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Les chaînes de valeur mondiales gouvernées par la grande distribution dans le secteur agro-alimentaire : une analyse des entreprises françaises

Résumé

Le présent papier étudie le lien entre la décision des entreprises de l'industrie agro-alimentaire française d'approvisionner la grande distribution en produits marque de distributeur (MDD) et leur intégration dans les chaînes de valeur mondiales (CVM). En accord avec des travaux récents dans la littérature, nous identifions les entreprises qui participent aux CVM par leur engagement simultané dans des activités d'importation et d'exportation. Nous considérons la certification avec le standard privé International Featured Standard (IFS), exigée par tous les détaillants opérant en France, comme un indicateur du choix des entreprises de devenir des fournisseurs de produits marque MDD. Nous combinons des données issues de la base AMADEUS et des douanes françaises sur la période 2006-2011 pour estimer le lien entre la décision des entreprises de s'engager dans le commerce extérieur et de devenir fournisseur de la grande distribution à l'aide d'un modèle de choix binaire multivarié. Les résultats confirment une forte corrélation positive entre ces décisions et montrent que les fournisseurs de MDD (les entreprises certifiées IFS) ont une probabilité d'intégrer les CVM 5,83 points de pourcentage supérieure à celle des autres entreprises du secteur agroalimentaire. Ce chiffre correspond à un accroissement par presqu'un facteur de deux de la probabilité des entreprises de participer aux CVM observée dans le secteur. Nous montrons également que l'intégration dans les CVM s'explique principalement par la probabilité plus élevée d'exporter de ces entreprises. Nos résultats sont robustes au contrôle pour l'endogénéité et à l'utilisation de techniques alternatives d'estimation.

Mots-Clés : chaînes de valeur mondiales, grande distribution, marque de distributeur

Classification JEL : F14, F23

Retailer-driven value chains in the agri-food sector: An analysis of French firms

Abstract

The present paper investigates the link between the decision of French agri-food firms to supply retailers with private-label (PL) products and their integration in global value chains (GVCs). In line with the recent literature, we identify firms that participate to GVCs by the ones that engage simultaneously in import and export activities. We consider the certification with the private International Featured Standard (IFS), required by all retailers operating in France, as an indicator of firms' choice to become private label suppliers. We combine firm-level data from the AMADEUS database and French customs over the 2006-2011 period, and estimate the linkage betweens firms' decision to engage in foreign trade and to integrate a retailer-driven value chain using a multivariate binary choice model. Results confirm a strong positive correlation of these decisions, and show that retailers' PL suppliers (*i.e.* IFS-certified firms) are by 5.83 percentage points more likely to integrate GVCs (*i.e.* to jointly import and export) than other firms in the agri-food sector. This figure corresponds to an almost twofold increase in firms' probability to participate to GVCs observed in the sector. We also show that the integration in GVCs is primarily driven by the higher probability to export of these firms. Our findings are robust to the control for endgeneity and the use of alternative estimation techniques.

Keywords: global value chains, retailers, private standards

JEL classification: F14, F23

1. Introduction

Over the past two decades, the development of global value chains (GVCs) in the agri-food sector followed a similar dynamics as in the manufacturing sectors. For example, 45% of global agri-food trade target other uses than final household consumption (Beaujeu *et al.*, 2018). This expansion of agri-food GVCs is related to trade liberalization but also to retailers' activities at the global level.

In this paper, we analyze the specific behavior of agri-food firms that participate to retailer-driven chains. More specifically, we question whether firms that participate to retailer-driven chains are more integrated into GVCs compared to other firms. We measure the integration of firms in GVCs by their joint involvement in import and export activities.

In the agri-food sector, the commitment to respect food safety standards throughout the chain has led to the development of private certification standards. Firms willing to sell their products under a private label (PL) in retailer outlets must comply with the standards set out by that retailer.[1] This compliance requires obtaining a certification from an accredited organization, which aims to standardize practices in terms of food safety and product quality.[2] Since obtaining certification is costly and needs to be renewed annually, we consider that firms that make this choice become de facto suppliers of PL products, *i.e.* integrates a retailer-driven value chain. In the light on the governance approach of GVCs (Gereffi and Korzeniewicz, 1994), the development of retailer-driven GVCs is characterized by a shift from *producer-driven chains* to *buyer-driven chains*. Recent works have shown that firms participating to retailer-driven value chains are more likely to export, and export larger amounts than the rest of firms (Cheptea *et al.*, 2019; Giovannetti and Marvasi, 2016). Our paper contributes to this literature by accurately estimating the differences between firms integrated in value chains governed by retailers and the rest of firms in the sector, with respect to their joint involvement in import and export activities. Understanding these differrences is a key element for analyzing the resilience of food supply chains in a challenging international context marked by crises and instability. The analysis proposed in this article is also linked to the work of Head *et al.* (2014) and Emlinger and Poncet (2018), who show that the presence of foreign retailers in Chinese cities promotes the exports and imports of these cities.

[1] The alternative for agri-food firms to sell their products under their own brands.

[2] We consider the certification with the International Featured Standard (IFS), a private standard required by all French retailer from firms willing to supply PL products.

The contributions of our analysis to the literature are twofold. First, we use original and detailed data on French agri-food firms that allow us to identify IFS-certified firms and to analyze their international behavior. In France, agri-food firms willing to conclude contracts with retailers for supplying PL products must comply with retailers' technical requirements and obtain priorly the certification with the International Featured Standard (IFS). The specific case of France is particularly instructive for the development of GVCs because French retail chains are strongly internationalized, both in terms of the share of sales in foreign markets and the number of penetrated markets. Second, in line with World Bank (2019), we assess the integration of firms in GVCs through their joint import and export activities. Although most of the international trade literature treats separately firms' choices to export and import, recent work shows a strong interdependence of these two decisions (Castellani *et al.*, 2010; Aristei *et al.*, 2013; Bas and Strauss-Kahn, 2014; de Backer and Miroudot, 2014; Elliott *et al.*, 2019; Arnoletto *et al.*, 2020). We show that French IFS-certified firms are significantly more likely to be jointly importers and exporters compared to their non-certified counterparts. Our results are robust when we control for annual and economic activity fixed effects, the self-selection mechanism, and the endogeneity of firms' certification and trade decisions. Alternative estimation strategies, such as difference-in-difference and matching techniques, also confirm our results.

The rest of the article is organized as follows. Section 2 reviews the literature on the participation of agri-food firms in GVCs, the relationship between import and export activities, and the self-selection of firms for engaging in foreign trade. Section 3 describes the used data and presents some stylized facts. Section 4 develops our empirical strategy. Estimation results are presented and discussed in section 5. Section 6 summarizes implemented robustness checks. Our main conclusions are resumed in section 7.

2. Related literature

2.1. Certification, firm internationalization and global value chains

Luo and Tung (2007), consider GVCs as a launch pad for firms. Similarly, Giovannetti *et al.* (2015) show that small and less productive Italian firms from the manufacturing and service sectors significantly improve their export probability and export volume when they integrate a global production chain. Certification also seems to affect positively firms' foreign trade. For instance, Martincus *et al.* (2010) observe over the 1998-2006 period that Argentinian firms

certified with the ISO 9001: 2000 standard export to a larger number of destinations and a higher volume than their non-certified counterparts. Otsuki (2011) finds a similar result for firms from 25 European and Central Asian countries between 2002 and 2009. Authors explain these results by the fact that certification reduces costs and information asymmetry between economic agents. Focusing specifically on private standards, Cheptea *et al.* (2019) show that IFS-certified French firms, identified as retailers' suppliers, have a higher probability to export than non-certified firms to destinations where French retailers established outlets. They also export larger amounts to these markets than their non-certified competitors, benefiting from a retailer network effect. Giovannetti and Marvasi (2016) find that participation to retailer-driven chains significantly contributes to the internationalization of agri-food firms, increasing the likelihood of exporting, especially for small firms. Head *et al.* (2014) explore the differences in the exposure of Chinese cities to the activities of large global retailers,[3] and find that cities with a strong presence of foreign retailers experience an increase in exports. Emlinger and Poncet (2018) show, using panel data from 1997 to 2012, that the presence of global retailers in Chinese cities leads to a disproportionate increase of their imports from retailers' origin countries.

Despite the strong interconnection of import and export activities, and the key role of imports in the global economy highlighted by Castellani *et al.* (2010), few analyses address the participation of firms in retailer-driven chains and their joint import and export activities. The present paper attempts to fill in this gap. Before analyzing the link between participation in retailer-driven chains and GVCs, it is important to understand the mechanisms by which firms' imports and exports are highly interconnected.

2.2. Relationship between imports and exports

There is increasing evidence in the literature that firms' export performance is highly dependent on activities in import markets (Castellani *et al.*, 2010; Aristei *et al.*, 2013; Bas and Strauss-Kahn, 2014; de Backer and Miroudot, 2014; Elliott *et al.*, 2019; Arnoletto *et al.*, 2020). Indeed, de Backer and Miroudot (2014) emphasize that export competitiveness relies on the efficient procurement of inputs in value chains. Several mechanisms explain this point. Greenville *et al.* (2017) argue that import barriers reduce the involvement in GVCs, as well as the value-added and revenues of agri-food exports. Kasahara and Lapham (2013) show that

[3] They use data on the location of supply centers of four main foreign retailers (Walmart, Carrefour, Tesco and Metro) operating in China.

trade policies, import barriers on foreign intermediate goods (inputs) can have a significant negative effect on the exports of final goods due to complementarities between imports and exports. Amiti and Konings (2007) use data from Indonesian manufacturing firms from 1991 to 2001 and show that trade liberalization and tariff reduction led to a drop in the price of imported intermediate goods. Imports improve firms' productivity by opening access to a higher variety of inputs, to high quality inputs, and by engaging them into a learning process. Similarly, Pierola *et al.* (2018) use transaction-level data on Peruvian over the 2000-2012 period and show that a stronger use of highly diversified and high quality imported inputs are associated with higher firm productivity. Authors also find a positive link between firms' imports and the level of exports to a wide variety of markets, as well as the rapid growth of exports of higher quality products.

Hummels *et al.* (2001) analyze the sequential production process in 10 OECD countries and 4 emerging markets between 1970 and 1990. Using input-output tables, they find that vertical specialization, reflected by a high level of input imports, explains over 20% of a country's exports and around 30% of its exports' growth over the considered period. Using data on French firms over the 1996-2005 period, Bas and Strauss-Kahn (2014) highlight three channels through which diversified imports of intermediate goods increase firms' exports: (i) imported inputs may enhance productivity, permitting to cover export fixed costs; (ii) low-priced foreign inputs increase expected export revenues; (iii) importing inputs permits to meet quality and technology requirements in export markets. Elliott *et al.* (2019) find similar results using panel data on Chinese firms over the 2002-2006 period. They show that firms make export and import decisions simultaneously and that sunk costs play an important role in this process. Similarly, Arnoletto *et al.* (2020) show, using data on Argentinian exporting firms over the 2007-2017 period, that firms characterized by a high level of imported intermediate inputs experience a stronger growth of their export activity.

2.3. Self-selection mechanism of firms in international trade

The literature explains the strong interconnection between imports and exports by a self-selection mechanism. For instance, Kasahara and Lapham (2013) show that firms face sunk and fixed costs for both exporting and importing, and that only the most productive firms, which can bear these costs and earn positive profits, actually engage into exports and import activities. They find that sunk and fixed costs are particularly high in food industries and highlight important cost complementarities allowing firms that simultaneously export and

import to save up to 26% of these costs. These assertions are supported by Kraay *et al.* (2002), who argue that before becoming importers, firms incur sunk costs associated with finding foreign suppliers and familiarizing themselves with the customs procedures of origin countries. Moreover, Castellani *et al.* (2010) classify firms according to their economic performance, and show that firms that simultaneously export and import outperform the others. They find that firms engaged exclusively in import activities are more performant than firms engaged exclusively in export activities, and conclude that self-selection is stronger in the import market than in the export market. Analyzing firms' *ex ante* differences, authors also show that future importers are larger, more productive and more capital intensive than future exporters. Similarly, Kugler and Verhoogen (2008, 2009) provide supporting evidence that importing firms are more productive, and thus suggest that the selection of firms into importing is stronger than into exporting.

Other factors than fixed costs may also explain the participation of firms to international trade. Goldberg *et al.* (2009) and Amiti and Konings (2007) show that trade liberalization has reduced the price of imported intermediate goods and allowed firms to substitute domestic inputs with more diversified, more affordable and higher quality foreign inputs. This may permit less productive firms to enter the import market, benefit from higher quality inputs, and improve thereby their productivity and the quality and variety of their products. Not surprisingly, when defining participation to GVCs by firms' involvement in both import and export activities, Baldwin and Yan (2014) find that participation to GVCs improves promptly firms' productivity and has a long-lasting effect, relative to exclusive exporters, exclusive importers and domestic firms. Similarly, Giovannetti *et al.* (2015) and Giovannetti and Marvasi (2016) show that small and low productivity firms may start exporting when integrated into a global value chain. This point of view is also shared by Castellani *et al.* (2010) who defend the presence of GVC post-entry effects. Firms without an *ex ante* productivity premium can become more productive after joining a GVC and may therefore engage in international trade activities. These findings fuel the debate on the mechanisms that promote the participation of firms to international trade, in general, and in GVCs in particular.

This literature review emphasizes the importance of evaluating firms' import and export decisions simultaneously. We integrate this aspect in the analysis of the participation of French agri-food firms in retailer-driven value chains.

3. Data and stylized facts

3.1. Identification of firms involved in retailer-driven value chains

We question whether firms integrated in retailer-driven chains are more likely to participate to GVCs. In other words, we seek to determine whether an agri-food firm that supplies PL products to a retailer (*e.g.* Carrefour) has a higher probability (or not) of buying inputs and jointly selling its products on foreign markets. To this end, we compare the import and export decisions of IFS-certified firms (*i.e.* firms supply retailers with PL products) to the decisions of the agri-food firms that sell their products under own brand.

The IFS certification can be obtained individually by each firm complying with a set of requirements established by the retailer. It is provided separately for each production line and needs to be renewed every year. The complete audit of a firm's production line lasts, on average, two and a half days and costs about 3,500 €. As a results of this audit, the IFS certification is issued to the firm if the inspected production line meets all the requirements of the standard. In case of a negative audit outcome, the firm needs to make additional investments to ensure the compliance of the production line (or abandons the process). A firm with multiple production lines incurs higher audit costs to obtain certification for all its products. A firm willing to preserve its certification over a longer period of time needs to repeat the audit every year and pay each time the associated costs.

3.2. Data sources and descriptive statistics

The data we use comes from different sources:

(i) The AMADEUS database permits to identify firms in the French agri-food sector and provides information on each firms' type of economic activity, turnover, number of employees, and financial links with other firms. We use this information to account for the size, productivity, and level of independence of firms.

(ii) French customs database includes information on each firms' product-level bilateral imports and exports. For the purposes of our study, we have aggregated import and export data at firm-year level (by summing across products and countries of origin or destination).

(iii) The exhaustive list of French agri-food firms that have the IFS-certification each year from 2003, when certification was introduced, until 2011. This data is provided by an independent accredited certification organization. We use this information to identify firms involved in retailer-driven value chains. The first three years since the official introduction of the IFS certification were marked by a very low participation rate, due to novelty phenomenon and reduced awareness. Accordingly, we focus our analysis on the 2006-2011 period.

Information on the IFS certification of firms is combined with the other two datasets via the identification of each firm with a unique SIREN number, available in each data source.

Limiting the analysis to a single sector – the agri-food –reduces the effects of unobserved factors on firms' characteristics and decisions (strategies). Still, the data contains a certain degree of heterogeneity, due to the diversity of firms' economic activities (industries) in the agri-food sector. In the dataset, the main economic activity of the firm is registered according to the NACE Rev.2 classification. We exclude the firms in sub-industries characterized by a very low rate of IFS certification rate or participation in international trade (*e.g.* bakeries, manufacture of animal feed, manufacture of starch products, manufacture of malt and tobacco products).

Our final database covers the period 2006-2011 and includes 24,351 observations. Out of these, 1,269 (5.2%) represent exclusively importing firms, 3,060 (12.6%) exclusively exporting firms, 4,112 (16.9%) jointly importing and exporting firms, and 15,910 (65.3%) domestic firms. There are 1,157 IFS certified firms in our panel, *i.e.* less than 5%.

Table 1 presents the distribution of firms in the first and last years of the sample, according to their exporter and importer status and IFS certification. It shows a very uneven composition of IFS certified and non-certified firms, according to their participation in international trade. The group of IFS-certified firms is composed predominantly of joint importing and exporting firms (72% in 2006 and 60% in 2011), while the group of non-certified firms contains mainly domestic firms (62% in 2006 and 73% in 2011). Certified firms are more actively engaged in international trade than non-certified firms. As an illustration, in 2006, 88% of IFS certified firms were importing and/or exporting, compared to 37% of non-IFS certified firms. This gap widened by 2011: 86% for certified firms versus 26% for non-certified firms.

Table 1: Frequency of firms participating in international trade by IFS certification status

Types of firms	Number of firms					
	Agri-food firms		IFS firms		Non-IFS firms	
	2006	2011	2006	2011	2006	2011
Exporting firms	470	738	5	51	465	687
(proportion of total in %)	(13%)	(14%)	(7%)	(19%)	(13%)	(13%)
Importing firms	218	215	6	18	212	197
(proportion of total in %)	(6%)	(4%)	(9%)	(7%)	(6%)	(4%)
Both importing and exporting firms	692	645	49	159	643	486
(proportion of total in %)	(19%)	(12%)	(72%)	(60%)	(18%)	(9%)
Sum of the three categories	1 380	1 598	60	228	1 320	1 370
(proportion of total in %)	(38%)	(30%)	(88%)	(86%)	(37%)	(26%)
Domestic	2 186	3 828	8	37	2 178	3 791
(proportion of total in %)	(61%)	(71%)	(12%)	(14%)	(62%)	(73%)
Total	3 566	5 426	68	265	3 498	5 161

Source: AMADEUS, IFS organization and French customs.

The distribution of firms by size and IFS status (Table 2) shows that, in 2006, most IFS-certified firms were medium-size (50 to 499 employees) or large-size (over 499 employees) firms: 57.35% and respectively 25%. However, by 2011, we note that the share of certified small-size firms (less than 50 employees) has exceeded that of certified large firms. In contrast to certified firms, non-IFS certified firms are mainly small-size firms (85.71% in 2006 and 93.12% in 2011), followed by medium-size firms (12.72% in 2066 and 6.28% in 2011).

Regarding the distribution of firms by size with respect to their international trade activity, we note that, in 2006, most IFS-certified firms were medium-size (39.71%) and large-size (23.53%) joint exporters and importers. Medium-size joint exporters and importers were still the dominant group in 2011 (35.09%). However, we see a strong increase in the number of small-size join exporters and importers (15.85%), that by 2011 outnumber large-size joint exporters and importers. We observe a similar evolution for certified small-size firms engaged exclusively in exporting. The share of these firms increased from low level in 2006 (observation dropped for statistical secret reason) to 10.19% in 2011, reflecting a strong increase in the interest of small firm for IFS certification and/or their capacity to obtain the certification. At the same time, non-certified firms are dominated by small-size domestic firms (60.60% in 2006 and 72.04% in 2011).

Table 2: Frequency and proportion of firms by size and IFS certification status

Year	No. of employ-yees	No. of exporting firms (share in %)		No. of importing firms (share in %)		No. of importing & exporting firms (share in %)		No. of domestic firms (share in %)		Total no. of firms (share in %)	
		IFS	Non-IFS	IFS	Non-IFS	IFS	Non-IFS	IFS	Non-IFS	IFS	Non-IFS
2006	<50	S	396 (11.32%)	S	169 (4.83%)	6 (8.82%)	313 (8.95%)	3 (4.41%)	2 120 (60.60%)	12 (17.65%)	2 998 (85.71%)
	50 à 499	4 (5.88%)	68 (1.94%)	4 (5.88%)	43 (1.23%)	27 (39.71%)	277 (7.92%)	4 (5.88%)	57 (1.63%)	39 (57.35%)	445 (12.72%)
	> 499	S	S	S	S	16 (23.53%)	53 (1.52%)	S	S	17 (25.00%)	55 (1.57%)
	Total									68	3 498
2011	<50	27 (10.19%)	634 (12.28%)	6 (2.26%)	161 (3.12%)	42 (15.85%)	293 (5.68%)	20 (7.55%)	3718 (72.04%)	95 (35.85%)	4 806 (93.12%)
	50 à 499	24 (9.06%)	52 (1.00%)	12 (4.53%)	36 (0.70%)	93 (35.09%)	164 (3.18%)	16 (6.04%)	72 (1.40%)	145 (54.72%)	324 (6.28%)
	> 499	S	S	S	S	24 (9.06%)	29 (0.56%)	S	S	25 (9.43%)	31 (0.60%
	Total									265	5 161

Source: AMADEUS, IFS organization and French customs. S denotes dropped for statistical secret reason.

3.3. The interconnection of firms' import, export and certification decision

We pool observations from all years in our panel and analyze the joint and marginal probabilities of firms to engage in international trade and certify, as well as the conditional and unconditional probabilities for each observed choice or combinations of choices.

Table 3 shows that about 29% of firms in our panel are at least exporting, 22% at least importing, and only 4.76% are IFS-certified. Joint exporters and importers are the largest share in our sample (13.82%), after domestic firms. They are followed by exclusively exporting firms (11.92%) and at a great distance by exclusively importing firms (4.82%). The share of firms that participate jointly in import and export markets is even greater in the group of IFS-certified firms, exceeding the share of domestic firms (3.07% vs. 0.65%). These stylized facts indicate that there is a strong correlation between a firm's participation in international trade and relationship with retailers, reflected in its choice to certify or not.

Based on the statistics listed in Table 3, we compute the observed conditional probabilities for each type of firm. The results reported in Table 4 confirm the strong interdependencies between firms' import, export, and certification decisions. Indeed, 72.69% of the IFS-certified firms are engaged in importing and 78.15% in exporting. These probabilities are much higher than the unconditional probabilities of 22.10% and respectively 29.46% for the whole sample.

Table 3: Observed joint and marginal probabilities for different types of firms

	Joint probability	Marginal effect (Importer)	Marginal effect (Exporter)	Marginal effect (IFS)
Importer only	4.82	4.82		
Exporter only	11.92		11.92	
IFS and Domestic	0.65			0.65
Importer and Exporter	13.82	13.82	13.82	
Importer and IFS	0.39	0.39		0.39
Exporter and IFS	0.65		0.65	0.65
Importer and Exporter and IFS	3.07	3.07	3.07	3.07
Domestic only	64.68			
Total	100.00	22.10	29.46	4.76

Source: Authors' calculations based on AMADEUS data, IFS organization and French customs.

In addition, certified firms engaged in imports or exports have a very high probability of engaging in the other trade activity (88.73% and 82.53%). These statistics confirm the strong correlation between the group of importing, exporting and certified firms, and indicate that the probability that a firm belongs to only one of these groups is quite low. We also note that the probability that importing and/or exporting firms get certified is relatively low, compared to the probability that certified firms import and/or export: 15.66% for importers, 12.63% for exporters, and 18.18% for both importing and exporting firms.

Table 4: Observed conditional and unconditional probabilities

	Importer	Exporter	IFS
$Pr(.)$	22.10	29.46	4.76
$Pr(.\|\text{Importer} = 1)$	100.00	76.43	15.66
$Pr(.\|\text{Exporter} = 1)$	57.33	100.00	12.63
$Pr(.\|\text{IFS} = 1)$	72.69	78.15	100.00
$Pr(.\|\text{Exporter} = 1, \text{IFS} = 1)$	82.53	100.00	100.00
$Pr(.\|\text{Importer} = 1, \text{IFS} = 1)$	100.00	88.73	100.00
$Pr(.\|\text{Importer} = 1, \text{Exporter} = 1)$	100.00	100.00	18.18

Source: Authors' calculations based on observed statistics in the data.

4. Empirical strategy

We model firms' decisions to involve in international trade activities as a function of their choice to participate or not to retailer-driven chains. We propose a multivariate probit estimation procedure tailored to our empirical framework. We draw on the work of Goy and

Wang (2016), who analyze the relationship between knowledge tradability (engagement in licensing agreements) and firms' choice of intellectual property protection strategies (patents *vs.* secrecy). We adapt this framework to firms' decisions regarding their participation to international trade. We assume that firms' import and export choices reflect the outcome of a maximization program of profits obtained from international trade activities.

We consider that the decision to export or import, noted by binary variables $y_{EXP,i}$ and $y_{IMP,i}$, is the result of maximizing associated profits, $\pi_{EXP,i}(\mathbf{X}_i, \boldsymbol{\theta}_i)$ and $\pi_{IMP,i}(\mathbf{X}_i, \boldsymbol{\theta}_i)$:

$$\pi_{k,i} = \boldsymbol{\beta}_k' \mathbf{X}_i + \boldsymbol{\theta}_i + \varepsilon_{k,i} \; ; \;\; k = EXP, IMP \tag{1}$$

where $\mathbf{X}_i$ is a vector of observed firm-specific variables, $\boldsymbol{\theta}_i$ is a vector of unobservable characteristics but known to the firm, $\boldsymbol{\beta}_{EXP}'$ and $\boldsymbol{\beta}_{IMP}'$ are the vectors of the parameters to be estimated, and $\varepsilon_{EXP,i}$ and $\varepsilon_{IMP,i}$ are zero-mean error terms. Since the profits earned by firms $\pi_{k,i}$ are not directly observed, we consider them as latent variables. Firms choose to export or import if they earn non-negative profits:

$$\begin{cases} y_{k,i} = 1 & \text{if} \quad \pi_{k,i}(\mathbf{X}_i, \boldsymbol{\theta}_i) \geq 0 \\ y_{k,i} = 0 & \text{if} \quad \pi_{k,i}(\mathbf{X}_i, \boldsymbol{\theta}_i) < 0 \end{cases} \quad k = EXP, IMP \tag{2}$$

We also consider that firms' certification decision, reflected in the binary variable IFS_i, is determined by the value of a latent variable $\pi_{IFS,i}$ that measures the benefits of certification for the firm:

$$\begin{cases} IFS_i = 1 & \text{if} \quad \pi_{IFS,i}(\mathbf{Z}_i, \varphi_i) \geq 0 \\ IFS_i = 0 & \text{if} \quad \pi_{IFS,i}(\mathbf{Z}_i, \varphi_i) < 0 \end{cases} \tag{3}$$

Regarding these three decisions (to import, export and get certified), some specificities have to be accounted for. A firm's choice to export and import are not mutually exclusive. The decision to export can be linked to the decision to import or vice versa. Indeed, Kasahara and Lapham (2013) show that firms that simultaneously export and import face lower overall sunk and fixed costs associated with engaging in international trade activities. In other words, common unobservable factors $\boldsymbol{\theta}_i$ impact both decisions. Moreover, as shown in appendix B2, IFS-certified firms have a higher productivity than non-certified firms. This *ex ante* difference in productivity levels shows that there is a self-selection of firms into certifying with the IFS.

The separate estimation of each equation would produce inconsistent estimators. In this case, the use of a multivariate model remains the best solution (Maddala, 1986; Bhattacharya *et al.*, 2006). To account for the possible endogeneity of firms' decision to certify, we construct a trivariate probit model:

$$\begin{cases} \pi_{EXP,i} = \boldsymbol{\beta}'_{EXP}\mathbf{X}_i + \delta_{EXP}Inst_{EXP,i} + \gamma_{EXP}IFS_i + \theta_i^{EXP} + \varepsilon_{EXP,i} \\ \pi_{IMP,i} = \boldsymbol{\beta}'_{IMP}\mathbf{X}_i + \delta_{IMP}Inst_{IMP,i} + \gamma_{IMP}IFS_i + \theta_i^{IMP} + \varepsilon_{IMP,i} \\ \pi_{IFS,i} = \boldsymbol{\alpha}'\mathbf{Z}_i + \delta_{IFS}Inst_{IFS,i} + \varphi_i + \upsilon_i \end{cases} \quad (4)$$

The identification of multivariate binary choice models is achieved solely through the non-linear form of the estimator (probit in our case). To reduce this fragility of the model, Wooldridge (2010, pp. 594–599) and Goy and Wang (2016) recommend imposing exclusion restrictions by introducing at least one instrumental variable for each explained variable. We add three instrumental (exclusion) variables – $Inst_{EXP,i}$, $Inst_{IMP,i}$ and $Inst_{IFS,i}$– in system (4). We follow the approach adopted by Cheptea *et al.* (2019) and construct our instruments based on the strategies adopted by competing firms from the same industry. Thus, for firms' decision to export (import) we compute the share of exporting (importing) firms in the overall turnover of competing firms from the same industry. By construction, the two instruments are uncorrelated with the firm's export and import decision because we exclude the analyzed firm and focus only on the activity of its competitors. Accordingly, these instruments can be interpreted as average evaluations by pairs of the profitability of export and import activities. The variable $Inst_{IFS,i}$ is constructed similarly to the exclusion variables for firms' export and import decisions. It corresponds to the share of certified firms in the overall turnover of competing firms from the same industry.[4] Following Cheptea *et al.* (2019), we consider that firms' competition for retailers' shelf space should affect their certification strategies, but not their decisions to export and/or import.

The vector of observed characteristics $\mathbf{X}_i$ includes the productivity, size and financial links (degree of independence) of the firm. We compute a firm's productivity as its annual turnover per employee. The size of a firm is reflected in its turnover and number of employees, but these two variables are highly correlated with our productivity measure. To overcome this problem (eliminate a possible multicollinearity bias), we identify three categories of firms based on the number of employees and include in equation system (4) three dummies

[4] This variable is computed as the ratio between the sales of firms from the same industry less the sales of the analyzed firm and the overall sales of all firms in the industry.

associated with size class: (i) small firms with less than 50 employees; (ii) medium-size firms with 50-499 employees; and (iii) large firms with 500 or more employees. Similarly, we include dummies for the four types of firms' financial linkages: (i) independent firms that don't have any financial linkages with other firms; (ii) heads of group, which hold financial parts in other firms and keep full control over their own parts, (iii) connecting firms, which hold financial parts in other firms and at the same time are partially owned by other firms, and (iv) affiliates, which have no financial parts in other firms and are totally or partially owned by other firms. We include as well industry and year fixed effects in the system of equations (4) in order to capture the impact of unobservable factors $\boldsymbol{\theta}_i$.[5]

The trivariate error terms $(\varepsilon_{EXPi}, \varepsilon_{IMPi}, \upsilon_i)$ are assumed to follow joint normal distributions, and the terms of the variance-covariance matrix: $var(\varepsilon_{EXPi}) = var(\varepsilon_{IMPi}) = var(\upsilon_i) = 1$, $cov(\varepsilon_{EXP,i}, \varepsilon_{IMP,i}) = \rho_1$, $cov(\varepsilon_{EXP,i}, \upsilon_i) = \rho_2$ and $cov(\varepsilon_{IMP,i}, \upsilon_i) = \rho_3$. The relevance of the trivariate probit model is confirmed by obtaining estimates of parameters ρ_1, ρ_2 and ρ_3 statistically different from zero.

We use a simulated maximum likelihood estimator (SML) to obtain the estimated values of model parameters. This estimator is a multivariate normal probability simulation computed with the Geweke-Hajivassiliou-Keane (GHK) simulator. We employ this estimator because of its suitable properties: simulated probabilities are unbiased and in the interval (0,1), the simulator is a continuous and differentiable function of model parameters, and estimators are asymptotic in the sense that they become more consistent as the number of draws and the number of observations tend to infinity (Cappellari and Jenkins, 2003).

5. Results and discussion

We estimate the system (4) with a trivariate probit.[6,7] Indeed a potential bias may arise due to the endogeneity of the certification decision (see Appendix B1 for details of the Durbin-Wu-

[5] The best way to capture the effects of unobservable factors would be to include firm-level fixed effects. We cannot implement this solution because of the large number of firms in our sample (about 8,000) and the difficulty of convergence of a probit model with a very large number of fixed effects.

[6] Tables A1 and A2 of Appendix A present the descriptive statistics and correlation of the model variables.

[7] We estimate system (2) separately on the sub-samples of certified and of non-certified firms (Tables A3 and A4 of Appendix A). The main message we retain from these results is that an equal increase in firm productivity has different effects on the import and export strategies of the two types of firms, especially on their probability to engage jointly in importing and exporting (column 4) or exclusively in one of these two activities (columns 5 and 6). An equal increase in productivity has a strong effect on the joint probability to export and import for IFS certified firms (column 4 of Table A3). More surprisingly, productivity has a negative effect on the probability

Hausman augmented endogeneity test) and to the self-selection of the most productive firms towards certification (see Appendix B2 for details).

The results of the tri-probit presented in Table 5 confirm the importance of the correlation between the decisions to import and to export (ρ_1=0.60). Note that Table 5 lists marginal effects at the sample mean of different variables on predicted univariate, conditional and joint probabilities. The positive sign of the error correlation coefficient between export status and IFS status (ρ_2) and its significance indicate that there are factors improving the probability of being IFS certified and the probability of being an exporter. In contrast, the non-significance of the error correlation coefficient between IFS and importer status (ρ_3) suggest that the decisions to be certified and to import are not directly linked. The link between these two decisions, if it exists, may pass through other channels. The factors that explain the error correlations are not directly observable through the model estimation.

Taking into account the correlations between the unobserved factors of the three choice variables leads to a change in the estimates (Table 5). The effect of certification becomes negative on the probability of exporting and non-significant on the probability of importing. We observe a general increase in the effect of all control variables, indicating the importance of unobserved factors (with respect to bi-probit estimations in Tables A3 and A4). The correlation of the effects of unobservable factors makes it insufficient to interpret the results for specification 1 only, in Table 5. To better understand the effect of certification, we calculate the conditional probabilities of importing and exporting separately for IFS and non-IFS firms. These conditional probabilities allow us to calculate the treatment effect of IFS certification on the decision to import and/or export (Table 6) and thus complete the interpretation of the tri-probit results (Table 5).

of IFS certified firms to engage exclusively in exporting or importing (columns 5 and 6 of Table A3), but positive for non IFS firms (column 5 and 6 of Table A4). These findings suggest that IFS firms are more likely to engage simultaneously in import and export activities and less likely to engage only in exporting or only in importing. This self-selection of certified firms is a first evidence that participation in retailer-driven value chains increases firms' odds to integrate GVCs.

Table 5: Partial marginal effects on firms' probabilities to export and import, computed at the sample mean, tri-probit estimator

	Univariate probabilities			Conditional probabilities			
		(1)		(2)	(3)	(4)	(5)
VARIABLES	Pr(EXP=1)	Pr(IMP=1)	Pr(IFS=1)	Pr(EXP=1|IMP=0)	Pr(EXP=1|IMP=1)	Pr(IMP=1|EXP=0)	Pr(IMP=1|EXP=1)
IFS Certification	-0.151***	0.041		-0.152***	-0.274***	0.056**	0.183**
	(0.050)	(0.042)		(0.039)	(0.063)	(0.025)	(0.071)
ln *productivity*	0.117***	0.120***	0.004***	0.067***	0.052***	0.063***	0.162***
	(0.004)	(0.003)	(0.000)	(0.003)	(0.006)	(0.002)	(0.006)
Financial linkages:							
Independent firm	reference	reference	reference	reference	reference	reference	reference
Head of group	0.224***	0.147***	0.019***	0.155***	0.187***	0.063***	0.146***
	(0.013)	(0.011)	(0.002)	(0.011)	(0.019)	(0.007)	(0.020)
Connecting firm	0.312***	0.246***	0.021***	0.203***	0.218***	0.116***	0.284***
	(0.012)	(0.009)	(0.002)	(0.010)	(0.017)	(0.006)	(0.017)
Affiliate	0.217***	0.176***	0.021***	0.140***	0.147***	0.085***	0.208***
	(0.007)	(0.006)	(0.001)	(0.006)	(0.011)	(0.004)	(0.011)
Firm size:							
1 to 49 employees	reference	reference	reference	reference	reference	reference	reference
50 to 499 employees	0.333***	0.266***	0.029***	0.216***	0.229***	0.127***	0.311***
	(0.012)	(0.011)	(0.002)	(0.010)	(0.017)	(0.007)	(0.019)
500 employees or more	0.560***	0.492***	0.044***	0.347***	0.338***	0.244***	0.612***
	(0.036)	(0.032)	(0.004)	(0.032)	(0.054)	(0.022)	(0.060)
Share of competing exporting firms in the same industry	-0.061			-0.056	-0.093	0.011	0.041
	(0.060)			(0.055)	(0.092)	(0.011)	(0.040)
Share of competing importing firms in the same industry		-0.103**		0.035**	0.108**	-0.072**	-0.206**
		(0.046)		(0.015)	(0.048)	(0.032)	(0.092)
Share of competing certified firms in the same industry			-0.016***				
			(0.004)				
Year fixed effects		YES					
Industry fixed effects		YES					
Likelihood ratio		-19426.521					
$\rho_1 = cov(IMP, EXP)$		0.605***					
$\rho_2 = cov(EXP, IFS)$		0.393***					
$\rho_3 = cov(IMP, IFS)$		0.084					
Observations		24,351					

*Notes: *** p<0.01, ** p<0.05, * p<0.1; standard errors in parentheses.*

The results in Table 6 confirm, first and foremost, the strong relationship between the importing and exporting status of firms, which we have captured so far through the correlation coefficients of the errors of the importing and exporting decisions. Indeed, the status of exporter significantly increases the probability of being an importer of the average firm by 29.21 p.p. (Table 6: Pr(IMP=1 | EXP=1)-Pr(IMP=1 | EXP=0)= 36.31 – 7.10 = 29.21). Moreover, results show that being an importer increases the probability of being an exporter by 43.39 p.p. and this effect is significant. This suggests that integration into GVCs is driven by being a prior exporter, but more so when the firm is a prior importer, regardless of IFS status. These results are consistent with the literature and are mainly explained by self-selection mechanisms but also by post-entry effects (Castellani *et al.*, 2010; Kasahara and Lapham, 2013; Aristei *et al.*, 2013; Bas and Strauss-Kahn, 2014; Elliott *et al.*, 2019). Indeed, the self-selection mechanism is explained by the fact that only the most productive firms (those that have reached a productivity threshold)[8] import and/or export. Thus, a firm that enters the import or export market is assumed to have reached a productivity threshold that allows it to participate in international trade and to enter the import and export markets jointly. The post-entry effect is due to the fact that some firms may participate in international trade (import and/or export) with a productivity below the threshold. This can be explained by some other factors, not necessarily observable as the implementation of an internationally oriented management or managers' knowledge of foreign markets. Such factors allow small and less productive firms to participate into international trade. These firms after entering the import or export market, become more productive and have the opportunity to engage jointly in import and export markets.

We seek to determine the effects of certification status on the other system-dependent variables in order to compare them to the coefficients obtained directly with the trivariate model estimation. The results in Table 6 show that certification increases the probability to import by 5.60 p.p. and the probability to export by 41.07 p.p. These effects are different from the effects of IFS certification estimated directly by our model. They confirm the role of unobservable factors at play in firms' import, export and certification decisions.

[8] See Chevassus-Lozza and Latouche (2012).

Table 6: Conditional predicted probabilities and treatment effects

	Average conditional probabilities (%)	
	IFS certified and non-certified firms	
$\Pr(EXP = 1 \mid IMP = 1)$ Probability of exporting if importer	60.31 (0.518)***	
$\Pr(EXP = 1 \mid IMP = 0)$ Probability of exporting if not importer	16.92 (0.296)***	
$\Pr(IMP = 1 \mid EXP = 1)$ Probability of importing if exporter	36.31 (0.553)***	
$\Pr(IMP = 1 \mid EXP = 0)$ Probability of importing if not exporter	7.10 (0.193)***	
	IFS Certified	*Not IFS certified*
$\Pr(EXP = 1)$ Probability of exporting	63.61 (0.632)***	22.54 (0.334)***
$\Pr(IMP = 1)$ Probabilité of importing	19.34 (0.362)***	13.74 (0.285)***
$\Pr(EXP = 1, IMP = 1)$ Probability of both exporting and importing	13.59 (2.200)***	7.76 (0.268)***
$\Pr(EXP = 0, IMP = 0)$ Probability of being domestic	59.02 (12.184)***	72.00 (0.474)***
$\Pr(EXP = 1, IMP = 0)$ Probability of exporting without importing	29.30 (2.487)***	15.56 (0.348)***
$\Pr(EXP = 0, IMP = 1)$ Probability of importing without exporting	1.77 (1.080)	4.67 (0.204)***
	Average treatment effect (p.p.)	
$\Pr(EXP = 1 \mid IMP = 1) - \Pr(EXP = 1 \mid IMP = 0)$ Probability of exporting: importer vs. non-importer	43.93 (0.000)***	
$\Pr(IMP = 1 \mid EXP = 1) - \Pr(IMP = 1 \mid EXP = 0)$ Probability of importing: exporter vs non-exporter	29.21 (0.000)***	
$\Pr(EXP = 1 \mid IFS = 1) - \Pr(EXP = 1 \mid IFS = 0)$ Probability of exporting: IFS certified vs. not IFS certified	41.07 (0.000)***	
$\Pr(IMP = 1 \mid IFS = 1) - \Pr(IMP = 1 \mid IFS = 0)$ Probability of importing: IFS certified vs. not IFS certified	5.60 (0.000)***	
$\Pr(EXP = 1, IMP = 1 \mid IFS = 1) - \Pr(EXP = 1, IMP = 1 \mid IFS = 0)$ Probability of exporting & importing: IFS certified vs. not IFS certified	5.83 (2.086)***	
$\Pr(EXP = 0, IMP = 0 \mid IFS = 1) - \Pr(EXP = 0, IMP = 0 \mid IFS = 0)$ Probability of being domestic: IFS certified vs. not IFS certified	-12.98 (12.160)***	

*Notes: *** p<0.01, ** p<0.05, * p<0.1; standard errors in parentheses; p.p stands for percentage points.*

The core question of this analysis is to determine whether certification allows firms to integrate GVCs by jointly importing and exporting. Our results show that certification significantly improves the probability of being a joint importer and exporter, by 5.83 p.p. This confirms our hypothesis that participation in retailer-driven chains is a springboard for firms to integrate GVCs. This result is far from trivial. Elliott *et al.* (2019) find that there is a substitution effect between importing and exporting, *i.e.* firms that import (export) in the past are less likely to become exporters (importers) in subsequent periods. Elliott *et al.* (2019) explain this result by the importance of fixed and sunk entry costs caused by decisions to import or export. These costs make exports (imports) less likely in subsequent years due to a lack of sufficient funds to invest in a new type of international market penetration. In our analysis, we show the fundamental role that certification plays in the participation of agri-

food firms in GVCs. Our result can be explained by the network effect of retailers that certified firms benefit from, as shown by Cheptea *et al.* (2019), to access foreign export markets. This mechanism operates through the presence of retailers brands in foreign markets, which facilitates the penetration of these markets by agri-food firms (Head *et al.*, 2014; Emlinger and Poncet, 2018; Cheptea *et al.*, 2019).

Our results also suggest that certification significantly reduces the probability for firms to operate only on the domestic market by 13 p.p. Certification significantly increases the probability to be exclusively an importer (5.60 p.p.), and more importantly, the probability to be exclusively an exporter (41.07 p.p.). This shows that certified firms differentiate from other firms primarily in terms of their presence on export markets than their choice to source from abroad or their activity on the domestic market. Accordingly, it is firms' decision to export that plays a key role in the participation of certified firms in GVCs. This result is confirmed by the partial marginal effects on the conditional probabilities to import and export reported in Table 5. Indeed, a certified non-exporting firm is 5.6% more likely than a similar non-certified firm to become an importer (column 4). This probability rises to 18.30% for exporting firms (column 5), while certification reduces the conditional probability of the firm to be an exporter, whether it is an importer or not (columns 2 and 3). This means that the effect of certification on the probability to jointly import and export is driven mainly by the export decision and only marginally by the decision to import. This also corroborates the fact discussed earlier that the link between importing and obtaining the IFS certification operates indirectly through the decision to export, a channel that is not directly observed with the trivariate model. This finding is consistent with the results of Bas and Strauss-Kahn (2014), who highlighted that firms can improve their export performance through imports in order to diversify their sourcing of inputs and seek inputs with a better quality-cost ratio.

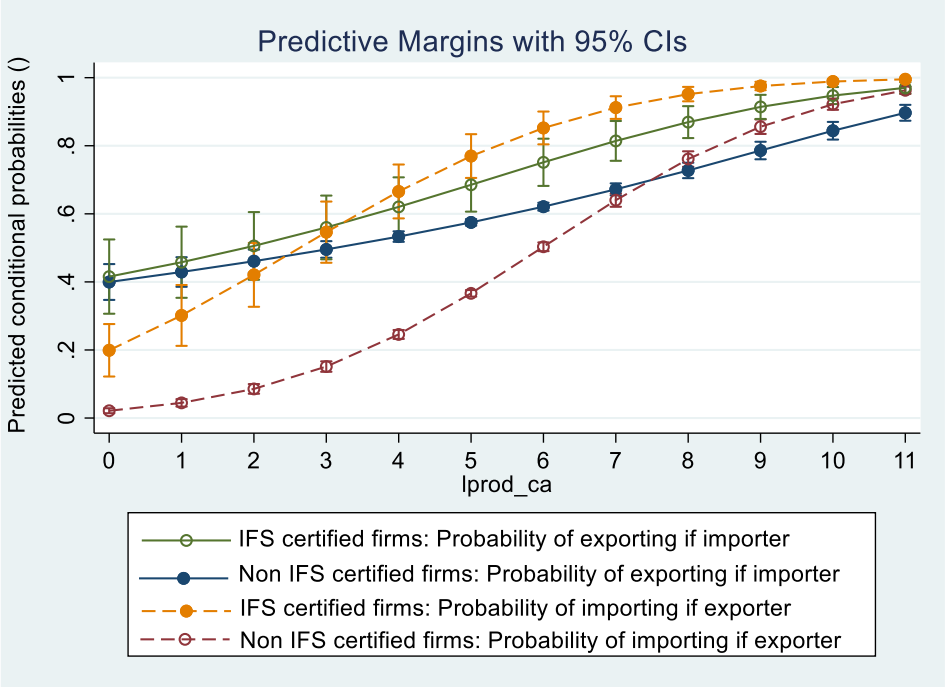
In summary, we show that the participation of agri-food firms in retailer-driven chains contributes significantly to their integration into GVCs. This integration occurs mainly through the channel of export.

For a better understanding of the effects of other variables of our model and to check that the selection bias was correctly accounted for with the tri-probit estimation, we illustrate the effect of productivity for different categories of certified and non-certified firms (Figure 1). This graphical illustration of the tri-probit results shows in details the path of the effect of productivity and certification on the conditional probability to engage in international trade. For a given level of productivity, certified firms are more likely to become joint importers and

exporters compared to non-certified firms. This highlights the positive effect of certification in Table 5 and confirms that our results are not driven by the self-selection of certified firms.

Moreover, Figure 1 shows that, above a certain productivity threshold, the probability of exporting firms to import exceeds the probability of importing firms to export. This threshold is considerably lower for IFS-certified firms. This confirms once more that retailers' suppliers benefit from important advantages that help them penetrate foreign markets.

Figure 1: Predicted conditional probabilities against firm productivity



Source: Based on tri-probit estimates of the probability to import, export and obtain IFS certification displayed in Table 5.

6. Robustness of results

In the present section, we test the robustness of results with alternative estimation techniques.

Difference-in-difference estimations

Since we have a panel dataset, the impact of IFS certification on firms' participation in GVCs discussed above captures the effect of intertemporal changes in their decision to certify (the within effect), as well as of differences in certification decision across firms (the between effect). We can use a difference-in-difference estimator to separate these two effects, which

are not necessarily equal in magnitude. In our case, the treatment corresponds to obtaining the IFS certification. To quantify the treatment effect on firms' choice to integrate a GVC, we identify the treatment group as the set of firms that obtain IFS certification in at least one year. Hereafter we refer to this group as IFS-ible firms. The control group is composed of firms that never get certified. Accordingly, we can estimate the following equation:

$$GVC_{it}\left[= y_{IMP,it} \cdot y_{EXP,it}\right] = \boldsymbol{\lambda}' \mathbf{X}_{it} + \eta\, IFSible_{it} + \mu\, IFS_{it} + v_{it} \qquad (5)$$

The explained binary variable GVC_{it} indicates the firm's choice to participate in a GVC, and is equal to the product of the dummies corresponding to the firm's import and export decisions (refer to notations introduced in section 4). Vector $\boldsymbol{\lambda}$ resumes the impact of firm-level observable characteristics $\mathbf{X}_{it}$. Parameter η reflects the difference in GVC participation between the treatment and control group of firms, while parameter μ captures the impact of acquiring the IFS certification (i.e. the average treatment on the treated, ATT). As in previous estimations, we include year and industry fixed effects to control for additional unobserved factors.

When estimating equation (5), we find that the probability to integrate a GVC is, on average, 15 percentage points higher for IFS-ible firms than for firms that never certify (column (3) of Table 7). Surprisingly, estimation results show that acquiring the IFS certification does not affect the probability of the firm to participate in GVCs. This indicates that the positive IFS effect found above comes essentially from differences in GVC participation between the treatment and control group. In Table 7, we estimate equation (5) not only on firms' choice to integrate a GVC, but also separately on their export and import decisions. In both cases, results display a strong positive effect for IFS-ible firms. In addition, obtaining the IFS certification seems to decrease the firm's probability to export in that year.

We lack data on some key control variables for some firms and years. For this reason, our data sample is unbalanced. The number of firms observed each year varies from 3,566 in 2006 to 3,455 in 2008 to 5,426 in 2011, and only 1,007 firms are observed in all years. To test the robustness of our findings, we run the estimations on different balanced subsamples of firms: firms observed each year (6,042 observations), firms observed any two consecutive years (18,444 observations), firms observed any two years (21,713 observations). Our findings are very similar to the results obtained on the full (unbalanced) sample (see Table C2 of Appendix C). The change in the set of observed firms does not affect the quality of our findings. Our conclusions remain unchanged if, instead of a linear probability, we consider a

Table 7: Difference-in-difference estimations

	Linear probability model			Probit model, marginal effects		
	Pr(EXP=1)	Pr(IMP=1)	Pr(EXP=1, IMP=1)	Pr(EXP=1)	Pr(IMP=1)	Pr(EXP=1, IMP=1)
VARIABLES	(1)	(2)	(3)	(3)	(4)	(5)
Treatment group (*IFS-ible firms*)	0.162*** (0.017)	0.130*** (0.017)	0.144*** (0.018)	0.522*** (0.067)	0.394*** (0.067)	0.420*** (0.064)
Acquire IFS certification	-0.051*** (0.002)	-0.013 (0.019)	-0.030 (0.021)	-0.207** (0.082)	-0.007 (0.080)	-0.087 (0.077)
Year fixed effects	YES	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES	YES
R^2	0.374	0.410	0.406	0.338	0.406	0.429
Observations	24,351	24,351	24,351	24,351	24,351	24,351

Notes: All estimations include the full set of firm-level controls: productivity, size, and financial links.
**** p<0.01, ** p<0.05, * p<0.1; standard errors in parentheses.*

binary probit model. Imposing the explained variable to take values between 0 and 1 (and assuming a Gaussian distribution of the error term) increases the estimated marginal effect of all variables, but qualitatively the results remain unchanged.

Note that, differently from the standard approach, we do not have a pre- and a post-treatment period. Each year firms decide whether to certify or not. Hence, each firm can have none, one or multiple pre-treatment and post-treatment periods, and some periods can qualify both as pre- and post-treatment. Consequently, treatment and no-treatment periods vary across firms in the treated group. In addition, since treatment may occur or end each year, it is impossible to identify a treatment and a no-treatment period for firms in the control group. This makes it difficult (impossible) to properly test whether covariates in the treatment and control groups follow parallel trends in the absence of treatment, a necessary assumption for obtaining an unbiased estimate of the treatment effect. Still, one can consider that the effects of covariates X_{it} are constant across years and equal for treated and control groups,[9] and judge on the validity of this assumption by comparing the annual evolutions of covariates for the two types of firms. Descriptive statistics displayed in Table C1 of Appendix C show that, although firms in the treatment and control groups differ significantly across all characteristics, they follow similar average annual evolutions. These results support our findings in Table 7.

[9] Otherwise, estimated parameters η and μ should be regarded as averages of annual and group-specific effects.

We also consider two different ways that permit to estimate the ATT effect. First, we repeat estimations in Table 7 on the subsample of firms in the treatment group. Second, we run estimations on the entire sample with firm fixed effects. In both cases, the variable identifying the treatment group ($IFSible_{it}$) drops due to collinearity and only the ATT is estimated. We find a small positive but statistically non significant effect of the IFS dummy. This shows that the impact of a change in firm's certification status, *i.e.* the within component of the IFS effect, is negligible.

Next, we allow for a different effect on firms that acquire IFS certification (starters) and those that renew their IFS certification (incumbents or continuers):

$$GVC_{it} = \boldsymbol{\lambda}' \mathbf{X}_{it} + \xi\, startIFS_{it} + \zeta\, continueIFS_{it} + u_{it} \quad (6)$$

where $startIFS_{it} = \{\mathbf{1}|IFS_{it-1} = \mathbf{0};\ IFS_{it} = \mathbf{1}\}$ and $continueIFS_{it} = \{\mathbf{1}|IFS_{it-1} = \mathbf{1}; IFS_{it} = \mathbf{1}\}$. Estimating equation (6) requires information on firms' certification decision in the previous year, and therefore leads to dropping observations in the first year of our dataset. Note that these two groups cover all firms with IFS certification: $IFS_{it} = startIFS_{it} + continueIFS_{it}$.[10]

We obtain positive and statistically significant effects of both variables, the estimate of parameter ξ being stronger than that of ζ (see Table 8). This indicates that acquiring IFS certification is more likely to lead to participation in GVCs that renewing an already obtained certification. Effects are similar when we focus on smaller balanced panels: firms observed any two consecutive years, and firms observed each year (each time excluding observations in the first year necessary for the computation of our variables of interest), as well as when we use a probit model (see Table C3 of Appendix C). Although the effect for firms that acquire certification is always higher, the difference between the two parameters is never statistically significant.[11]

Since the nature of the treatment does not permit to properly test the parallel trends assumption, we use propensity score matching as an alternative way for estimating the ATT effect of IFS certification on firms' participation in GVCs. The propensity score matching

[10] In an unbalanced panel, this identity is valid when we exclude the small number of observations referring to firms certified in *t* but not observed in *t-1*.

[11] The only exception is the impact on firms' decision to export. This result confirms our finding in Section 5 that the stronger participation in GVCs of IFS certified firms is induced by their higher probability to engage in export activities.

Table 8: Difference-in-difference estimators, starter vs. continuer firms

	Linear probability model			Probit model, marginal effects		
VARIABLES	Pr(EXP=1) (1)	Pr(IMP=1) (2)	Pr(EXP=1, IMP=1) (3)	Pr(EXP=1) (3)	Pr(IMP=1) (4)	Pr(EXP=1, IMP=1) (5)
Starter IFS firms (ξ) (acquire IFS certification)	0.132*** (0.026)	0.097*** (0.027)	0.131*** (0.028)	0.457*** (0.115)	0.301*** (0.111)	0.392*** (0.107)
Continuer IFS firms (ζ) (renew IFS certification)	0.068** (0.020)	0.104** (0.019)	0.088*** (0.021)	0.174** (0.079)	0.395*** (0.077)	0.269*** (0.077)
Year fixed effects	YES	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES	YES
R^2	0.359	0.396	0.390	0.329	0.399	0.422
p-stat test $\xi \neq \zeta$	0.039	0.819	0.191	0.470	0.330	0.642
Observations	20,447	20,447	20,447	20,447	20,447	20,447

Notes: All estimations include the full set of firm-level controls: productivity, size, and financial links.
**** p<0.01, ** p<0.05, * p<0.1; standard errors in parentheses.*

permits to better specify / chose the control group of firms. Therefore, it also permits to correct for the fact that treatment (IFS certification) may not be entirely exogenous.

Propensity score matching

We match IFS certified firms with non-certified competitors from the same industry, observed in the same year, and with similar levels of covariates (control variables X_{it}). Matching firms on the observation year permits to exclude matches with oneself in a different year. Therefore, results presented below reflect the between component of the IFS effect identified in section 5. We perform four types of matching: Mahalanobis matching, radius matching (within a caliper equal to 0.2 of the standard variation of the logit propensity score), nearest 3 neighbors matching, and one-to-one (nearest neighbor) matching. The last three techniques yield a positive and strongly significant ATT effect of IFS certification on firms' participation in GVCs (upper part of Table 9). In our data panel, some industries contain very few firms, which makes it difficult to find a good match for certified firms in these industries. To overcome this drawback, we alternatively match firms on more broadly defined industries (3-digit NACE Rev.2 instead of original 4-digit NACE Rev.2). In this case, we obtain a statistically significant ATT effect for all matching techniques, except one-to-ne matching. According to results in Table 9, IFS certified firms are on average 5 to 6 percentage points more likely to participate in GVCs than their non certified counterparts.

Table 9: Propensity score matching

Matching methodology	Change in the probability to participate in GVCs in *t*			
	4-digit NACE industries		3-digit NACE industries	
	ATT	t-stat	ATT	t-stat
(A) *IFS certified firms in t, matched on observable characteristics in t* (1,157 treated; 23,194 controls)				
Mahalonabis	0.0156	0.81	0.0467***	2.29
Radius	0.0594***	3.72	0.0586***	3.72
3 nearest neighbors	0.0472***	2.36	0.0349*	1.77
One to one matching	0.0527***	2.20	0.0182	0.77
(B) *IFS certified firms in t, matched on observable characteristics in t-1* (751 treated; 12,339 controls)				
Mahalonabis	0.0226	0.96	0.0413*	1.77
Radius	0.0531***	2.62	0.0584***	2.94
3 nearest neighbors	0.0448*	1.77	0.0431*	1.75
One to one matching	0.0493	1.63	0.0599***	2.05
(C) *IFS certified firms in t-1, matched on observable characteristics in t-2* (423 treated; 7,442 controls)				
Mahalonabis	0.0213	0.72	0.0307	1.04
Radius	0.0580***	2.15	0.0775***	2.94
3 nearest neighbors	0.0868***	3.26	0.1022***	3.94
One to one matching	0.0284	0.72	0.0213	0.53

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Firms matched across years, industries, and similar levels of covariates.*

In the middle and lower part of Table 9, we allow for time-delayed effects. First, we match firms on their characteristics in the year before the choice to certify and participate to a GVC. Second, we let a one-year lag for the IFS certification effect on GVC participation. In both cases, more than half of the estimating techniques yield a positive significant effect similar to or stronger than the one found with contemporaneous effects and matching criteria. These results confirm the fact that retailers' suppliers are more likely to participate in GVCs, and suggests that the effect persists in time.

Similarly to the previous subsection, we estimate the effects of acquiring and renewing IFS certification (starter and continuer firms) and display results in Table 10. The ATT effect for IFS starter firms is about twice the effect on the entire sample and mostly significant at a 1% level. On the contrary, the effect on continuer IFS firms is rarely significantly different from zero. We obtain similar effects when we allow for time gaps between firms' decisions to certify and participate to GVCs and their matching criteria.

Table 10: Propensity score matching, starter vs. continuer firms

Matching methodology	Change in the probability to participate in GVCs in *t*			
	Starter IFS firms (acquire IFS certification)		*Continuer* IFS firms (renew IFS certification)	
	ATT	t-stat	ATT	t-stat
(A) *IFS certified firms in t, matched on observable characteristics in t* (1,157 treated; 23,194 controls)				
Mahalonabis	0.0905***	2.26	0.0000	0.00
Radius	0.0965***	3.05	0.0495***	2.13
3 nearest neighbors	0.1001***	2.71	0.0394	1.39
One to one matching	0.1235***	2.71	0.0433	1.27
(B) *IFS certified firms in t, matched on observable characteristics in t-1* (751 treated; 12,339 controls)				
Mahalonabis	0.0823***	2.08	-0.0059	-0.21
Radius	0.0902***	2.83	0.0354	1.45
3 nearest neighbors	0.0947***	2.51	0.0289	0.96
One to one matching	0.0988***	2.14	0.0276	0.77
(C) *IFS certified firms in t-1, matched on observable characteristics in t-2* (423 treated; 7,442 controls)				
Mahalonabis	0.0662	1.40	-0.0037	-0.10
Radius	0.0911***	2.23	0.0326	0.96
3 nearest neighbors	0.0706	1.46	-0.0012	-0.03
One to one matching	0.1192**	2.02	-0.0037	-0.07

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Firms matched across years, 4-digit NACE industries, and similar levels of covariates.*

To sum up, alternative estimation techniques, which explore the variability of firms' certification strategy over time and reduce the heterogeneity of (dissimilarity between) certified and non certified firms by defining a more similar control group, confirm the results obtained with more rigid multivariate estimators (that make strong assumptions on the distribution of model residuals). The estimated effect obtained with difference-in-difference and matching approaches is similar to that with bi-probit and tri-probit models. It shows that retailers' domestic suppliers, identified by IFS certified firms, are on average more likely to participate to a GVC than similar agri-food firms. Results also indicate that the effect arises mainly from differences between the two groups of firms rather than from changes in a firm's certification strategy. The effect is stronger when firms acquire certification than when they renew it. Recall that this result is induced by differences across firms, not by changes in the same firm's certification strategy. It reflects the between component of the IFS effect on GVC participation, the within component being negligible.

7. Conclusion

This paper shows that firms that participate in retailer-driven chains (certified firms) are much more likely to enter GVCs. Moreover, we show that this result occurs mainly through the channel of firms' export status. We obtain these results through the analysis of firms' decisions to involve in foreign trade and in retailer-driven chains. These decisions are jointly considered with a bi-probit or tri-probit analysis. We also use difference-in-difference and propensity score matching estimators to test the robustness of our results. These approaches confirm our main findings and bring some new insights. We find that the within component of the IFS effect is negligible. The effect of IFS certification on firms' choice to participate in GVCs is driven mainly by the difference between certified and non-certified firms. Still, the effect is stronger when firms acquire IFS certification than when they renew a previously obtained certification.

This result shows the importance of retailers in the coordination and dynamics of agri-food GVCs. Thus, the participation of the retailer-driven value chains necessarily play an important role in the international strategies of agri-food firms and in their integration into the GVCs. Any economic policy that aims to encourage firms to participate in GVCs should account for the role that retailers play in agri-food GVC. In the specific context of this study, our results highlight the potential benefit for agri-food firms to integrate retailer-driven chains because of the induced benefits for internationalization. However, as reported by Dudás *et al.* (2020), participation in retailer-driven chains also entails disadvantages for agri-food firms. The three most important disadvantages are the low profitability of PL products, the substitutability between these products, and the vulnerability of agri-food firms to retailers.

This study has some potential limitations. First, it should be noted that there are non-certified firms that sell their products under their own brands in retail outlets. We do not have the means to identify these firms. Therefore, the estimated effects between IFS-certified firms and their non-certified counterparts may be underestimated. Second, the choice of our indicator of participation in GVCs, as the joint import and export activities of firms, may reflect a simple search for new markets by firms to expand their market share. This is different from a more specialized and advanced configuration of GVCs where we observe a sequentially integrated production process across countries, as shown by Beugelsdijk *et al.* (2009). An alternative way to control for this limitation would be to have additional information on the specialization of firms in specific productions within GVCs, the continuity of firms' participation in GVCs, and

the proportion of firms' turnover from participation in GVCs, following Giovannetti and Marvasi (2016).

These limitations offer perspectives to this paper with respect to the analysis of value-added creation, which is the central concept of GVCs. To go further in this direction, it is necessary to focus on the product dimension at firm level by distinguishing between intermediate and final goods in order to measure the position of firms and the intensity of their participation in GVCs. This would foster a better understanding of the positions that generate more value added, and would help improve the design of trade policies. Moreover, the turbulent international context of the past few years (the Covid-19 pandemic, the Brexit, the war in Ukraine, and the resulting huge tensions on international markets) sheds light on the critical need for resilience in food supply chains. The governance of food supply chains seems to be an important aspect for reaching (or not) resilience and absorbing international chocks. The analysis of retailer- An analysis with updated data of the performance of firms in retailer-driven chains would permit to address these questions. It will constitute the subject of a future research.

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Appendix A: Descriptive statistics and bi-probit estimation results

Table A1: Variables, descriptions and descriptive statistics

Variable	Types of variable	No. Obs.	Mean	Std. Err.	Min	Max
IFS $Certification$	Binary (1 if the firm is IFS certified; 0 otherwise)	24,351	0.048	0.213	0	1
IMP	Binary (1 if the firm is importer; 0 otherwise)	24,351	0.221	0.415	0	1
EXP	Binary (1 if the firm is exporter; 0 otherwise)	24,351	0.295	0.456	0	1
ln $Productivity$	Continue	24,351	5.115	0.985	0	10.910
Independent firm	Binary (1 if the firm has the independent status; 0 otherwise)	24,351	0.629	0.483	0	1
Head of group	Binary (1 if the firm has the Group head status; 0 otherwise)	24,351	0.046	0.210	0	1
Connecting firm	Binary (1 if the firm has Maillon status; 0 otherwise)	24,351	0.089	0.284	0	1
Independent	Binary (1 if the firm has the Affiliate status; 0 otherwise)	24,351	0.236	0.425	0	1
1-49 employees	Binary (1 if the number of employees of the firm is between 1 and 49 included; 0 otherwise)	24,351	0.868	0.339	0	1
50-499 employees	Binary (1 if the number of employees of the firm is between 50 and 499 included; 0 otherwise)	24,351	0.116	0.320	0	1
≥500 employees	Binary (1 if the number of employees of the firm is strictly greater than 499; 0 otherwise)	24,351	0.016	0.126	0	1
$Inst_{IMP}$	Continue	24,351	0.815	0.128	0	1
$Inst_{EXP}$	Continue	24,351	0.831	0.105	0	1
$Inst_{IFS}$	Continue	24,351	0.305	0.191	0	0.971

Table A2: Correlation coefficients and dependency test between explanatory variables

Variables	ln $Prod$	$Inst_{IMP}$	$Inst_{EXP}$	$Inst_{IFS}$	1-49 empl	50-499 empl	≥500 empl	Indep.	Head	Connecting
ln $Productivity$	1.00									
$Inst_{IMP}$	-0.12***	1.00								
$Inst_{EXP}$	0.12***	0.59***	1.00							
$Inst_{IFS}$	-0.10***	0.13***	-0.11***	1.00						
1-49 employees	-0.18***	-0.06***	-0.10***	-0.01	1.00					
50-499 employees	0.15***	0.05***	0.09***	0.02**	-0.93***	1.00				
≥500 employees	0.09***	0.03***	0.05***	-0.01	-0.33***	-0.05***	1.00			
Independent firm	-0.28***	-0.09***	-0.18***	0.06***	0.42***	-0.39***	-0.15***	1.00		
Head of group	0.14***	-0.07***	0.06***	-0.07***	-0.01**	0.01*	0.01	-0.29***	1.00	
Connecting firm	0.21***	0.03***	0.10***	-0.04***	-0.42***	0.34***	0.27***	-0.41***	-0.07***	1.00
Affiliate	0.12***	0.12***	0.12***	-0.00	-0.19***	0.21***	-0.01	-0.72***	-0.12***	-0.17***

*Notes: *** p<0.01, ** p<0.05, * p<0.1*

Table A3: Average marginal effects on the export and import probabilities of *IFS-certified* firms, bi-probit estimator

	Univariate probabilities		Conditional probabilities		Joint probabilities			
	(1)		(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Pr(EXP=1)	Pr(IMP=1)	Pr(EXP=1|IMP=1)	Pr(IMP=1|EXP=1)	Pr(EXP=1, IMP=1)	Pr(EXP=1,IMP=0)	Pr(EXP=0,IMP=1)	Pr(EXP=0,IMP=0)
ln *productivity*	0.141***	0.175***	0.071***	0.142***	0.201***	-0.059***	-0.025**	-0.116***
	(0.018)	(0.016)	(0.017)	(0.016)	(0.017)	(0.012)	(0.010)	(0.011)
Financial linkages:								
Independent firm	reference	reference	reference	reference	reference	reference	reference	reference
Head of group	0.250***	0.029	0.210***	-0.031	0.161***	0.089**	-0.133***	-0.118***
	(0.064)	(0.046)	(0.057)	(0.046)	(0.054)	(0.037)	(0.037)	(.034)
Connecting firm	0.079**	0.101***	0.039	0.082**	0.114***	-0.035	-0.013	-0.066***
	(0.040)	(0.036)	(0.034)	(0.034)	(0.038)	(0.025)	(0.022)	(0.023)
Affiliate	0.060	0.077**	0.030	0.062**	0.087**	-0.026	-0.010	-0.050**
	(0.037)	(0.033)	(0.031)	(0.031)	(0.035)	(0.023)	(0.020)	(0.022)
Firm size:								
1 to 49 employees	reference	reference	reference	reference	reference	reference	reference	reference
50 to 499 employees	0.121***	0.170***	0.054**	0.141***	0.185***	-0.064***	-0.015	-0.105***
	(0.025)	(0.021)	(0.022)	(0.021)	(0.023)	(0.016)	(0.014)	(0.015)
500 employees or more	0.355***	0.452***	0.175***	0.367***	0.512***	-0.157***	-0.060**	-0.295***
	(0.047)	(0.041)	(0.045)	(0.041)	(0.042)	(0.031)	(0.026)	(0.030)
Share of competing exporting firms in the same industry	-0.360		-0.314	0.086	-0.203	-0.156	0.203	0.156
	(0.225)		(0197)	(0.055)	(0.127)	(0.098)	(0.127)	(0.098)
Share of competing importing firms in the same industry		-0.106	0.032	-0.106	-0.073	0.073	-0.033	0.033
		(0.190)	(0.057)	(0190)	(0.131)	(0.131)	(0.059)	(0.059)
Year fixed effects	YES							
Industry fixed effects	YES							
Likelihood ratio	-826.100							
ρ (correlated decisions)	0.558***							
Observations	1,157							

*Notes: *** p<0.01, ** p<0.05, * p<0.1; standard errors in parentheses*

Table A4: Average marginal effects on the export and import probabilities of *non-certified firms*, bi-probit estimator

	Univariate probabilities		Conditional probabilities		Joint probabilities			
	(1)		(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Pr(EXP=1)	Pr(IMP=1)	Pr(EXP=1|IMP=1)	Pr(IMP=1|EXP=1)	Pr(EXP=1, IMP=1)	Pr(EXP=1,IMP=0)	Pr(EXP=0,IMP=1)	Pr(EXP=0,IMP=0)
ln *productivity*	0.081***	0.090***	0.041***	0.123***	0.066***	0.016***	0.024***	-0.106***
	(0.003)	(0.003)	(0.005)	(0.005)	(0.002)	(0.002)	(0.001)	(0.003)
Financial linkages:								
Independent firm	reference	reference	reference	reference	reference	reference	reference	reference
Head of group	0.150***	0.115***	0.130***	0.124***	0.096***	0.054***	0.019***	-0.169***
	(0.009)	(0.008)	(0.016)	(0.016)	(0.006)	(0.007)	(0.004)	(0.009)
Connecting firm	0.231***	0.197***	0.179***	0.231***	0.158***	0.073***	0.039***	-0.270***
	(0.009)	(0.007)	(0.015)	(0.014)	(0.005)	(0.006)	(0.004)	(0.008)
Affiliate	0 151***	0 137***	0.108***	0.166***	0.107***	0.044***	0.030***	-0.180***
	(0.005)	(0.004)	(0.009)	(0.008)	(0.003)	(0.004)	(0.002)	(0.005)
Firm size:								
1 to 49 employees	reference	reference	reference	reference	reference	reference	reference	reference
50 to 499 employees	0.232***	0.209***	0.167***	0.254***	0.164***	0.068***	0.045***	-0.277***
	(0.008)	(0.006)	(0.013)	(0.012)	(0.004)	(0.005)	(0.003)	(0.007)
500 employees or more	0.371***	0.367***	0.233***	0.472***	0.278***	0.093***	0.089***	-0.460***
	(0.034)	(0.028)	(0.058)	(0.055)	(0.018)	(0.025)	(0.015)	(0.032)
Share of competing exporting firms in the same industry	-0.017		-0.030	0.013	-0.005	-0.013	0.005	0.013
	(0.046)		(0.078)	(0.033)	(0.012)	(0.034)	(0.012)	(0.034)
Share of competing importing firms in the same industry		-0.076**	0.082**	-0.154**	-0.037**	0.037**	-0.039**	0.039**
		(0.037)	(0.040)	(0.076)	(0.018)	(0.018)	(0.019)	(0.019)
Year fixed effects	YES							
Industry fixed effects	YES							
Likelihood ratio	-15549.087							
ρ (correlated decisions)	0.608***							
Observations	23,194							

*Notes: *** p<0.01, ** p<0.05, * p<0.1; standard errors in parentheses.*

Appendix B: Potential estimation biases

Appendix B1: Durbin-Wu-Hausman Test of Endogeneity on the IFS Status Variable

The certification dummy is our main variable of interest for assessing the extensive margin of firms' participation in GVCs. We check whether the coefficients associated with this variable in our estimations suffer from any form of bias. More specifically, we test the endogeneity of firms' decision to obtain IFS certification using the augmented Durbin-Wu-Hausman two-step test for endogeneity. First, we regress the IFS certification dummy on all explanatory variables in system (4). Second, we recover the residuals from this estimation and introduce them on the right hand side of the equations reflecting firms' export and import decisions. A statistically significant and different from zero effect of first-stage residuals indicates that the IFS certification decision is endogenous, and this endogeneity must be taken into account when estimating the model.

The test results presented in Table B1 show that the p-value<1% of Fisher's test on the coefficients associated with the residuals in the second stage estimates do not reject the hypothesis of endogeneity of the IFS certification variable. This result supports the use of a multivariate binary model to address this problem.

Table B1: Durbin-Wu-Hausman test of endogeneity on the IFS certification variable

	Extensive margin: Sample of all firms		
	First step	Second step	
	(1)	(2)	(3)
VARIABLES	Pr(IFS=1)	Pr(EXP=1)	Pr(IMP=1)
ln *productivity*	0.007***	0.089***	0.091***
	(0.002)	(0.004)	(0.004)
Financial linkages:			
Independent firm	reference	reference	reference
Head of group	0.037***	0.234***	0.129***
	(0.011)	(0.026)	(0.023)
Connecting firm	0.054***	0.301***	0.287***
	(0.014)	(0.021)	(0.021)
Affiliate	0.043***	0.201***	0.192***
	(0.005)	(0.013)	(0.012)
Firm size:			
1 to 49 employees	reference	reference	reference
50 to 499 employees	0.192***	0.327***	0.380***
	(0.013)	(0.018)	(0.017)
500 employees or more	0.399***	0.424***	0.540***
	(0.0445)	(0.029)	(0.028)
Share of competing exporting firms in the same industry	0.031	-0.058	
	(0.027)	(0.039)	
Share of competing importing firms in the same industry	0.036		-0.085***
	(0.025)		(0.033)
First-stage residue term		0.087***	0.098***
		(0.021)	(0.020)
Year fixed effects	YES	YES	YES
Industry fixed effects	YES	YES	YES
R^2	0.202	0.371	0.408
Fisher test (P-value)		0.000	0.000
Observations	24,351	24,351	24,351

*Notes: *** p<0.01, ** p<0.05, * p<0.1; standard errors in parentheses.*

Appendix B2: Certification self-selection test: Ex ante firm productivity premium by certification status

We seek to test the self-selection of IFS certified firms. We test whether firms that obtain IFS certification at time t were more productive when they were still non-certified at an earlier time $t-\tau$ $(0 \leq \tau \leq 2)$ than their non-certified counterparts at that time. To do so, we draw on the methodology used by Castellani *et al.* (2010) to determine the self-selection of Italian firms in international trade. We test for the presence of a productivity gap between firms that obtained IFS certification in t and the others, one and two years before obtaining certification. More precisely, we estimate the following equation:

$$\ln \text{Productivity}_{i,t-\tau} = \alpha_0 + \alpha_1 \text{IFSstarter}_{i,t-\tau} + \phi_{i \in APE} + \text{T}_t + \varepsilon \qquad \text{(A.1)}$$

where $\ln \text{Productivity}_{i,t-\tau}$ is the logarithm of firm i's productivity in $t-\tau$, $0 \leq \tau \leq 2$, and the binary variable $\text{IFSstarter}_{i,t-\tau}$ indicates the certification status of that firm in the same year. The variable $\text{IFSstarter}_{i,t}$ takes the value 1 if firm i was certified in t, regardless of its certification status in previous years. $\text{IFSstarter}_{i,t-1}$ is equal to 1 if the firm was certified in t but not certified in $t-1$ and is equal to 0 in the rest of the cases. By the same rule, $\text{IFSstarter}_{i,t-2}$ takes the value 1 if the firm was certified in t but not certified in $t-1$ and $t-2$ and the value 0 in the rest of the cases. In equation (A.1) we include fixed effects by APE activity code $\phi_{i \in APE}$ to control for heterogeneity in firm performance by specific activity. We add year fixed effects T_t to capture annual shocks that hit the economy as a whole. α_0 and α_1 are the parameters to be estimated and ε is a zero expectation error term.

Table B2: Evaluation of the ex ante productivity premiums of IFS firms

	Explained variable: ln *productivity*					
	All firms			Firms involved in int'l trade		
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{IFSstarter}_{i,t}$	0.501***			0.212***		
	(0.035)			(0.033)		
$\text{IFSstarter}_{i,t-1}$		0.421***			0.176***	
		(0.047)			(0.049)	
$\text{IFSstarter}_{i,t-2}$			0.420***			0.177***
			(0.0403)			(0.042)
Year fixed effects	YES	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES	YES
Observations	24,351	16,089	15,084	8,441	5,910	5,672
R^2	0.182	0.209	0.219	0.202	0.202	0.197

*Notes: *** p<0.01, ** p<0.05, * p<0.1; standard errors in parentheses.*

We estimate equation (A.1), on all firms (columns 1 to 3) and on firms that participate only in international trade (columns 4 to 6), by ordinary least squares and present the results in Table B2. The results in column (1) indicate that certified firms are on average 50% more productive than non-certified firms. IFS certified firms also have an ex ante productivity premium over their non-certified counterparts. Indeed, firms that obtain certification were on average 42% more productive than non-certified firms one and two years before certification. The contemporaneous and ex ante productivity premium of certified firms over non-certified firms is about half as large if we restrict the analysis to firms that participate in international trade.

Appendix C: Additional results with the difference-in-difference approach

Table C1: Descriptive statistics for firms in the treatment vs the control group

		Magnitude of covariates							
		Control group (22,484 observations)				***Treatment group*** (1,867 observations)			
VARIABLES		min	max	mean	std dev	min	max	mean	std dev
ln *productivity*	*	0	10.91	5.0722	0.9926	0	10.86	5.6282	0.7020
Financial linkages:									
Independent firm	*	0	1	0.6725	0.4693	0	1	0.1002	0.3003
Head of group	*	0	1	0.0442	0.2055	0	1	0.0723	0.2591
Connecting firm	*	0	1	0.0679	0.2515	0	1	0.3390	0.4735
Affiliate	*	0	1	0.2155	0.4112	0	1	0.4885	0.5000
Firm size:									
1 to 49 employees	*	0	1	0.9151	0.2788	0	1	0.2957	0.4565
50 to 499 employees	*	0	1	0.0770	0.2666	0	1	0.5881	0.4923
500 employees or more	*	0	1	0.0080	0.0889	0	1	0.1162	0.3206
		Annual evolutions of covariates							
		Control group (12,067 observations)				***Treatment group*** (1,108 observations)			
VARIABLES		min	max	mean	std dev	min	max	mean	std dev
ln *productivity*	*	-5.94	4.43	0.0339	0.3935	-2.83	5.56	0.0495	0.3807
Financial linkages:									
Independent firm	*	0	0	0	0	0	0	0	0
Head of group		0	0	0.0000	0.0000	0	0	0.0000	0.0000
Connecting firm	*	0	0	0.0000	0.0000	0	0	0.0000	0.0000
Affiliate		0	0	0.0000	0.0000	0	0	0.0000	0.0000
Firm size:									
1 to 49 employees	*	-1	1	-0.0018	0.0863	-1	1	-0.0009	0.1778
50 to 499 employees		-1	1	0.0018	0.0910	-1	1	-0.0018	0.2125
500 employees or more	*	-1	1	0.0000	0.0288	-1	1	0.0027	0.1377

*Notes: * indicates a difference in means between control and treatment groups statistically significant at 5%.*

Table C2: Difference-in-difference estimators, balanced panels

	Firms observed each year			Firms observed every 2 consecutive years		
	Pr(EXP=1)	Pr(IMP=1)	Pr(EXP=1, IMP=1)	Pr(EXP=1)	Pr(IMP=1)	Pr(EXP=1, IMP=1)
VARIABLES	(1)	(2)	(3)	(3)	(4)	(5)
Treatment group (*IFS-ible firms*)	0.200***	0.097**	0.091**	0.157***	0.119***	0.138***
	(0.032)	(0.031)	(0.033)	(0.018)	(0.018)	(0.019)
Acquire IFS certification	-0.068*	-0.005	-0.003	-0.060***	-0.017	-0.039*
	(0.036)	(0.035)	(0.038)	(0.021)	(0.021)	(0.022)
Year fixed effects	YES	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES	YES
R^2	0.472	0.470	0.492	0.397	0.429	0.422
Observations	6,042	6,042	6,042	18,444	18,444	18,444

*Notes: Linear probability model. All estimations include the full set of firm-level controls: productivity, size, and financial links. *** p<0.01, ** p<0.05, * p<0.1; standard errors in parentheses.*

Table C3: Difference-in-difference estimators, starter vs. continuer firms, balanced panels

	Firms observed each year			Firms observed every 2 consecutive years		
	Pr(EXP=1)	Pr(IMP=1)	Pr(EXP=1, IMP=1)	Pr(EXP=1)	Pr(IMP=1)	Pr(EXP=1, IMP=1)
VARIABLES	(1)	(2)	(3)	(3)	(4)	(5)
Starter IFS firms (ξ) (acquire IFS certification)	0.177***	0.089**	0.099**	0.120***	0.085***	0.117***
	(0.042)	(0.045)	(0.047)	(0.026)	(0.027)	(0.028)
Continuer IFS firms (ζ) (renew IFS certification)	0.077**	0.071**	0.059*	0.059***	0.094***	0.077***
	(0.032)	(0.030)	(0.033)	(0.020)	(0.019)	(0.021)
Year fixed effects	YES	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES	YES
R^2	0.463	0.470	0.486	0.388	0.424	0.414
p-stat test $\xi \neq \zeta$	0.038	0.723	0.457	0.044	0.744	0.213
Observations	5,035	5,035	5,035	15,572	15,572	15,572

*Notes: Linear probability model. All estimations include the full set of firm-level controls: productivity, size, and financial links. *** p<0.01, ** p<0.05, * p<0.1; standard errors in parentheses.*

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