Import Penetration, Intermediate Inputs and Firms' Productivity in the EU Food Industry [1]

Alessandro Olper [a,b] Daniele Curzi [a] Valentina Raimondi [a]

[a] *Department of Economics, Management and Quantitative Methods,University of Milan, Italy*

[b] *LICOS – Centre for Institution and Economic Performance, KU Leuven, Belgium*

Abstract: The aim of this contribution is to study empirically the effect of trade liberalization on productivity growth exploiting a large micro-dataset of more than 20,000 French and Italian food firms, over the 2004-2012 period. This relationship has been studied focusing on import penetration at both industry and upstream sectors level, to investigate the role played by imports in intermediate inputs. Main findings show that import penetration in both final products and intermediate inputs systematically contributed to firm-level productivity growth. Yet, the productivity growth effect induced by import penetration in upstream sectors is 10 times higher than the one at the industry level. Horizontal import competition coming from the EU15 and OECD countries exerts the strongest effect on productivity growth. By contrast, when vertical import penetration is considered, also sourcing intermediate inputs from emerging markets appears important for firms' productivity growth. Finally, we also find a strong confirmation that the effects of import penetration are increasing with the initial level of firms' productivity. All these stylized facts may have interesting policy implications.

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Corresponding author: alessandro.olper@unimi.it

Does trade liberalization in upstream sectors improve firm productivity in the food industry? Answering this question is crucial for the EU, as it is strictly related to trade liberalization in the agricultural sector. Whether imported intermediate inputs bring more benefits or costs at the food industry level would obviously have strong policy implications. Yet, despite the growing importance of trade in intermediate inputs, very few papers to date have investigated the relationship between imported inputs and food firms' productivity growth both in the EU countries and elsewhere.

Conceptually, the literature on endogenous growth provides theoretical grounds to study the role of foreign inputs in enhancing efficiency gains and economic growth at the aggregate level (e.g., Romer, 1987; Rivera-Batiz and Romer 1991). At the firm level, gains are measured in terms of productivity growth realized through better complementarities of inputs, lower input prices, access to higher quality of inputs and access to new technologies embodied in the imported varieties (see Ethier, 1982; Markusen, 1989; Grossman and Helpman, 1991).[i] Robust empirical findings, obtained using micro-level data and focusing mainly on developing countries, recently confirmed that imported inputs lead to an increase in firm productivity growth (Amiti and Konings 2007; Halpern, Koren and Szeidl 2011; Kasahara and Rodrigue 2008; Topalova and Khandelwal 2011), in the number of new domestic products (Goldberg et al. 2010; Colantone and Crinò, 2014) and in the probability of firms' entry in the export market (Bas and Strauss-Kahn, 2011; Chevassus-Lozza Gaigné and Le Mener 2014).

Yet, with the notable exception of Chevassus-Lozza, Gaigné and Le Mener (2014), who showed that lower input tariffs in agriculture may increase the export sales of high-productivity manufacturing French food firms (but at the expense of low-productivity firms), no papers to date has explicitly tested this relationship in the EU food industry[ii].

The estimation of the effect of imports in intermediate inputs is complicated by the lack of input-output tables with a sufficient level of disaggregation at the EU level. As a consequence, when direct information on the intermediate consumption structure for each firm is lacking, as it is often the case, then the researcher is forced to adopt *ad hoc* solutions. For example, Chevassus-Lozza, Gaigné and Le Mener (2014) combine trade and firm level data to identify the imported products processed by a firm belonging to each 4-digit industry.[iii]

In this article we propose an alternative strategy based on the use of the US input-output tables, notoriously more detailed than the EU one. To the extent to which technology is comparable between the US and the EU food processing industry, and this should be indeed the case, then this strategy offers a relatively simple and, especially, more consistent solution to the lack of disaggregated input-output tables for the EU countries. By relying on this solution, we empirically study the effect of import competition at both industry and upstream sectors level, on food firms' productivity, exploiting a large micro-dataset of more than 20,000 French and Italian food firms, over the 2004-2012 period.

Working with Italian and French food firms presents some interesting advantages. In fact, the two countries share a worldwide recognized quality reputation of their food products, based on a strong food tradition and culture. Second, their food sectors, taken together, represent a large fraction of the EU food industry revenue. However, at the same time, the two countries have a fundamental difference in their agricultural sector, the industry that produces the majority of the intermediate inputs used in the food industry. Indeed, while France is a net exporter of agricultural products, Italy is a net importer. These similarities and differences add interesting insights to the analysis of the effect of horizontal and, especially, vertical import penetration on firms' productivity growth.

As stated above, how imported intermediate inputs are measured is critical for our empirical strategy. Following Acemoglu et al (2014) and Altomonte, Barattieri, and Rungi (2014), we measure an index of vertical input penetration at very detailed level, by combining the BEC classification, which distinguishes between intermediates goods and products for final consumption, with the input-output table taken from the US Bureau of Economic Analysis (BEA). By combining these sources we are able to measure an upstream inputs penetration index and to study in detail whether horizontal or vertical import penetration matters the most in affecting firms' productivity growth.

In our context, the use of import penetration instead of tariffs to capture trade liberalization offers some important advantages. First because agri-food products at the EU border, besides tariffs, are also protected by non-tariff barriers to trade, like sanitary and phitosanitary standards (see Li and Beghin, 2012; Curzi, Raimondi and Olper, 2014). Thus, by using a positive indicator of trade integration like import penetration, we implicitly take this into account. Second, the use of import penetration also offers the possibility to investigate how the impact of foreign competition on output and intermediate inputs changes by geographic origin of imports. Assessing this provides an important piece of evidence, necessary to better understand the micro-economics of trade liberalization. Finally, another important advantage of using positive trade integration indices is that, in France and Italy, like in any other EU country, firms are primarily affected by import competition coming from other EU countries (see Olper, Pacca and Curzi, 2014), and the majority of (imported) intermediate inputs is sourced from the same EU market. Thus, since tariffs do not change within the EU, by using variation in tariffs to identify the effect of trade liberalization, we would omit from the analysis a large piece of reality.

The remainder of the article is organized as follows. In section 2, we present how we measure productivity, horizontal and vertical import penetration, as well as our identification strategy. In section 3 we report the main econometric results. Finally, section 4 concludes.

Data, measures and empirical strategy

In order to apply our empirical strategy, we combine several different data sets. First, we used the micro-data from Amadeus (Bureau van Dijk), to measure firm-level total factor productivity. Second, detailed trade flows and production information data from Eurostat, supplemented by information from the FAO for the (agricultural) row material inputs, are combined with the US input-output information from the US Bureau of Economic Analysis, to measure vertical import penetration. Below we give details of the different procedures.

Firm level total factor productivity

In order to estimate Total Factor Productivity at the firm level, we start by considering a standard Cobb-Douglas production function $Y_{it} = A_{it}L_{it}^{\beta_l}K_{it}^{\beta_k}M_{it}^{\beta_m}$, where Y_{it} is revenue-based output of firm *i* in the year *t*; L_{it}, K_{it} and M_{it} are, respectively, labour, capital and materials inputs, and β_l, $\beta_k$and β_m are the input coefficients to be estimated; finally A_{it}represents the Total Factor Productivity.

A log-linearization of the production function yields $y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \eta_{it}$, with $lnA_{it} = \beta_0 + \eta_{it}$, where β_0 represents a measure of the mean efficiency level across firms and over time, and η_{it} is the time-firm-specific deviation from that mean. TFP is extracted from the above equation as a residual and, thus, the parameter of interest is the error term η_{it}.

To get a consistent estimator from the production function, η_{it} must be uncorrelated with the input variables. Since the use of OLS to estimate the production function would lead η_{it} to be correlated with the input variables, thus generating well known simultaneity biases (see

Griliches and Mairesse 1995), we make use of the Levinsohn and Petrin (2003) approach to overcome this problem. [iv]

The method proposed by Levinsohn and Petrin (2003) (hereafter LP, for brevity), allows to obtain an unbiased estimation of the residual from a Cobb-Douglas production function, based on a semi-parametric estimation. According to this approach, the error term, η_{it}, is decomposed into two parts, $\eta_{it} = \varpi_{it} + \varepsilon_{it}$, with ϖ_{it}representing the transmitted productivity component and ε_{it} an error term that is uncorrelated with input choices. The key difference between the two components is that ϖ_{it} is a state variable that impacts the productivity shocks and is observed by the firm but not by the econometrician.

LP propose an estimation method which allows to make the productivity shocks observable, by finding an observable proxy for the productivity term ϖ_{it}. Specifically, the LP methodology identifies this proxy with the material costs. LP assume that the materials demand function depends on the two firm's state variables, k_{it} and ϖ_{it}. Hence, assuming that this demand functions monotonically increases with TFP, then the TFP will be expressed in terms of observables, $\varpi_{it} = y_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_m m_{it}$, where ϖ_{it} is the (log of) TFP. Productivity in levels can be obtained as the exponential of ϖ_{it}, i.e. $\Omega_{it} = \exp(\hat{\varpi}_{it})$.

In this paper we estimated firm-level TFP by using balance sheet data coming from the Bureau van Dijk Amadeus database, over the period 2004-2012. In particular, we collected data for food firms of two different countries that share similar characteristics in the food sector, Italy and France. The database contains balance sheet data for more than 36,000 food firms, classified at the NACE 4-digit industry level. In order to estimate a revenue-TFP with the LP method, we made use of the following variables: operating revenue (turnover) as output variable, labor cost, fixed assets and materials costs as input variables. [v] Before implementing the LP method separately for each of the two considered countries, an extensively data cleaning has been necessary. At this purpose, we first considered only those firms for which we have data for at least three consecutive years. Second, we drop firms reporting negative values for any of the considered variables in the TFP estimation. Third, considering the same variables, in order to get rid of outliers, we drop firms with values falling below the 1st percentile and above the 99th percentile. With the same purpose, we computed the growth rates of each variable and dropped all firms reporting growth rates smaller than the 1st or greater than the 99th percentile of the relevant distribution. After these cleaning procedures, the final database contains balance sheet data for 25,315 firms, 6,692 Italians and 18,623 French.

Table 1 reports some descriptive statistics for the estimated TFP, as well as for the variables used in the Cobb-Douglas production function estimation with the LP procedure. Firm-level TFP has been estimated separately for the sample of Italian and French Food firms. As it emerges from the results in Table 1, Italian food firms show, on average, higher TFP with respect to the French ones. A potential explanation of this result may stem from the relatively higher representativeness of small firms (in terms of number of employees) in the French sample with respect to the Italian one. As a results, since it is well known that small firms are characterized by lower TFP than bigger ones, the average value of the French firms' TFP results to be lower than the Italian firms' one.

Concerning the other variables presented in Table 1, the Italian food firms show an average higher value for all the variables considered (i.e. output, capital and material costs) with the exception of the labor cost, which is higher in the French sample.

Estimating horizontal and vertical imports penetration

We construct the horizontal and vertical import penetration for the period 2003-2011 for each of the 33 food products reported in the manufacturing sector, using the NACE Rev.2 4-digit level classification. The trade data are collected from Comext (Eurostat) according to the

Combined Nomenclature (CN) 8-digit classification and distinguishing among five different groups of origin/destination countries.[vi] The production data come from the Prodcom database made by Eurostat, following the Prodcom 8-digit classification, and from the FAO data for all the agricultural productions not included into the Prodcom database, but strongly relevant for the analysis of food industry sectors.[vii] Trade data and production data are both converted and aggregated at NACE 4-digit industry level using the correspondence tables.

The horizontal import penetration for each industry *z* in year *t* has been calculated as follows:

(1) $$h\_imp_{zt}^{g} = \frac{imp_{zt}^{g}}{prod_{zt}+imp_{zt}^{g}-exp_{zt}^{g}}$$

where imp_{zt}^{g} (exp_{zt}^{g}) are the imports (exports) from (to) the country group g (World or specific country groups) in industry *z* at time *t*, and $prod_{zt}$ is the production of industry *z* in year *t*.

The vertical import penetration is a measure of the foreign presence in the industry *z* that is being supplied by sector *j*. Its calculation requires a more elaborated procedure and, following Acemoglu et al. (2014) and Altomonte, Barattieri and Ruggi (2014), the *Backward* or vertical import penetration of industry *z* is defined as the weighted average of the import penetration of its inputs, according to the formula:

(2) $$v\_imp_{zt}^{g} = \sum_{j \in z} d_{jz} h\_imp_{jt}^{g*}$$

where d_{jz} is the weight of inputs used by industry *z* from industry *j* ($d_{jz}= use_{jz} / \sum_{j\in z} use_{jz}$) on the total inputs utilized by industry *z*, while $h\_imp_{jt}^{g*}$ is the import penetration of all inputs coming from industry *j* whose goods are used as inputs in the production processes of industry *z*. Thus, to calculate import penetration of intermediate inputs, starting from the databases previously described, we measure production and trade considering only those products that, at CN 8-digit and Prodcom 8-digit level, are classified as "intermediate" goods according to Broad Economic – SNA Categories (BEC).[viii]

Finally, to construct the input-output weight (d_{jz}), namely the share of input from industry *j* in the production of industry *z*, we use the 2007 US Input-Output tables provided by the Bureau of Economic Analysis.[ix] These Input-Output accounts show how industries interact with each other at a highly disaggregated level, namely six-digit I-O industry codes, and provide detailed information on the flows of goods and services that comprise the production process of industries. To construct the (d_{jz}) weight, we employ the "Use table", which reports the value of inputs of commodity *j* used in the production of industry *z*.[x] Converted into the NACE classification, the final number of intermediate inputs involved in the 33 food NACE 4-digit industries, is equal to 94. Most of the inputs come from agricultural and food sectors, representing on average 70% of the inputs used in the food industry, with an almost equal partition in between them, but with strong differences among industries. For each of these 94 inputs we calculate, yearly, the horizontal import penetration $h\_imp_{jt}^{g*}$, including only those goods that are classified as 'intermediate goods' by the BEC classification.

Table 2 and Table 3 present simple descriptive statistics of horizontal and vertical import penetration, obtained distinguishing among trade partner groups and industry 3-digit aggregations, respectively. During the observed period, the average measure of vertical import penetration was around 0.5 for both Italy and France. However, for Italian food firms the vertical dependency from abroad, other than increasing over time, is significantly higher than the horizontal import penetration. By contrast, for France the vertical index is decreasing across the observed period, and only slightly higher than the horizontal one. As discussed in the introduction, these patterns in vertical import penetration between Italy and France are especially due to differences in agricultural comparative advantage.

Among commercial partners, European Union countries represent the most important source of food industry inputs, generally followed by Emerging and OECD countries, although the largest positive changes in the vertical penetration ratio are always observed for the new Member States of the European Union. By contrast, the two import penetration indices, when measured with respect to the developing countries, are on average decreasing over time.

Food sectors considerably vary in terms of their average import competition (see Table 3). It is worth noting that four out of eleven 3-digit sectors register, in both Italian and French markets, an horizontal import penetration over the mean (fish, fruit and vegetable, oils and tobacco), and that some sectors show a relevant increase in import competition, in particular oils, dairy, mill and bakery products. Moving to vertical import penetration, the changes are less pronounced, but the average value of the index is generally higher than the horizontal one. In Italy, where only fish and tobacco sectors have a vertical index that is lower than the horizontal one, the measure ranges from a maximum of 1 (meat), to a minimum of 0.1 (tobacco) and increases in most of the analyzed sectors, and in manufacture of beverage in particular. Quite different is the French situation, where almost all sectors registered a decrease in the vertical import penetration. The only exceptions are meat, fish and animal feed products, which show a weak increase in the observed period.

Identification strategy

With the import penetrations and firm-level total factor productivity measures in hand, we can now move to the econometric model used to test the baseline relationship. We use the following empirical specification to relate horizontal and vertical import penetration to productivity (see Altomonte, Barattieri and Ruggi 2014):

(3) $$y_{it} = \beta_0 + \beta_1 \log h\_imp_{zt-1}^{g} + \beta_2 \log v\_imp_{zt-1}^{g} + \alpha_i + \theta_t + \varepsilon_{izt},$$

where y_{it} is the log of TFP of the firm *i* in year *t* and is regressed on the NACE 4-digit sectors lagged logs of horizontal and vertical import penetration, related to the geographic origins g. Moreover, α_i and θ_t are firm and time fixed effects, respectively, and ε_{izt} is an iid error term.

By including firm (and time) fixed effects, equation (3) identifies the impact of the import penetration variables by exploiting the within firm variation in productivity, hence controlling for time invariant observed and unobserved firms heterogeneity. Moreover, note that the import penetration variables enter the equation lagged one year, because we are assuming that a firm needs some time to adapt to the new situation, and to avoid some spurious correlation induced by some common shocks affecting both imports and productivity. Apart from this, it is important to note that, by working at firm level, equation (3) suffers significantly less from the traditional reverse causality bias that impinges on industry level regressions (see Olper, Pacca and Curzi, 2014).

Results

Table 4 reports the baseline results of the analysis performed by regressing the log of firm-level total factors productivity on our two indicators of horizontal and vertical import penetration, plus a full set of firm and time fixed effects.[xi] In these regressions, we pooled together both French and Italian food firms, thus assuming that they are similarly affected by import penetration indices. Later, we will relax this assumption.

In column 1 the import penetration ratios refer to the World. The one year lagged horizontal import penetration positively affects productivity. However, although the coefficient is estimated with high precision (*p-value* < 1%), the magnitude of the economic effect is quite small. Indeed, quantitatively, a 10% increase in import penetration will induce a TFP growth of only 0.07%, all other things being equal.[xii]

Moving to the effect of vertical import penetration, its estimated coefficient also displays a statistically high significant positive sign (*p-value* < 1%). Thus, consistent with previous evidence, an increase in imports in the upstream intermediate inputs contributes to firm level productivity growth. However, and interestingly, the economic effect of vertical import penetration is of one order of magnitude higher than the one of horizontal import penetration. A 10% increase in upstream integration would result in a 2.1% increase in productivity, *ceteris paribus*. This is a large economic effect and its order of magnitude is the same as in previous findings (see, e.g., Amiti and Konings, 2007). Thus, the results show that the productivity gains from increasing integration in upstream sectors are much higher than those from increasing integration in output, a finding that is consistent with the literature.

The subsequent columns of Table 4 display the results obtained by considering import penetration indices measured for different trading partners. First, considering import penetration coming from the EU15 countries (Column 2), once again more integration in both output and upstream sectors induced by the single market positively contributed to productivity gains. Here the main differences with respect to previous results are that the estimated effect of horizontal import penetration coming from the EU15 countries, as expected, is higher in magnitude, while the one of vertical import penetration is lower, but still about five times greater than the previous one. Very similar results are obtained when considering import penetration indices from Emerging countries (see column 3), but not from OECD (column 4). In the last case, horizontal import penetration significantly contributed to productivity growth, while the effect of vertical import penetration is negative, although the magnitude of the estimated coefficient, equal to −0.007, is close to zero.

In Column 5 the import penetration indices are evaluated considering the EU new member states as partners. Both horizontal and vertical import penetration display a significant negative productivity growth effect. This result, especially considering vertical import penetration, is somewhat unexpected because one can argue that, for both French and Italian food firms, sourcing intermediate inputs from NMS could represent a way for reducing production costs.[xiii] We will come back later to the interpretation of this result. Finally, considering import penetration from the residual "Other countries" group, mainly represented by developing countries, both indices have their expected positive effect on productivity growth (see column 6).

In Table 5, the effect of horizontal and vertical import penetration is analyzed considering separated coefficients for French and Italian firms, so as to study in detail whether the patterns discussed above change for the two countries. Generally speaking, the overall pattern is quite similar, namely both indices tend to positively affect productivity, and import penetration in upstream sectors systematically exerts a stronger effect on both Italian and French food firms. However, some interesting differences emerge, which are worth noting.

First, considering horizontal import penetration, the overall productivity growth effect is significantly positive for French firms, but not for the Italian ones, whose estimated coefficient is still positive but insignificant at conventional level. The productivity growth of French firms appears to be largely driven by horizontal competition coming from the EU15 and, especially, OECD countries. By contrast, Italian firms are affected especially by competition coming from emerging and NMS countries.

Second, moving to vertical import penetration, the productivity growth for French firms is, once again, largely and positively driven by intermediates inputs coming from the EU15 countries, but it is negatively affected by inputs coming from both the OECD and NMS countries, although the magnitude of these effects is very low. Considering Italian firms, they are considerably affected, besides the imports coming from EU15, by imports in intermediate inputs coming from emerging and NMS countries.

While with the data in hand it is difficult to understand the reasons at the root of these findings, factors related to differences in agricultural comparative advantage between the two countries could be at work here. Consider, for example, the opposite pattern of import competition coming from NMS countries. NMS vertical import penetration is significantly positive for Italian food firms, but significantly negative, although lower in magnitude, for French firms. How can we interpret these differences? One way is to look at the patterns of vertical integration indices reported in Table 2. For Italy, NMS vertical import penetration displays an average value of 19% and a growth rate in the 2003-2011 period of about 11% per year. By contrast, the same numbers for France are 11.5% and 3.5%. Thus, the Italian firms bought about twice as much material inputs from NMS as French firms, on average, and displayed a growth rate in the observed period that was three times higher. These are big differences that can be at the root of the contrasting evidence related to the impact of vertical integration from NMS.[xiv]

Finally, in Table 6 we ask to the data an important question: is the impact of horizontal and vertical import penetration conditional to the (initial) level of firms' productivity? Indeed, standard firm heterogeneity trade models predict that an increase in horizontal import competition should induce a market share reallocation from low- to high-productivity firms (see Melitz, 2003; Melitz and Ottaviano, 2008). A similar prediction, although based on a different mechanism, has been recently highlighted by Chevassus-Lozza, Gaigné and Le Mener (2014) for trade liberalization in upstream sectors. These authors indeed showed that the output price elasticity of downstream firms, with respect to a change in input tariffs, increases with firms' productivity.

To test these predictions we run our baseline regression by interacting both horizontal and vertical integration indices with four dummies that identify the different quartiles of the TFP distribution, using the TFP sample distribution of the initial year to attenuate possible endogeneity bias.[xv] The results are interesting and, for both import penetration indices, the magnitude of the TFP growth tends to be significantly higher for firms with higher initial level of productivity, *ceteris paribus* (see Table 6).[xvi] When considering horizontal import penetration, the estimated effect for the lower quartile is negative, although insignificant, and it progressively increases as we move to the higher quartiles of TFP distribution. This pattern proves to be consistent with the prediction of Melitz-type firm heterogeneity models. The only unexpected result is the one related to the upper quartile, where the estimated TFP growth effect induced by horizontal import competition is not significantly different from the previous third quartile. Different reasons can justify this finding. For example, one can argue that more efficient firms, being often multinationals in nature, use a different strategy and, thus, they can be less affected by the increasing competitive environment (Colantone, Coucke and Sleuwaegen, 2014).

Interestingly, the effect is even starker for vertical import penetration, where the estimated coefficients tend to grow progressively as we move from the lower to the upper quartiles of the TFP distribution. Here, the most efficient firms show a TFP growth effect induced by an increase in imported intermediate inputs that is 2.5 times stronger than the least efficient firms. However, it is important to stress that also less productive firms significantly benefit from trade liberalization in intermediate inputs. Taken together, these findings appear interesting. Firstly because they confirm that importer firms, which are concentrated in the upper tail of the distribution (see Bernard, Redding and Schott, 2012), gain proportionally more from trade liberalization in upstream sectors, a result fully consistent with the predictions of Chevassus-Lozza, Gaigné and Le Mener (2014). Secondly, and perhaps more interestingly, these effects are also sizeable for the less efficient firms of the sample, suggesting that the benefits of more competitive upstream sectors spread also to firms that do not import directly.

Discussion and conclusions

Our results strongly support the idea that an increase in a firm's exposure to international trade translates into that firm's productivity growth. This view has been emerging from the new theoretical models of international trade allowing for firm heterogeneity (e.g. Melitz, 2003; Bernard et al., 2003), and has been supported by a number of empirical studies, which have found that trade liberalization in intermediate inputs significantly contributes to firm productivity growth, particularly in developing countries (Amiti and Konings 2007; Halpern, Koren and Szeidl, 2011; Kasahara and Rodrigue 2008; Topalova and Khandelwal 2011; Goldberg et al. 2010).

This article, by exploiting the US Input-Output tables to measure a consistent index of vertical import penetration for French and Italian food sectors, contributes to the existing literature by showing that the productivity growth effect of upstream trade liberalization holds true for the food industry, and significantly overcomes a similar effect induced by horizontal import competition. In particular, we find that trade liberalization in intermediate inputs induces a productivity growth effect that is ten times stronger than import competition coming from the same industry, and that this effect is largely attributable to imported material inputs coming from emerging and EU15 countries. Furthermore, and consistently with theory, we also showed that the magnitude of the economic effect is increasing with the initial level of firm's productivity.

These findings have important implications for the EU trade policy. In fact, if the objective of European institutions is to spur productivity growth in the food industry, further trade liberalization, in particular in the upstream (agricultural) sector, would be a potential valuable strategy. In addition, our analysis shows that not all imports affect all firms to the same extent. This provides useful elements for tailoring public policies to the real needs of heterogeneous firms, in such a way that the adjustment to globalization can be accommodated efficiently.

Yet, in evaluating these policy implications some caveats are necessary. This is because this article focused exclusively on the positive side effects of trade liberalization, disregarding the adjustment costs related to the possible (un-)employment effects. Indeed, the asymmetric growth effect of trade liberalization on firms of different size and productivity calls for a careful investigation of the unemployment effects of trade liberalization. This could be done, for example, along the line of the recent literature that focused on the US labor markets (see Autor, Dorn and Hanson, 2013; Acemoglu et al. 2014).

Furthermore, although this article found robust and sizeable economic effects of upstream trade liberalization on firm productivity, it does not say anything about the underlying channels, an important piece of evidence needed to get to sound evidence-based policy recommendations. Thus, further efforts should deserve particular attention to understand whether the impact of intermediate imports in the EU food industry works through better complementarities of imported inputs, lower input prices, or access to higher quality of inputs. Extending the analysis in these important directions will surely contribute to better understand the overall impact of globalization on the food industry.

References

Acemoglu, D., Autor, D., Dorn, D., Hanson, G. H. and Price, B. 2014. Import Competition and the Great U.S. Employment Sag of the 2000s, NBER Working Papers 20395.

Amiti M. and Konings J. 2007. Trade Liberalization, Intermediate Inputs and Productivity: Evidence from Indonesia. *American Economic Review*, 97 (5), pp. 1611-1638.

Autor, D., Dorn, D., and Hanson, G. H. (2013). The China Syndrome: Local Labor Market Effects of Import Competition in the United States, *American Economic Review*, vol. 103(6), 2121-2168.

Bas, M., Strauss-Kahn, V. 2011. Does Importing more Inputs Raise Exports? Firm Level Evidence from French. Working Papers 2011-15. CEPII research center.

Bernard, A.B., Redding, S.J., and Schott, P.K. 2012.The empirics of firm heterogeneity and international trade. *Annual Review of Economics*, 4, 283–313.

Bernard, A. B., J. Eaton, J. B. Jensen and Kortum, S. S. 2003. Plants and productivity in international trade, *American Economic Review*, 93(4), 1268–1290.

Chevassus-Lozza, E., Latouche, K., 2012. Firms, markets and trade costs: access of French exporters to European agri-food markets. *European Review of Agricultural Economics* 79 (2), 257–288.

Chevassus-Lozza, E., Gaigné, C., Le Mener, L.. 2014. Does input trade liberalization boost downstream firms' exports? Theory and firm-level evidence. *Journal of International Economics* 90 (2013) 391–402.

Colantone, I., Crinò, R. 2014. New imported inputs, new domestic products. *Journal of International Economics* 92 (2014) 147–165.

Curzi, D. and Olper, A. 2012. Export behavior of Italian food firms: does product quality matter? *Food Policy* 37 (5), 493–503.

Curzi, D., Raimondi, V. and Olper, A. 2014. Quality Upgrading, Competition and Trade Policy: Evidence from the Agri-Food Sector, *European Review of Agricultural Economics.* (In press).

Ethier, W. 1982, National and International Returns to Scale in the Modern Teory of International Trade, *American Economic Review*, 72(3), 389–405.

Feenstra, R. and Hanson, G. H. 1996. Foreign Investment, Outsourcing and Relative Wages, in R.C. Feenstra, G.M. Grossman and D.A. Irwin, eds., The Political Economy of Trade Policy: Papers in Honor of Jagdish Bhagwati, MIT Press, 89-127.

Goldberg, P.K., Khandelwal, A.K., Pavcnik, N., Topalova, P. 2010. Imported intermediate inputs and domestic product growth: evidence from India. *Quarterly Journal of Economics*, 125, 1727–1767.

Grossman G., Helpman E. 1991. *Innovation and Growth in The Global Economy*, Cambridge, Massachusetts, MIT Press.

Gullstrand, J. 2011. Firm and destination-specific export costs: the case of the Swedish food sector. *Food Policy,* 36 (2), 204–213.

Halpern, L., Koren, M., Szeidl, A. 2011. Imported Inputs and Productivity. CeFiG Working Papers 8, Center for Firms in the Global Economy, revised 16 Sep 2011.

Kasahara, H., Rodrigue, J. 2008. Does the use of imported intermediates increase productivity? Plant-level evidence. *Journal of Development Economics* 87, 106–118.

Levinsohn J., Petrin A. 2003. Estimating Production Functions Using Inputs to Control for Unobservables. *Review of Economic Studies*, 70, pp. 317-342.

Li, Y., and Beghin, J.C. 2012. A meta-analysis of estimates of the impact of technical barriers to trade. *Journal of Policy Modeling*, 34 (3), 497–511.

Markusen, J. 1989. Trade in Producer Services and in Other Specialized Intermediate Inputs, *American Economic Review*, 79(1), 85-95.

Melitz M.J. 2003. The Impact of Trade on Intra-industry Reallocations and Aggregate Industry Productivity, in *Econometrica*, 71, pp. 1695-1725.

Olley S., Pakes, A. 1996. The Dynamics of Productivity in the Telecommunications Equipment Industry, in *Econometrica*, 64 (6), pp. 1263-1298.

Olper, A., Pacca, L. and Curzi, D. 2014. Trade, import competition and productivity growth in the food industry, *Food Policy*, 49, 71–83.

Rivera-Batiz, L. and P., Romer. 1991. International trade with endogenous technological change, *European Economic Review*, 35(4), 971–1001.

Romer, P. 1987. Growth Based on Increasing Returns Due to Specialization, *American Economic Review*, 77(2), 56–62.

Ruan, J., Gopinath, M., 2008. Global productivity distribution and trade liberalization: evidence from processed food industries. *European Review of Agricultural Economics,* 35 (4), 439–460.

Topalova, P. and Khandelwal, A. 2011. Trade liberalization and firm productivity: The case of India, *Review of Economics and Statistics* 93(3), 995-1009.

Table 1. Descriptive Statistics Relative to TFP

	All			Italy			France		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
(ln) TFP	129,454	3.26	0.91	36,050	4.23	0.89	93,404	2.88	0.58
(ln) Output	129,454	6.73	1.41	36,050	7.58	1.19	93,404	6.40	1.35
(ln) L	129,454	5.34	1.14	36,050	5.26	1.06	93,404	5.38	1.17
(ln) K	129,454	5.32	1.51	36,050	6.12	1.43	93,404	5.02	1.43
(ln) Materials	129,454	5.81	1.69	36,050	6.99	1.37	93,404	5.35	1.57

Notes: TFP has been estimated separately for the Italian and French sample using the Levinsohn and Petrin (2003) method. The estimated coefficients of the Cobb-Douglas production function for the Italian sample are: 0.353 for Labor, 0.062 for Capital and 0.523 for Material costs (return to scale 0.94). The estimated coefficients for the French sample are: 0.389 for Labor, 0.069 for Capital and 0.549 for Material costs (return to scale 1). All the coefficients in the two samples are precisely estimated and significant at the 1% level.

Source: figures based on data described in the text.

Table 2. Horizontal and Vertical Import Penetration by Trade Partners

	Horizontal Import Penetration					
	Italy			France		
Country groups	Mean	Standard Dev.	Avg Annual Growth	Mean	Standard Dev.	Avg Annual Growth
World	0.324	0.278	0.30%	0.427	0.326	0.84%
EU 15	0.271	0.278	-0.47%	0.349	0.294	0.05%
Emerging Countries	0.085	0.295	4.62%	0.042	0.113	5.18%
OECD	0.032	0.181	-4.59%	0.024	0.049	3.61%
NMS	0.026	0.143	18.83%	0.009	0.026	22.28%
Other Countries	0.026	0.143	-1.03%	0.009	0.026	-2.41%

	Vertical Import Penetration					
	Italy			France		
Country groups	Mean	Standard Dev.	Avg Annual Growth	Mean	Standard Dev.	Avg Annual Growth
World	0.540	0.260	1.88%	0.487	0.229	-1.37%
EU 15	0.425	0.239	1.43%	0.371	0.180	1.56%
Emerging Countries	0.229	0.209	5.75%	0.163	0.153	1.46%
OECD	0.165	0.168	-4.15%	0.322	0.320	0.62%
NMS	0.190	0.182	10.97%	0.115	0.211	3.55%
Other Countries	0.100	0.177	-13.73%	0.048	0.096	-24.66%

Source: figures based on data described in the text.

Table 3. Horizontal and Vertical Import Penetration by NACE 3-digit Sectors

Horizontal Import Penetration		Italy			France		
NACE	Description	Mean	Standard Dev.	Avg Annual Growth	Mean	Standard Dev.	Avg Annual Growth
10.1	Processing and preserving of meat and production of meat products	0.168	0.171	1.37%	0.238	0.152	-1.22%
10.2	Processing and preserving of fish, crustaceans and molluscs	0.837	0.078	-2.50%	0.727	0.060	-1.84%
10.3	Processing and preserving of fruit and vegetables	0.409	0.142	-3.68%	0.857	0.359	0.87%
10.4	Manufacture of vegetable and animal oils and fats	0.499	0.210	3.16%	0.769	0.214	1.37%
10.5	Manufacture of dairy products	0.166	0.080	4.44%	0.184	0.051	2.63%
10.6	Manufacture of grain mill products, starches and starch products	0.257	0.169	8.92%	0.393	0.062	3.84%
10.7	Manufacture of bakery and farinaceous products	0.055	0.046	5.99%	0.224	0.141	5.94%
10.8	Manufacture of other food products	0.266	0.185	5.71%	0.421	0.282	-2.63%
10.9	Manufacture of prepared animal feeds	0.187	0.220	-3.50%	0.087	0.089	3.54%
11.0	Manufacture of beverages	0.305	0.354	-2.41%	0.290	0.241	1.96%
12.0	Manufacture of tobacco products	0.960	0.006	0.53%	0.988	0.156	4.61%

Vertical Import Penetration		Italy			France		
NACE	Description	Mean	Standard Dev.	Avg Annual Growth	Mean	Standard Dev.	Avg Annual Growth
10.1	Processing and preserving of meat and production of meat products	1.017	0.209	2.27%	0.168	0.061	0.65%
10.2	Processing and preserving of fish, crustaceans and molluscs	0.191	0.012	-1.00%	0.055	0.002	1.56%
10.3	Processing and preserving of fruit and vegetables	0.448	0.135	-0.18%	0.623	0.188	-2.22%
10.4	Manufacture of vegetable and animal oils and fats	0.911	0.026	0.65%	0.337	0.024	-1.14%
10.5	Manufacture of dairy products	0.735	0.013	-0.87%	0.159	0.014	-9.25%
10.6	Manufacture of grain mill products, starches and starch products	0.487	0.049	2.79%	0.566	0.064	-0.47%
10.7	Manufacture of bakery and farinaceous products	0.463	0.071	2.80%	0.638	0.104	-2.43%
10.8	Manufacture of other food products	0.447	0.169	2.76%	0.450	0.144	-1.40%
10.9	Manufacture of prepared animal feeds	0.666	0.147	0.45%	0.551	0.131	0.41%
11.0	Manufacture of beverages	0.364	0.136	4.06%	0.645	0.162	-0.34%
12.0	Manufacture of tobacco products	0.101	0.010	-1.79%	0.804	0.127	-0.68%

Source: figures based on data described in the text.

Table 4. Import Penetration and Productivity: Baseline Regression Results

Dependent variable: log of TFP	(1) World	(2) EU 15	(3) Emerging Countries	(4) OECD	(5) NMS	(6) Other Countries
Log Horizontal IP (t-1)	0.0073***	0.0233***	0.0142***	0.0238***	-0.0075***	0.0131***
	(0.0027)	(0.0028)	(0.0026)	(0.0030)	(0.0015)	(0.0011)
Log Vertical IP (t-1)	0.213***	0.104***	0.112***	-0.0073**	-0.0096***	0.0165***
	(0.0088)	(0.0068)	(0.0091)	(0.0034)	(0.0016)	(0.0015)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	129454	131025	131011	131014	131021	131000
R-square	0.922	0.921	0.921	0.921	0.921	0.921

Notes: Robust standard errors clustered at firm level under the coefficients; * p<0.1, ** p<0.05, *** p<0.01.

Source: figures based on data described in the text.

Table 5. Import Penetration and Productivity: Results Split by French and Italian Firms

Dependent variable: log of TFP	(1) World	(2) EU 15	(3) Emerging Countries	(4) OECD	(5) NMS	(6) Other Countries
Log Horizontal IP (t-1) FR	0.0088***	0.0223***	0.0017	0.0474***	-0.0184***	0.0113***
	(0.0026)	(0.0029)	(0.0028)	(0.0033)	(0.0016)	(0.0013)
Log Horizontal IP (t-1) IT	0.0048	0.0213	0.0303***	-0.0061	0.0214***	0.0143***
	(0.0147)	(0.0149)	(0.0049)	(0.0054)	(0.0030)	(0.0020)
Log Vertical IP (t-1) FR	0.234***	0.0934***	0.0170	-0.0098**	-0.0137***	0.0387***
	(0.0107)	(0.0079)	(0.0110)	(0.0044)	(0.0017)	(0.0018)
Log Vertical IP (t-1) IT	0.175***	0.128***	0.216***	-0.0058	0.0792***	-0.0104***
	(0.0209)	(0.0147)	(0.0161)	(0.0047)	(0.0071)	(0.0024)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	129454	131025	131011	131014	131021	131000
R-squared	0.922	0.921	0.921	0.921	0.921	0.921

Notes: Robust standard errors clustered at firm level under the coefficients; * p<0.1, ** p<0.05, *** p<0.01.

Source: figures based on data described in the text.

Table 6. Import Penetration and Productivity: Results Split by Initial Level of TFP

Dependent variable: Log of TFP	Horizontal	Vertical
Log IP (t-1) first quartile of TFP	-0.0012	0.128***
	(0.0030)	(0.0142)
Log IP (t-1) second quartile of TFP	0.0133***	0.163***
	(0.0043)	(0.0127)
Log IP (t-1) third quartile of TFP	0.0196***	0.227***
	(0.0062)	(0.0128)
Log IP (t-1) fourth quartile of TFP	0.0209**	0.325***
	(0.0097)	(0.0190)
Firm FE	Yes	
Time FE	Yes	
Observations	98221	
R-squared	0.918	

Notes: Robust standard errors clustered at firm level under the coefficients; * p<0.1, ** p<0.05, *** p<0.01.

Source: figures based on data described in the text.

[i] A growing literature focuses on the impact of import competition coming from developing countries, like China, on employment and inequality. Early studies conclude that there exists a low, or moderate, role of outsourcing in explaining jobs lost and wages decrease (see Feenstra and Hanson 1996; Biscourp and Kramarz 2007). However, more recent studies on the US labor market, by disentangling the trade exposure at local level, are fairly more pessimistic about the effect on jobs lost and wages inequality (see Autor, Dorn and Hanson, 2013; Acemoglu et al. 2014).

[ii] However, there exists a growing literature investigating the relationship between trade and productivity in the food industry, within the framework of firm heterogeneity trade models (see Ruan and Gopinath, 2008; Gullstrand, 2011; Curzi and Olper, 2012; Chevassus-Lozza, Latouche, 2012; Olper, Pacca and Curzi, 2014).

[iii] Specifically, to determine the set of products processed by a 4-digit industry, they used the French Customs Register, which provides information on imports of all French firms by product at the 8-digit level of the combined nomenclature. After knowing the main firm activity, namely its NACE 4-digit sector, they identify all products imported by a given 4-digit industry. This approach, despite having the advantage of being also based on firm imports information, has some drawbacks. First, information on the intermediate consumption structure for each firm is lacking, and second it assumes that all French firms' imports, in a given NACE 4-digit, are truly intermediate inputs used in the same industry.

[iv] Another valuable method that allows to overcome this problem has been proposed by Olley and Pakes (1996). Although such method is conceptually similar to the one by Levinsohn and Petrin (2003), our choice fell to the latter, due to data limitation. Indeed, the Olley and Pakes (1996) method requires the use of investments as proxy for the productivity shocks, an information not available in the Amadeus database.

[v] All the variables used in the TFP estimation have been deflated using national 2-digit industry deflators. Firms operating revenues have been deflated using the GDP price index from EUROSTAT, while for labor costs use was made of a labor cost deflator taken from the European Central Bank. For the intermediate inputs we used the intermediate input deflators from OECD and, finally, firms' capital stock has been deflated using the gross fixed capital formation deflator from EUROSTAT.

[vi] The country groups are defined as follows: EU15 refers to the 14 European countries, with Belgium and Luxembourg reported as a single country; EMG considers 21 emerging countries, following the MSCI classification; NMS includes the 12 new Member States of the EU; OECD, considers 13 OECD countries not included in previous groups; Other Countries includes the remaining countries, mainly developing ones.

[vii] Specifically, we include ten agricultural sectors, from NACE code 0111 to 0311.

[viii] The BEC categories set out the distinctions of primary and processed goods, of capital, intermediate and consumption goods, and of durable, semidurable and non-durable consumer goods. The SNA

(System of National Account) categories distinguish between intermediate, consumption and capital goods.

[ix] The Bureau of Economic Analysis reports IO tables with 389 BEA industry codes, of which 237 are in manufacturing and 13 in agriculture. Detailed data used to estimates the Industry Economic Accounts of the BEA come from 2007 Economic Census and are consequently available only for year 2007. BEA codes are connected with the North American Industry Classification System (NAICS) code structure, then converted to NACE codes.

[x] The "Use Table" shows the use of commodities by intermediate and final users. For example, for the bakery products industry, the table shows the amount (in dollars) of flour, eggs, yeast, and other inputs that are necessary to produce baked goods and the secondary products of the industry, such as flour mixes and frozen food. (data available at the website http://www.bea.gov/industry/io_annual.htm)

[xi] The Hausman test systematically identified fixed effect estimator as preferable to the alternative random effects estimator.

[xii] Interesting, running a specification that include only horizontal import penetration, the estimated coefficient doubles in magnitude, suggesting that omitting vertical import penetration from the model induces an omitted variable bias.

[xiii] However, note that, if we consider the theory of effective protection (Corden 1971), the integration of NMS in 2004 due to a reduction of inputs tariffs, *ceteris paribus*, increased the effective protection, and by reducing import competition could lead to lower productivity.

[xiv] Note also that these differences are largely attributable to what happens in the processing/preserving meat (NACE 10.3) and manufacture of dairy (NACE 10.5) industries. Indeed, in these two important food sectors, vertical import penetration for Italy is, respectively, 100% and 73%, and for French is only 16.8% and 15.9% (see table 2).

[xv] Because our panel is unbalanced, by using the initial year to identify the quartiles of the TFP distribution we lost about 25% of the observations.

[xvi] We conducted a battery of F tests for testing whether the estimated coefficients of horizontal and vertical import penetration reported in Table 6 are significantly different across the quartiles. These F test rejects the equality of the coefficients in all cases, but the one between the third and upper quartiles of horizontal import penetration. The outcomes of the test are available upon request.