

Completing Stan database was relatively easy given the recent publication of the new Stan database that provides series using the ISIC rev. 3 nomenclature. Although the new Stan uses ISIC rev. 3, correspondence with ISIC rev. 2 was relatively straightforward⁷. We were able to get a complete panel for production and value added (current and constant prices), employment and wages. Concerning those last two variables, data was missing for the United Kingdom in 1975 and sector ISIC rev.2 3845 and Japan, for the sector 3845 and the period 1975-1983. Capital series had more missing observations as indicated by table A1 below.

Table A.1: Sectors and years missing from capital series

	Canada	France	Germany	Japan	Netherlands	UK	US
ISIC rev.2							
3100				95	95		
3200				95	95		
3300				95	95		
3400				95	95		
3510				94-95	94-95		
3520				94-95	94-95		
3530				94-95	94-95		
3540				94-95			
3550				94-95	95-94		
3560				94-95	94-95		
3600				95	95		
3710					95		
3720					95		
3810	91-95				94-95		
3820					94-95		
	91-95	75-77, 92-		94-95	94-95		
3825		95					
3830	91-95	95		94-95	94-95		
3841	91-95	92-95	95	94-95	94-95		
3843				94-95	94-95		
		92-95	95	75-83, 94-	94-95		
3845				95			
3850	91-95	75-77, 95		94-95	94-95		
3900				95	95		

Source: OECD and authors' computations

⁷ We are grateful to Colin Webb for providing us with the last version of Stan and for useful comments when using the data.

Note also that, initially the Stan database provided a number of sectors larger to the one used in the paper. However, because some sectors were not present both in the Stan and the IOT databases we had to use a higher level of aggregation that provided us with the 18 sectors as described in tables 1 and 2. In fact, we have been mainly constrained by the industrial breakdown used in the input-output tables. For example, branches like Electrical Apparatus (ISIC 383) and Radio, TV and communications Equipment (3832) were not available separately for Germany and Netherlands. The same applies for Industrial Chemicals (351) and Drugs & Medicines (3522) for Germany, Iron & Steel (371) and Non-Ferrous Metals (372) for Netherlands. We then chose to aggregate these branches in order to get comparable data between countries. The Stan data was adjusted accordingly.

The OECD input-output (IOT) database is directly compatible with the Stan database both on the sectoral breakdown used (i.e. ISIC rev.2) and the definition of the variables. The IOT database provides details about domestic intermediate product flows and also domestic investment flows between sectors. Some adjustment had to be made however, especially in the capital flow matrices given the data availability. Some countries like France, Japan and Italy, had several missing sectors for certain years. For France, some sectors were not available separately for 1975: this is the case for Non-electrical Machinery (ISIC rev. 2 codes 382-3825) and Professional goods (385), Shipbuilding & Repairing (3841) and Aircraft (3845), Motor vehicles (3843) and Other Transport Equipment (3848), Electrical Apparatus (383) and Office and Computing Machinery (3825), we then used the data for 1980 and applied the shares of each sub-branch to compute the capital matrices. This appears not to be too restrictive given that data are at constant prices and that the capital matrices remained broadly similar over these years. Moreover, for the branch Wood Products & Furniture (3300), no data were available in 1975, we then also used the figures for 1980. In the case of Japan some branches were missing for 1975 and 1980: Petroleum & Coal Products (353+354) Metal Products (381) Office & Computing Machinery (3825) Electrical Apparatus (383), Shipbuilding & repairing (3841), Motor Vehicles (3843) and Aircraft (3845), in this case we used the coefficients for 1985.

The intermediate product matrices needed to be completed as well. The IOT matrices were missing in 1980 for Germany and the United Kingdom and 1990 for the Netherlands. In these cases we take the matrix for the preceding available year. This is not likely to be a problem given the stability of the input-output coefficients and the relatively aggregate sectoral breakdown.

More detailed information about the OECD IOT database is available at: <http://www1.oecd.org/dsti/sti/stat-ana/index.htm>.

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