Production and enterprise profitability in Ecuador's crop-growing sector

Xavier Arboleda, Natalia Bermúdez-Barrezueta and Segundo Camino-Mogro

Abstract

This article analyses the key determinants of enterprise profitability in Ecuador's crop-growing sector in 2007–2017. It presents data showing that productivity has a positive effect on the profitability of the firms in the sector, which suggests that higher productivity confers a competitive advantage that is reflected in higher profit levels. In contrast, capital stock, land valuation, foreign direct investment, exports and firm age are variables that are negatively related to profitability. Lastly, per capita GDP growth boosts enterprise profitability by increasing the aggregate demand for food products, which stimulates the sector's performance.

Keywords

Agriculture, agro-industry, agricultural productivity, labour productivity, income, profit, economic analysis, Ecuador

JEL classification

L2, L73, J43, Q12, Q17

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I. Introduction

The production structure in Latin America and many developing countries, has been based on development of the crop-growing sector, which has meant that they mainly export commodities. Authors such as Aghion and Durlauf (2005) and Restuccia, Yang and Zhu (2008) argue that most of the workers in these countries are employed in agriculture, and that the low productivity of labour in the sector affects nearly all labour productivity in the country. Lagakos and Waugh (2013) believe that understanding why productivity differences in some countries are so much larger in agriculture than in other sectors is the key to understanding global income inequality.

Throughout Ecuador's path to development, the most rapid growth periods were driven by strong external demand and high international prices that stimulated exports, mainly of commodities (Domínguez and Caria, 2016). The country has also been characterized as a producer and supplier of raw materials. Owing to the economic and trade liberalization of recent years, Ecuadoran products —mainly bananas, cocoa and flowers— have been traded internationally and have gained market share over time (Camino-Mogro, Andrade-Díaz and Pesantez-Villacis, 2016). However, several sectors have become less efficient and have lost international market share, which can lead to a loss of productivity impacting sector profitability.

An underexplored topic is the relationship between total factor productivity (TFP) and the profitability of the crop-growing sector. Foster, Haltiwanger and Syverson (2008) note that enterprise selection is based on profitability, rather than productivity (although the two are likely to be correlated), as productivity is only one of several idiosyncratic factors that can determine profitability. Accordingly, producer profits are a monotonically increasing function of productivity; and selection based on profits is equivalent to selection on productivity.

The aim of this paper is to analyse the key determinants of profitability in Ecuadoran firms in the crop-growing sector in 2007–2017, and to contribute new empirical data to the existing information, through: (i) the use of underexplored administrative data, which contain financial information on all firms in the Ecuador, provided by the Superintendency of Companies, Securities and Insurance; (ii) the distinction between traditional physical capital and land, since without the latter there would be no production; (iii) the analysis of TFP as a potential determinant of profitability, using a dynamic model that reduces potential endogeneity and simultaneity problems; and (iv) the analysis of different crop-growing subsectors, with the aim of demonstrating possible intra-sector heterogeneity.

II. Literature review

There are many studies that examine the relationship between agricultural development and a country's overall growth and development, including Syrquin (1988) and Foster and Rosenzweig (2007). Some authors, such as Mellor (2000) and Johnson (2000), highlight the importance of agricultural productivity growth for achieving national economic development, particularly because a more productive agriculture sector can produce more efficiently and meet local food demand, while also exporting, which generates a foreign exchange inflow.

According to Bustos, Caprettini and Ponticelli (2016), this result occurs when: (i) labour productivity in agriculture is lower than in other economic sectors (Lagakos and Waugh, 2013; Gollin, Lagakos and Waugh, 2014; İmrohoroğlu, İmrohoroğlu and Üngör, 2013); and (ii) the other sectors are characterized as economies at scale that demand a large amount of human capital, as they compete through learning-by-doing (Ngai and Pissarides, 2007).

1. Productivity and growth

It is well known that aggregate productivity is a determinant of economic growth. The conceptual framework of economic growth developed by Kendrick (1961), Solow (1957) and other pioneers in the study of the determinants of economic growth, establishes that aggregate output is a function of capital, labour and a given level of productivity, which is an important source of growth in an economy. Other authors, such as Scarpetta and others (2000), Fukao and others (2004), Mundlak, Butzer and Larson (2008) and Ivanic and Martin (2018), have analysed growth at the sector level and broken the sector growth rate into contributions made by the intermediate products used in the production process, along with capital, labour and productivity growth (Jorgenson, 1991).

Although the growth models were developed under the assumption of exogenous inputs, various authors have questioned this idea and have introduced an endogeneity criterion (Romer, 1994; Crafts, 1995; Bernanke and Gürkaynak, 2001), which means that input decisions can be influenced by output growth. Moreover, input growth may be accompanied by specialization strategies —research and development (R&D) and innovation— which affect the productivity of the factors involved in the production process (Ruttan, 2001; Nelson and Winter, 2009). Sahal (1981) studied the determinants of technological innovation in the particular case of the farm tractor, and concluded that farm size (scale hypothesis) and experience acquired in the production process (learning hypothesis) are important space and time factors driving technical progress. Vieira Filho and Fishlow (2017) analysed the agricultural modernization process in Brazil, based on two phases: the dissemination phase, which takes into account macroeconomic factors, and the technology adoption phase, related to absorption capacity and decisions made by firms in the sector. They concluded that technological dissemination increases productivity and lowers product prices. The authors also note that the technological intensification process can also reduce the cost of inputs such as land and labour.

Along the same lines, McArthur and McCord (2017) consider that the increased use of fertilizers and practices linked to the Green Revolution[1] is a way of increasing productivity in the sector; it tends to generate structural change, and it triggers forms of economic growth in countries with low productivity rates and a large proportion of unskilled labour in the crop-growing sector. They also obtained positive results in terms of increased labour productivity in non-agricultural sectors, as did McMillan and Rodrik (2011). In other words, these practices relocate the labour force, which makes it possible to increase labour productivity in other sectors and, hence, in the aggregate.

The determinants of growth and profitability of the firms that comprise the crop-growing sector has been an underexplored topic at the enterprise level, mainly because of poor data availability, since in most countries it is a sector with a large informal component. Zouaghi, Sánchez-García and Hirsch (2017) analysed the case of Spain and found that variables such as location, market structure, innovation activities, size and age of the firm are determinants of the profitability of enterprises in the crop-growing sector. On the other hand, Galarza and Díaz (2015), who studied the sector in Peru, found a positive relation between agribusiness productivity and the age, gender and education of the owners, while the relationship is negative with respect to the size and market power of the firm. Vieira Filho, Campos and Ferreira (2005) studied the crop-growing sector in Brazil and found that technological innovation, a determinant of productivity in the sector, increases with the size of agribusiness complexes and degree of market concentration.

In general, the factors that can influence the profitability of firms in the crop-growing sector has been little analysed in the current literature, so there is a clear need to create microeconomic knowledge in this area, in order to generate policies aimed at strengthening the sector, to make efficient use of natural resources and contribute to the country's economic growth and development.

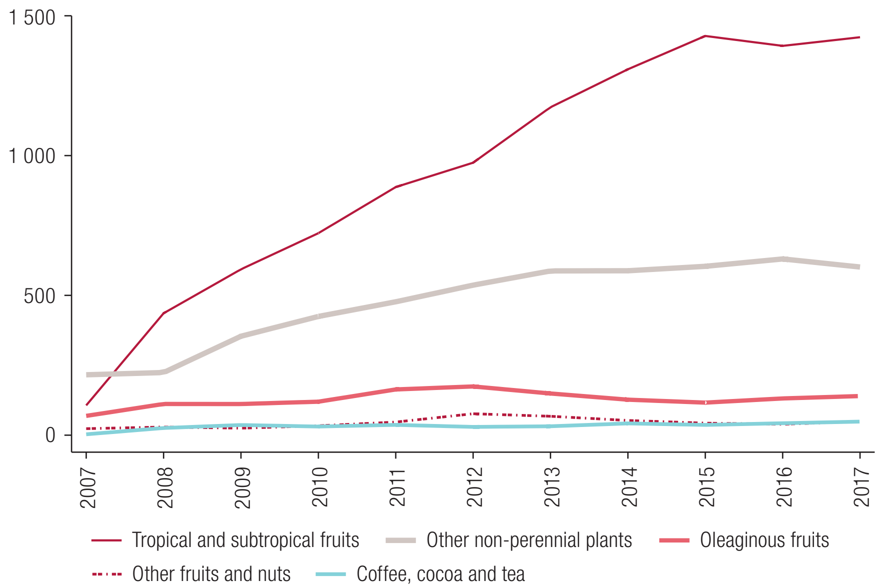
[1] This concept refers to productivity growth in the agriculture sector resulting from the use of more efficient techniques and practices.

III. Characteristics of the crop-growing sector in Ecuador

Agricultural policy has generated numerous lessons as a result of different approaches and public policy models aimed at reforming the agrarian structure implemented in the country. In the twenty-first century, the agriculture share of GDP declined relative to previous decades, reflecting less buoyancy than other sectors and a deterioration in the agricultural terms of trade relative to other industries in the economy. Nonetheless, the crop-growing sector is still of enormous economic and social importance, since it maintains production chains with major forward linkages, as in the case of the manufacturing sector through agribusiness, and backward linkages, as in the case of the transportation sector and other sectors that supply agricultural inputs.

Figure 1 illustrates the trend of sales revenue in the crop-growing subsectors that played the most important role in the Ecuadoran economy in 2007–2017. The tropical and subtropical fruit subsector (subsector A0122 of the International Standard Industrial Classification of All Economic Activities (ISIC)) accounts for 49% of the total annual revenues of the crop-growing sector in 2007–2017, according to data reported to the Superintendency of Companies, Securities and Insurance.[2] Eighty-one percent of the income generated by this subsector comes from the growing of bananas and plantains, 12% from mangoes and 6% from non-traditional fruits. Bananas and plantains account for an average of 42% of the income recorded in the crop-growing sector analysed in this study.

Figure 1
Ecuador: trend of sales revenue in the leading crop-growing subsectors, 2007–2017
(Millions of dollars)



Source: Prepared by the authors, on the basis of Superintendency of Companies, Securities and Insurance.

[2] In this study, the crop-growing sector refers to the following subsectors of the International Standard Industrial Classification of All Economic Activities (ISIC): Growing of non-perennial plants (A011), Growing of perennial plants (A012) and Plant propagation (A013).

The tropical and subtropical fruit-growing subsector has grown rapidly in revenue terms, expanding by an average of 20% per year in 2009–2014. However, its growth has slowed in recent years and, in 2017, it expanded by just 2%. The subsector with the highest growth rate is non-traditional fruits, at 42% per year. In 2016, revenues from the growing of non-traditional fruits —the product hit hardest within this subsector— fell by 36%.

The growing of non-perennial plants (A0119) is the second most dynamic subsector, accounting for an average of 27% of total agricultural revenue; the growing of flowers accounts for approximately 96% of this subsector (26% of the crop-growing sector as a whole). The flower growing subsector has posted annual growth averaging 12%, although in 2017 it actually shrank (-5%).

Crop exports have been one of Ecuador's main sources of income, despite it being a petroleum-producing economy. In 2004–2014, Ecuadoran exports mostly consisted of oil shipments to international markets. However, since 2014, the majority of export revenues have originated in the non-oil sector. This is explained partly by the fall in international crude oil prices, which has had a direct impact on the trade balance in oil.

Since 2014, non-oil products have represented an average of 61% of total annual exports. In 2018, 24% of non-oil exports were bananas, 7% natural flowers, 5% cocoa and 2% vegetable extracts and oils, according to figures reported by the Ministry of Production, Foreign Trade, Investments and Fisheries in 2019. Banana exports have seen sustained growth since 2016 (in which year they declined by 3% owing to the fall in commodity prices internationally), followed by positive growth rates of 11% and 5% in 2017 and 2018, respectively, evidencing the sector's slight recovery.

In the case of natural flowers, exports peaked in 2014 at US$918 million, but then fell back by 11% in 2015 and by a further 2% in 2016. In the following year, flower exports recovered with growth of 10%, before slipping again in 2018, by 3% relative to the previous year's level.

The commodity export matrix is thus driven by products such as bananas, cocoa, flowers and African palm, which play a key role in creating employment and generating non-oil income in the country. The boom in these products depends largely on the growth of demand in the international market and on efficient input use, which makes it possible to obtain quality products that are globally competitive.

IV. Methodology and data

1. Data

An unbalanced panel of data spanning 2007–2017 was used to estimate the production function of Ecuador's crop-growing sector and to determine the factors that affect the profitability of its constituent enterprises. The panel uses firm-level administrative data from financial statements reported to the Superintendency of Companies, Securities and Insurance, the entity tasked with supervising and controlling the formal business sector in Ecuador. On average, there were 1,015 active firms in the crop-growing sector each year, for which financial information is available for the entire period of analysis.

Table 1 describes each of the variables used to estimate the production function and then calculate total factor productivity (TFP).

Table 1
Definition of variables

Variable	Definition
Estimation of the production function	
Y	Total sales revenue: revenue obtained the firms' ordinary activities (excluding revenue from occasional activities, such as the sale of machinery and other fixed assets).
L	Number of workers
K	Capital stock: total net fixed assets. This is the sum of the real dollar value of buildings, machinery and vehicles, assuming depreciation rates of 5%, 10% and 20%, respectively, following Bravo-Ortega, Benavente and Gonzalez (2014).
M	Raw materials consumption: fuel expense + lubricant expense + transport expense + water and energy expense + raw material initial inventory expense + local purchase expense + raw material imports + maintenance and repair expense.
R	Land: book value of land assets in dollars as reported by the firm.
Estimation of the determinants of profitability	
Dependent variable	
ROA	Return on assets
Independent variables	
K	Capital stock
Terreno	Real dollar value of firms' land
HHI	Herfindahl-Hirschman Index
d.IED	Dummy variable that takes the value of 1 if the firm has foreign direct investment (FDI) and 0 otherwise, for each year of analysis.
PTF	Total factor productivity (TFP)
d.Exportación	Dummy variable that takes the value of 1 if the firm exports and 0 if the firm does not export any agricultural product for each year of analysis.
IPC Agri	Consumer price index (CPI) for goods in the crop-growing sector, obtained from the National Institute of Statistics and Censuses (INEC).
PIBpc	Per capita GDP growth rate
Antigüedad	Age of the firm

Source: Prepared by the authors, on the basis of C. Bravo-Ortega, J. Benavente and Á. González, "Innovation, exports, and productivity: learning and self-selection in Chile", *Emerging Markets Finance and Trade*, vol. 50, No. 1, Milton Park, Taylor & Francis, 2014.

Active firms engaging in activities related to the growing of non-perennial plants (A011), the growing of perennial plants (A012) and plant propagation (A013) of sector A of the International Standard Industrial Classification of All Economic Activities (ISIC) were selected.

Table 2 presents the descriptive statistics of the factors of production included in the function estimated to calculate TFP, such as sales revenue, net fixed assets (capital stock), consumption of raw materials,[3] the number of workers, and the number of observations analysed during the study period (2007–2017).

Table 2
Ecuador: descriptive statistics of the variables used to estimate the production function, 2007–2017
(Dollars and number of workers)

	N	Mean	Standard deviation	Min.	Max.	Percentile 25	Percentile 50	Percentile 75
Y	7 353	2 725 818.92	10 186 070.80	0.01	285 938 880.00	238 890.00	837 762.69	2 389 494.75
K	7 353	900 998.19	5 896 943.96	0.00	230 176 992.00	21 013.31	157 227.53	592 734.50
Terreno	7 353	684 700.57	3 675 217.29	0.00	94 305 513.90	0.00	84 169.93	445 482.97
L	7 125	108.00	407.00	1.00	13 679.00	5.00	23.00	96.00
M	7 353	941 763.96	4 737 022.31	4.46	185 246 112.00	26 665.63	151 013.52	618 447.69
N	7 353							

Source: Prepared by the authors.
Note: Y: sales revenue; K: capital stock; *Terreno*: value of the firms' land; L: number of workers; M: input expenses (including consumption of raw materials); N: number of observations between 2007 and 2017.

[3] This item includes fuel and electric energy expenses.

At the aggregate level, average income (Y) in 2007–2017 is US$ 2.7 million. The subsector with the highest (average) income during this period is the growing of tropical and subtropical fruits (A0122), in which 81% of income comes from the growing of bananas and plantains, 12% from mangoes and 6% from non-traditional fruits. Bananas and plantains account for an average of 42% of the income recorded in the crop-growing sector analysed in this study. The growing of non-perennial plants (A0119) ranks next and represents on average 27% of total income in the crop-growing sector, and the growing of flowers represents approximately 96% of this subsector (26% of the entire crop-growing sector).

In terms of employment, the number of workers (L) employed by firms in the crop-growing sector averaged 108 (a median of 23) during 2007–2017, although the number varies widely according to firm size.[4] Large firms report an average of 524 workers (a median of 321), compared to 103 (mean) and 89 (median) in medium-sized enterprises. In contrast, small and microenterprises in the sector report averages of 22 and seven workers, respectively.

The capital stock (K) reported by each firm in the crop-growing sector,[5] which has been approximated from the measurement of net fixed assets (having deducted cumulative depreciation and impairment by asset type), averages approximately US$ 900,000 (median US$ 157,000) in the 2007–2017 period. The average reported capital stock differs across subsectors. For example, the subsector with the highest level of capital is the growing of other tree and bushfruits and nuts (A0125), with each firm employing capital averaging US$ 11.5 million.[6] Another subsector with a high level of capital is the growing of oleaginous fruits (A0126), with average capital of US$ 3.4 million per firm in 2007–2017. Firms in the tropical and subtropical fruit growing (A022) and in the non-perennial plant growing sector (A019) report average capital of US$ 1.8 million and US$ 1.5 million per year, respectively.

Given the nature of the crop-growing sector and its intensive use of land as a factor of production, the analysis is performed by weighting this factor separately from the capital stock. In general, not all firms report this asset, since many of them choose to rent land from third parties, which is then considered as a production input. Expenses on inputs (M), which include raw materials consumption, average US$ 942,000 (median US$ 151,000) per firm in the crop-growing sector (A011, A012 and A013).

Table 3 details the factors used to analyse the determinants of corporate profitability in the sector, which include: ROA; capital stock (in natural logarithms); land value reported in dollars (in natural logarithms); TFP; the consumer price index (CPI) of products in the agriculture, livestock and fisheries sector, the age of the firm and the growth rate of per capita gross domestic product (GDP). In addition, descriptive statistics are included for the dummy variables included, such as FDI, exports and firm size.

Table 3

Ecuador: descriptive statistics of the variables used to estimate the determinants of profitability, 2007–2017

	N	Mean	Standard deviation	Min.	Max.	Percentile 25	Percentile 50	Percentile 75
ROA	7 347	0.156	3.585	0.000	234.790	0.000	0.018	0.067
K[a]	6 640	11.865	2.565	-13.393	19.254	10.679	12.249	13.453
Terreno[a]	4 928	12.254	1.967	3.595	18.362	11.307	12.534	13.468
d.IED	7 353	0.259	0.438	0.000	1.000	0.000	0.000	1.000
PTF	6 649	12.677	1.686	-5.175	17.985	11.786	12.870	13.768
d.Exportación	7 353	0.305	0.460	0.000	1.000	0.000	0.000	1.000
Antigüedad	7 353	12.639	11.241	0.000	78.000	4.000	10.000	18.000
IPC Agri	7 353	0.882	0.109	0.601	1.005	0.779	0.895	0.975
d.Microempresa	7 353	0.147	0.354	0.000	1.000	0.000	0.000	0.000

[4] Firm size is defined in the Organic Code of Production, Commerce and Investments of Ecuador.

[5] Does not include land, since this factor is analysed separately.

[6] This sector has a small number of enterprises and is highly concentrated. In 2017 there were approximately four firms.

Table 3 (concluded)

	N	Mean	Standard deviation	Min.	Max.	Percentile 25	Percentile 50	Percentile 75
d.Pequeña	7 353	0.395	0.489	0.000	1.000	0.000	0.000	1.000
d.Mediana	7 353	0.342	0.475	0.000	1.000	0.000	0.000	1.000
d.Grande	7 353	0.115	0.320	0.000	1.000	0.000	0.000	0.000
ΔPIBpc[b]	5 933	0.015	0.027	-0.027	0.061	-0.012	0.016	0.033
HHI	7 353	205.747	34.327	165.572	309.611	179.186	200.689	226.149
d.Exportación x d.IED	7 353	0.126	0.331	0.000	1.000	0.000	0.000	0.000
N	7 353							

Source: Prepared by the authors.

Note: ROA: return on assets; K: capital stock; *Terreno*: real value of firms' land in dollars; d.IED: dummy variable (1 if the firm has FDI and 0 otherwise); PTF: total factor productivity; d.Exportación: dummy variable (1 if the firm exports and 0 otherwise); Antigüedad: age of the firm; IPC Agri: consumer price index for goods in the crop-growing sector; d.Microempresa: indicator variable for firms belonging to the microenterprise group; d.Pequeña: indicator variable for firms belonging to the small enterprise group; d.Mediana: indicator variable for firms belonging to the medium-sized enterprise group; d.Grande; indicator variable for firms belonging to the large enterprise group; Δ PIBpc: per capital GDP growth rate; HHI: Herfindahl-Hirschman index; and N: number of observations between 2007 and 2017.

[a] Variables expressed in logarithms.

[b] PIBpc expressed as a logarithm.

The return on assets, which is used as an indicator of enterprise profitability in this analysis, reports a mean of 0.16 in the case of firms in the crop-growing sector and a median of 0.02. This reveals wide dispersion between sectors, as illustrated figure A1.2A of the annex, which shows the trend of ROA in the most profitable subsectors.[7] According to the information provided by the Superintendency of Companies, Securities and Insurance, the growing of other tree and bush fruits and nuts is the most profitable sector, with an average median return on assets of 0.09 in 2007–2017; and it also displays the highest productivity levels. Nonetheless, the subsector is highly concentrated, with an average of just two firms per year in 2007–2017. The second most profitable subsector is the growing of tropical and subtropical fruits, with a median ROA of 0.02 (mean 0.29), followed by the growing of oleaginous fruits, with a median ROA of 0.01 (mean 0.05).

(a) Empirical strategy

Seminal studies of the transition from macro to micro growth models, focusing especially on the agriculture sector, include Tintner (1944), Mundlak (1961), Heady and Dillon (1961) and Griliches and Mairesse (1995). These studies motivate the analysis of technological change as a component of the production function used to determine productivity.

To estimate the production function and then calculate TFP in the crop-growing sector, this study initially uses the traditional Cobb-Douglas production function model, on which the seminal studies of economic growth by Solow (1957), Denison (1967) and Romer (1986) are based. According to this traditional model, production is determined by intermediate goods, capital inputs, land and labour, controlling for the time factor and subsector (to reduce the possible macroeconomic and industrial shocks generated by the heterogeneity of firms), as expressed in the following equation:

$$Y_{it} = A_{it} F\left(X_{it}\right) \quad (1)$$

where Y_{it} is the sales revenue of each firm i in period t; X_{it} is a vector of factors containing K_{it} (which represents the real capital stock, approximated through net fixed assets excluding the value of land),

[7] ISIC sectors: Growing of other tree and bush fruits and nuts (A0125), Growing of other non-perennial plants (A0119), Growing of tropical and subtropical fruits (A0122), Growing of oleaginous fruits (A0126) and Growing of beverage crops (coffee, cocoa and tea) (A0127).

L_{it} is the number of workers reported by each firm in the crop-growing sector, and M_{it} is the amount of intermediate inputs (or raw materials) used in the production process. In addition, R_{it} is the value reported by the firm for land as a factor of production, given the nature of the crop-growing sector; and A_{it} is Hicks-neutral technical change, which is used as a measure of productivity. Among the controls, time dummy variables are included to capture and control for possible macroeconomic shocks in each of the years and controls for subsector, which are firm-specific characteristics that can vary over time.

Along these lines, the production function chosen to estimate TFP is of the Cobb-Douglas type, because it makes it easy to separate growth into contributions by the different factors of production, by taking advantage of the efficiency gains obtained by using these factors, as with the data provided in Gonçalves and Martins (2016), Syverson (2011), Van Beveren (2012) and Van Biesebroeck (2007). However, when controlling for time and the subsectors to which the agribusinesses belong, the returns to scale of the determinants were found to be decreasing, contrary to the results obtained when using the Cobb-Douglas type production function, in which returns to scale are constant. To some degree this responds to Gechert and others (2019), who warn of this problem when using this convenient simplification. However, the estimation advantages offered by this function for obtaining levels of return and input elasticities, mean it continues to be widely used in both theoretical and empirical growth studies.

In addition, land (R_{it}) is added as another fixed factor of production, as in Yutopoulos and Lau (1974) and Dias and Evenson (2010), to give:

$$Y_{it} = A_{it} K_{it}^{\alpha} L_{it}^{\beta} R_{it}^{\tau} M_{it}^{\gamma} \tag{2}$$

Equation (2) is then expressed in logarithmic form, and the elasticities of the observable productive inputs with respect to sales revenue are obtained as follows.

$$\begin{gathered} y_{it} = \beta_0 + \alpha k_{it} + \tau r_{it} + \beta l_{it} + \gamma m_{it} + \varepsilon_{it} \\ a_{it} = \beta_0 + \varepsilon_{it} \\ \varepsilon_{it} = \mu_{it} + \upsilon_{it} \end{gathered} \tag{3}$$

In the above, a_{it} represents TFP, which decomposes into β_0 representing the average efficiency level of firms over time, and ε_{it} , which corresponds to the time- and firm-specific deviation from its mean. The latter term (ε_{it}) has two independent and identically distributed idiosyncratic error components: μ_{it} and υ_{it}. Of these, μ_{it} represents unobservable heterogeneity; in other words, it captures productivity that is not observed by analysts, but is observed by firms in the crop-growing sector, since it affects their inputs; while the υ_{it} term is a random error that is uncorrelated with the inputs used to produce a good. Thus, equation (3) can be rewritten as follows:

$$y_{it} = \beta_0 + \mu_{it} + \alpha k_{it} + \tau r_{it} + \beta l_{it} + \gamma m_{it} + \upsilon_{it} \tag{4}$$

Equation (4) is used to estimate the production function of the Ecuadoran crop-growing sector, as well as those of the two subsectors with the highest levels of sales revenue and profits, namely tropical and subtropical fruits and non-perennial crops. Total factor productivity is then calculated using the elasticities estimated for each production input through the following equation:

$$\hat{a}_{it} = y_{it} - \hat{\alpha} k_{it} - \hat{\tau} r_{it} - \hat{\beta} l_{it} - \hat{\gamma} m_{it} \tag{5}$$

Equation (4), which contains the proposed crop-growing sector production function, is estimated through the generalized method of moments (GMM) proposed by Blundell and Bond (1998), in the style of Bournakis and Mallick (2018), since it deals with the problem of simultaneity bias and random measurement error bias in both the inputs and outputs of the function (Griliches and Mairesse, 1995; Van Biesebroeck, 2007; Bournakis and Mallick, 2018). This distinguishes it from the ordinary least squares (OLS) method, which causes biases in the estimators, overestimating the input coefficients of (endogeneity of inputs), underestimating the coefficient of capital (endogeneity of wear and tear) (Olley and Pakes, 1996) and causing biases related to the heterogeneity of technology inputs used by firms in production (De Loecker, 2007).

Using the OLS method with standard errors clustered by firm,[8] profitability, proxied by ROA, is modelled as a function of factors both internal and external to the firm, such as TFP, capital value, land value, firm age, crop-growing sector CPI, the Herfindahl-Hirschman index, whether or not it is an exporting firm, and whether it has any foreign direct investment in its capital structure. Whether the interaction between FDI and exports in any way influences the profitability of firms in the crop-growing sector is also analysed. Furthermore, it is estimated through fixed effects, without incorporating the fixed effect of time, since the aim is to evaluate variables such as per capita GDP, which fluctuate over time but are constant across firms.

The dependent variable with a one-period lag is also included among the independent variables, because profitability has a dynamic component; in other words, it is posited that previous years' profitability affects the firm's future performance. This is then estimated through the generalized method of moments, incorporating the lagged ROA, which captures the dynamic effect in the process of determining profitability, dealing with serial autocorrelation.

The final specification is as follows:

$$\begin{aligned} ROA_{it} &= \beta_0 + \beta_1 ROA_{i,t-1} + \beta_2 Ln(K)_{it} + \beta_3 Ln(Terreno)_{it} + \beta_4 HHI_t + \beta_5 PTF_{it} \\ &+ \beta_6 Antigüedad_{it} + \beta_7 IPC_t + \beta_8 \Delta PIBpc_t + \beta_9 d.IED_{it} + \beta_{10} d.Exportación_{it} \\ &+ \beta_{11} d.IED * d.Exportación + Tamaño_{it} + Subsector_i + \mu_{it} \end{aligned} \quad (6)$$

with variables defined as follows: K is the capital stock, $Terreno$ is the value invested in land by firm I; HHI is the Herfindahl-Hirschman index, which captures the market concentration of the crop-growing sector each year; PTF is enterprise total factor productivity calculated previously through the production function, and $Antigüedad$ is the length of time the firm has been operating at the cut-off point in each year. In addition, the group of macroeconomic factors includes the variable $\Delta PIBpc_t$, which is the growth rate of per capita GDP, and IPC, which is the consumer price index of products in ISIC sector A. The dummy variables, $Exportación$ and IED, control for the existence of firms that export or whose capital structure includes some type of FDI, reepectively. In addition, controls were introduced for size and subsector.

V. Results

According to the characteristics of the productivity model specified above, table 4 reports the coefficients obtained for each of the inputs of the Cobb-Douglas type production function, as estimated through two methods: pooled OLS with a lagged dependent variable, and GMM.

The pooled OLS model overestimates the coefficient of the lagged dependent variable (that is, it maintains an upward bias (Angrist and Pischke, 2009)), while GMM is more consistent, because it corrects the simultaneity problem and minimizes the endogeneity effect among the inputs used by the firm (Arellano and Bond, 1991). Thus, the coefficient of the first lag of the dependent variable obtained through GMM is below that recorded in the OLS model, as can be seen in table 4.

[8] The results obtained using the OLS method with clustered standard errors can be provided upon request to persons wishing to consult them.

Table 4
Ecuador: estimation of the crop-growing sector production function, 2007–2017

y_{it}	Ordinary least squares (OLS))		Generalized method of moments (GMM)	
	(1)	(2)	(3)	(4)
y_{it-1}	0.7566***	0.7569***	0.6802***	0.6966***
	(0.0426)	(0.0448)	(0.0308)	(0.0397)
k_{it}	0.0337***	0.0347***	0.0259***	0.0271***
	(0.0119)	(0.0118)	(0.0089)	(0.0087)
r_{it}	0.0237**	0.0277**	0.0109	0.0151**
	(0.0112)	(0.0110)	(0.0068)	(0.0074)
l_{it}	0.0612***	0.0630***	0.0238**	0.0221**
	(0.0111)	(0.0111)	(0.0101)	(0.0096)
m_{it}	0.1168***	0.1095***	0.0557***	0.0416***
	(0.0130)	(0.0121)	(0.0079)	(0.0074)
Control for years	Yes	Yes	Yes	Yes
Control for sector	No	Yes	No	Yes
AR(1)[a]	-	-	0.0000	0.0000
AR(2)[a]	-	-	0.2756	0.2237
AR(3)[a]	-	-	0.4455	0.1552
CRS test[b] (F-stat)	898***	964***	2 373***	2 884***
R^2	0.9280	0.9314	-	-
Sargan test[a]	-	-	0.2150	0.1863
Instruments	-	-	139	139
Observations	3 096	2 964	3 096	2 964

Source: Prepared by the authors.
Note: Standard errors clustered by company in parentheses. * p<0.1; ** p<0.05; *** p<0.01. y_{it}: log sales revenue; k_{it}: log capital stock; r_{it}: log real dollar value of firms' land; l_{it}: log number of workers; m_{it}: log input expenditures (including raw material consumption); AR: autoregressive test.
[a] The *p*-value of the first-, second- and third-order autocorrelation tests, as well as the Sargan test, which are required in GMM, are reported. The instruments used in the generalized method of moments are the lagged differences of the variables *K*, *L*, *M* and *Terreno* (Land) at *t-1* and *t-2*.
[b] Test of constant returns to scale.

It should be noted that the consistency of the GMM model depends on the validity of the instruments created by the model, based on the lag of the explanatory variables (Fariñas, López and Martín-Marcos, 2014). To test the validity of the model, the Arellano-Bond estimator is reported, which measures three autoregressive (AR) processes,[9] in order to test for serial non-correlation with the inputs in at least the second autoregressive process AR(2).[10] In addition, the Sargan test is performed, which demonstrates the null hypothesis that all the overidentification restrictions are valid in the model, provided the error term is independent and identically distributed. That is, this test verifies the validity of the instruments generated in the analysis (Cameron and Trivedi, 2010).

Along these lines, when analysing the GMM, which is the model that best addresses the identification problems that are present, several results are obtained with respect to the elasticities of inputs in the sector. It is important to note that the production function of the crop-growing sector does not exhibit constant returns to scale. In other words, an increase in inputs does not imply an equi-proportional increase in output. Specifically, there is evidence of decreasing returns to scale, since the sum of the coefficients is significant and statistically less than 1, which indicates that a given variation in inputs produces a less than proportional variation in output.[11] This finding is closely related to the results obtained by Galarza and Díaz (2015) in the case of the Peruvian crop-growing sector.

[9] To simplify the content, table 4 only includes the results of the AR(1) and AR(2) autoregression tests. However, the null hypothesis of AR(3) is not rejected in any of the cases, as happens with AR(2).

[10] The null hypothesis is the absence of serial autocorrelation.

[11] Using lincom in Stata.

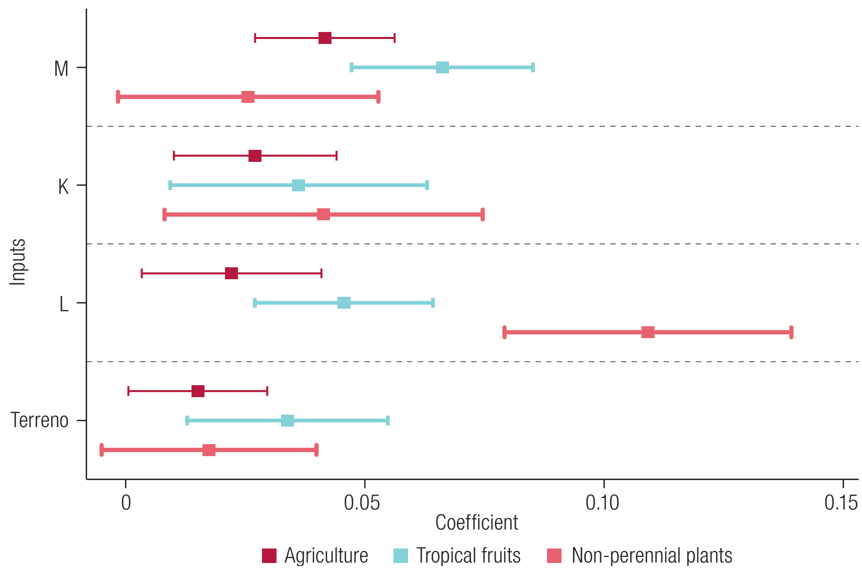
First, it is noted that the factor with the highest elasticity is M, which includes expenditures on inputs or raw materials. This is followed by K, with an elasticity of 0.03. Moreover, the results show that increase in the labour factor (number of employees) causes an increase in income. Lastly, $Terreno$ (Land) is the factor with the lowest elasticity (0.015), both in the overall sector average and in the two subsectors analysed.

The results differ when analysing the production function by subsector. Owing to their heterogeneity, the different agricultural subsectors have different patterns of input use that can depend on the degree of specialty of each subsector.

For example, the tropical and subtropical fruit growing subsector is intensive in raw materials use, which causes its results to be similar to those obtained for the crop-growing sector as a whole; however, the intensity of use of the other factors (K, L and $Terreno$) is above the average at the aggregate level.

In contrast, the perennial plant growing sector is, in general, more labour- and capital-intensive, but less intensive in the use of raw materials. In this subsector, land displays an elasticity similar to the average of the crop-growing sector as a whole. However, the coefficient in question is not significant, which indicates that this factor does not influence revenue generation in the sector. These results are shown in figure 2 and table 5.

Figure 2
Ecuador: estimated coefficients of the production function by subsectors of the crop-growing sector, 2007–2017



Source: Prepared by the authors.
Note: M: input costs (including consumption of raw materials); K: capital stock; L: number of workers; *Terreno*: real dollar value of land owned by the firms.

Table 5
Ecuador: estimation of the production function by subsectors of the crop-growing sector, 2007–2017

y_{it}	(1) Agriculture*	(2) Tropical fruits	(3) Non-perennial plants
y_{it-1}	0.697***	0.598***	0.780***
	(0.035)	(0.038)	(0.038)
k_{it}	0.027**	0.036***	0.041**
	(0.009)	(0.014)	(0.017)
r_{it}	0.015**	0.034***	0.017
	(0.007)	(0.011)	(0.011)
m_{it}	0.042***	0.066***	0.026*
	(0.007)	(0.010)	(0.014)
l_{it}	0.022**	0.046***	0.109***
	(0.010)	(0.010)	(0.015)
Controls[a]	Yes	Yes	Yes
Sargan test[b] [*p* value]	0.260	0.259	0.869
AR(1)[b] [*p* value]	0.000	0.000	0.003
AR(2)[b] [*p* value]	0.183	0.636	0.475
CRS test[c] (F-stat)	2 884***	1 488***	1 168***
Instruments	139	104	75
Observations	2 964	1 576	634

Source: Prepared by the authors.

Note: Standard errors clustered by company in parentheses. * p<0.1; ** p<0.05; *** p<0.01. y_{it}: log sales revenue; k_{it}: log capital stock; r_{it}: log real dollar value of firms' land; l_{it}: log number of workers; m_{it}: log input expenditures (including raw material consumption); AR: autoregressive test.

a Time and subsector controls from the six-digit International Standard Industrial Classification of All Economic Activities (ISIC) were included.

b Estimate for the entire crop-growing sector analysed, which includes ISIC subsectors A011, A012 and A013. The p-value of the first, second and third order autocorrelation tests, as well as the Sargan test, which are required in the generalized method of moments, are reported. The instruments used in the generalized method of moments are the lags of the differences of *K*, *L*, *M* and *Terreno* at *t-1* and *t-2*.

c Test of constant returns to scale.

Having obtained estimators for the inputs of the production function for the crop-growing sector described above, using GMM, total factor productivity was calculated using equation (5). This indicator is included as part of the determinants of profitability, the results of which are shown in table 6.

Table 6
Ecuador: analysis of the determinants of the return on assets among agribusinesses, 2007–2017

	Fixed effects			Generalized method of moments	
	(1)	(2)	(3)	(4)	(5)
L.ROA				0.2340***	0.2312***
				(0.0156)	(0.0165)
k	-0.0052**	-0.0051**	-0.0049**	-0.0024*	-0.0034*
	(0.0020)	(0.0020)	(0.0021)	(0.0015)	(0.0019)
r	-0.0075***	-0.0076***	-0.0069***	-0.0178***	-0.0188***
	(0.0022)	(0.0021)	(0.0021)	(0.0019)	(0.0021)
HHI	0.0003	0.0003	0.0002	-0.0001***	-0.0001**
	(0.0006)	(0.0006)	(0.0006)	(0.0000)	(0.0000)
d.IED	0.0016	0.0012	0.0003	-0.0146*	-0.0247***
	(0.0045)	(0.0046)	(0.0045)	(0.0083)	(0.0093)
PTF	0.0172***	0.0173***	0.0173***	0.0060*	0.0088**
	(0.0029)	(0.0035)	(0.0037)	(0.0036)	(0.0043)
d.Exportación	-0.0146***	-0.0151***	-0.0150***	-0.0218***	-0.0180***
	(0.0038)	(0.0038)	(0.0039)	(0.0044)	(0.0051)

Table 6 (concluded)

	Fixed effects			Generalized method of moments	
	(1)	(2)	(3)	(4)	(5)
Antigüedad	-0.0072	-0.0069	-0.0063	-0.0006***	-0.0007***
	(0.0100)	(0.0100)	(0.0103)	(0.0002)	(0.0002)
IPC Agri	0.4557	0.4299	0.3744	-0.0562	-0.0141
	(0.6338)	(0.6341)	(0.6545)	(0.0378)	(0.0399)
ΔPIBpc	0.1179	0.1103	0.1238	0.0908***	0.0916***
	(0.1099)	(0.1086)	(0.1117)	(0.0213)	(0.0216)
d.Exportación x d.IED	0.0052	0.0058	0.0047	0.0173***	0.0155**
	(0.0047)	(0.0048)	(0.0050)	(0.0057)	(0.0068)
Constant	-0.4057	-0.3760	-0.3285	0.1357***	0.4150***
	(0.5488)	(0.5524)	(0.5740)	(0.0368)	(0.1192)
Years	Yes	Yes	Yes	No	No
Size	No	Yes	Yes	Yes	Yes
Subsectors	No	No	Yes	No	Yes
Sargan [test *p*-value]	-	-	-	[0.0425]	[0.1564]
AR(1) [*p*-value]	-	-	-	[0.0000]	[0.0000]
AR(2) [*p*-value]	-	-	-	[0.9570]	[0.9551]
Instruments	-	-	-	193.0000	193.0000
Observations	3 921	3 921	3 754	3 595	3 443

Source: Prepared by the authors.

Note: Standard errors clustered by firm in parentheses. * $p<0.1$; ** $p<0.05$; *** $p<0.01$. L.ROA: return on assets in a previous period; k: capital stock in logarithms; r: real dollar value of firms' land in logarithms; HHI: Herfindahl-Hirschman index; $d.IED$: dummy variable (1 if the firm has foreign direct investment but 0 otherwise); PTF total factor productivity; $d.Exportación$: dummy variable (1 if the firm exports but 0 otherwise); $Antigüedad$: age of the firm; $IPC\ Agri$: consumer price index for agricultural goods; $\Delta PIBpc$: per capita GDP growth rate; AR: autoregression test.

Using ordinary least squares with clustered standard errors and fixed effects, results were obtained for equations (6) and (7), which analyse the different domestic, sectoral and macroeconomic factors that affect the profitability of enterprises in the crop-growing sector, as measured through ROA. In addition, to capture the dynamic component of profitability, the first order lag (t-1) is included in the specification, with estimation through GMM, and the results are compared. Table 6 shows the coefficients obtained for each of the variables analysed in the two different models, with standard errors that are robust to inter-firm heteroscedasticity.

First, incorporating the lag shows that this is a significant component in determining profitability. On average, improvement in the previous year's profitability has a positive influence on profitability in the current year, as shown in models (4) and (5).

Second, when analysing how the specific characteristics of agribusinesses affect their profitability, a negative and significant effect was obtained in the case of capital stock. This indicates that higher levels of capital, which include net fixed assets, are associated with negative returns, albeit weakly.

In other words, it can be inferred that investments in machinery as an asset are not generating positive returns in the agribusiness sector, so public policies that encourage farmers to use efficient technologies in the sector should be implemented. This result is consistent with the asset fixity theory, which claims that, in the crop-growing sector, periods of disinvestment or capital depreciation last longer than those of investment (Nelson, Braden and Roh, 1989), since it is difficult to dispose of capital that is specific to agricultural production and to transition to new technologies. In this connection, Rosenzweig and Binswanger (1993) note that agribusiness owners are generally risk-averse and only decide to invest in machinery when there are higher returns.

Land also has a negative and significant effect on the profitability of firms in the crop-growing sector, which is another indication that capital in the form of land is not being used most efficiently in the sector. It is worth noting that, although this effect is not very strong, it is greater than in the case of net fixed assets (K). Another hypothesis is that each unit of land is not profitable in terms of costs for the agricultural entrepreneur, since the acquisition of an additional unit of land does not generate positive returns, which may be related to the cost assumed by the producer.

The potential effect of foreign capital on profitability in the crop-growing sector is also analysed, and it is found that, in general, firms that have some form of FDI in their capital report lower levels of profitability in the short term, while there is no conclusive evidence of its effects in the long term. It could thus be inferred that firms in the crop-growing sector, on average, do not channel FDI (acquisition of capital goods, including land) appropriately; but that investment could be targeted towards movable working capital in the short term. This idea supports the hypothesis of the low technical level of agribusinesses in Ecuador, since investment in machinery that generates enterprise profitability is not taking place.

The impact on profitability of exporting was also analysed, and it was concluded that, on average, firms that export are 1.8% less profitable than those that do not. This result can be justified theoretically in terms of the sunk costs of entering international markets (for example, adjustments in quality requirements or logistical costs), whereby exporting firms initially incur unrecoverable fixed costs that may undermine the firm's profitability in the short run (Roberts and Tybout, 1997).

The simultaneous effect of being an exporting firm and the presence of FDI in the firm's capital structure reports a positive and significant effect on corporate profitability in the sector. In other words, firms that export and also have some type of foreign capital in their capital are 1.5% more profitable than those that do not satisfy these two conditions together. Abor and Adjasi (2008) analyse how FDI can influence the development of exports by a local firm, since it promotes technology transfer, which facilitates access to new international markets and improves the competitiveness of products with respect to the rest of the world. However, it could also be inferred that, by maintaining links with the international market, exporting firms are more attractive to investors, since they have a certain advantage in terms of generating income in the crop-growing sector, by operating in a larger market with more demanding quality standards.

Enterprise productivity also has a positive and significant effect on the profitability of firms in the crop-growing sector. On average, each 1% increase in productivity translates into a 0.01% increase in financial profitability. This result, as concluded in Stierwald (2009), seems to indicate that firms with higher productivity levels have a superior competitive advantage that is reflected in higher profits.

Lastly, firm age has a slight negative impact on corporate profitability in the sector: for each additional year that a firm has been operating, profitability decreases by 0.1%. This result is consistent with the empirical data found in previous work. Majumdar (1997), for example, concludes that the oldest firms in India have the lowest profitability rates, despite being the most productive, because they have not been able to adapt to the competitive business culture, in which the concept of satisfying consumer needs is becoming increasingly important. Other authors, such as Glancey (1998), Tan (2003), Fok, Chang and Lee (2004), Loderer and Waelchli (2010), and Coad, Segrar and Teruel (2013) also report results that are compatible with these conclusions.

In the case of market structure, it was found that greater concentration of the crop-growing sector has a negative impact on average corporate profitability, although the magnitude of this effect is small compared to the determinants analysed previously. It is therefore of little relevance to conclude that concentration really does negatively affect the profitability of firms in the sector, contrary to what has traditionally been proposed by Bain (1951) and Peltzman (1977), who defend the structure-conduct-performance hypothesis. From the result obtained, it would clearly be interesting to perform a more detailed analysis of the relationship between concentration and profitability at the subsector level, in the case of the firms in this segment, since the products involved are not very homogeneous. However, this is not the main aim of this paper.

As for external factors that could affect profitability in the crop-growing sector, the per capita GDP growth rate and the consumer price index for agricultural products were included. The results obtained show that increases in per capita GDP boost the profitability of agribusinesses by increasing the aggregate demand for food products, which stimulates the sector's performance. On the other hand, there is no significant evidence that the price index of agricultural products affects the profitability of agribusinesses.

VI. Conclusions and public-policy proposals

This paper analyses the key determinants of the profitability of Ecuadoran enterprises in the crop-growing sector between 2007 and 2017, using an administrative database covering all formally constituted firms in the sector provided by the country's business regulation and supervision agency. In addition, the two largest agricultural subsectors are studied, namely "Growing of tropical and subtropical fruits" (A0122) and "Growing of non-perennial plants" (A0119).

To obtain the main determinants of profitability, a traditional Cobb-Douglas type production function was estimated; and it was found that the crop-growing sector as a whole is intensive in the use of raw materials. It was also found to have, not constant but, decreasing returns to scale. On the other hand, the results by subsector are different in the use of inputs, since the tropical and subtropical fruit growing subsector uses raw materials intensively, as does the crop-growing sector as a whole, while the perennial plant growing sector is more labour- and capital-intensive, which demonstrates intra-sector heterogeneity in the use of traditional inputs in the production processes of agribusinesses.

It is also found that TFP has a positive effect on the profitability of firms in the sector, which seems to indicate that firms with higher levels of productivity have a greater competitive advantage that is reflected in higher profits. However, capital stock, land, FDI, exports and firm age are negatively related to profitability.

In terms of industrial and macroeconomic determinants, there is evidence that industry concentration reduces average enterprise profitability. On the other hand, per capita GDP growth boosts agribusiness profitability by increasing the aggregate demand for food products, which stimulates sector performance.

The results obtained suggest certain public policy recommendations, since capital stock and exports do not affect the profitability of agribusinesses positively in the short term. Policy-makers should promote the use of efficient technologies in the sector by providing incentives for farmers; or else provide financial credits that allow them to replenish capital more quickly, and, at the same time, serve as a more efficient technical upgrading of the sector to enhance financial returns.

On the export side, the process of internationalizing the products of agribusinesses should be monitored closely. It would need to be coordinated with the technical upgrading process, to ensure that the final product is of high quality and can be launched on the international market. It is worth noting that incentives should be applied equitably so as not to aggravate distortions in the market, but foster egalitarian development in the crop-growing sector.

Public policies to promote the technical upgrading of agribusinesses in Ecuador would make it possible to improve production yields, since having a crop-growing sector with diminishing returns to scale does not foster development or economic growth, especially in an agro-exporting country.

These proposals are consistent with the effect of simultaneously exporting and having of FDI in the firm's capital, since this increases profitability by promoting technology transfer, which facilitates access to new international markets and enhances the global competitiveness of its products.

Lastly, this study suggests future debates not only on enterprise profitability, but also on productivity and the heterogeneity of enterprises in this sector. The topic is therefore open to further research, whether from a methodological or from an economic development standpoint.

Bibliography

Abor, J. and C. Adjasi (2008), "How does foreign direct investment affect the export decisions of firms in Ghana?", *African Development Review*, vol. 20, No. 3, Hoboken, Wiley.

Aghion, P. and S. Durlauf (2005), *Handbook of Economic Growth*, Amsterdam, Elsevier.

Angrist, J. and J. Pischke (2009), *Mostly Harmless Econometrics: An Empiricist's Companion*, Princeton, Princeton University Press.

Arellano, M. and S. Bond (1991), "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations", *The Review of Economic Studies*, vol. 58, No. 2, Oxford, Oxford University Press.

Bain, J. (1951), "Relation of profit rate to industry concentration: American manufacturing", *Quarterly Journal of Economics*, vol. 65, No. 3, Oxford, Oxford University Press.

Bernanke, B. and R. Gürkaynak (2001), "Is growth exogenous? Taking Mankiw, Romer, and Weil seriously", *NBER Macroeconomics Annual*, vol. 16, Cambridge, National Bureau of Economic Research (NBER).

Blundell, R. and S. Bond (1998), "Initial conditions and moment restrictions in dynamic panel data models", *Journal of Econometrics*, vol. 87, No. 1, Amsterdam, Elsevier.

Bournakis, I. and S. Mallick (2018), "TFP estimation at firm level: the fiscal aspect of productivity convergence in the UK", *Economic Modelling*, vol. 70, Amsterdam, Elsevier.

Bravo-Ortega, C., J. Benavente and Á. González (2014), "Innovation, exports, and productivity: learning and self-selection in Chile", *Emerging Markets Finance and Trade*, vol. 50, No. 1, Milton Park, Taylor & Francis.

Bustos, P., B. Caprettini and J. Ponticelli (2016), "Agricultural productivity and structural transformation: evidence from Brazil", *American Economic Review*, vol. 106, No. 6, Nashville, American Economic Association (AEA).

Cameron, A. and P. Trivedi (2010), *Microeconometrics Using Stata*, vol. 2, College Station, Stata Press.

Camino-Mogro, S., V. Andrade-Díaz and D. Pesantez-Villacis (2016), "Posicionamiento y eficiencia del banano, cacao y flores del Ecuador en el mercado mundial", *Ciencia UNEMI*, vol. 9, No. 19, Milagro, Milagro State University.

Coad, A., A. Segrar and M. Teruel (2013), "Like milk or wine: does firm performance improve with age?", *Structural Change and Economic Dynamics*, vol. 24, Amsterdam, Elsevier.

Crafts, N. (1995), "Exogenous or endogenous growth? the industrial revolution reconsidered", *The Journal of Economic History*, vol. 55, No. 4, Cambridge, Cambridge University Press.

De Loecker, J. (2007), "Product differentiation, multi-product firms and estimating the impact of trade liberalization on productivity", *Working Paper*, No. 13155, Cambridge, National Bureau of Economic Research (NBER).

Denison, E. (1967), *Why Growth Rates Differ: Postwar Experience in Nine Western Countries*, Washington, D.C., The Brookings Institution.

Dias, A. and R. Evenson (2010), "Total factor productivity growth in agriculture: the role of technological capital", *Handbook of Agricultural Economics*, vol. 4, Amsterdam, Elsevier.

Domínguez, R. and S. Caria (2016), "Ecuador en la trampa de la renta media", *Problemas del Desarrollo*, vol. 47, No. 187, Mexico City, National Autonomous University of Mexico.

Fariñas, J., A. López and A. Martín-Marcos (2014), "Assessing the impact of domestic outsourcing and offshoring on productivity at the firm level", *Applied Economics*, vol. 46, No. 15, Hoboken, Taylor & Francis.

Fok, R., Y. Chang and W. Lee (2004), "Bank relationships and their effects on firm performance around the Asian financial crisis: evidence from Taiwan", *Financial Management*, vol. 33, No. 2, Hoboken, Wiley.

Foster, A. and M. Rosenzweig (2007), "Economic development and the decline of agricultural employment", *Handbook of Development Economics*, vol. 4, Amsterdam, Elsevier.

Foster, L., J. Haltiwanger and C. Syverson (2008), "Reallocation, firm turnover, and efficiency: selection on productivity or profitability?", *American Economic Review*, vol. 98, No. 1, Nashville, American Economic Association (AEA).

Fukao, K. and others (2004), "Sectoral productivity and economic growth in Japan, 1970-98: an empirical analysis based on the JIP database", *Growth and Productivity in East Asia*, Cambridge, National Bureau of Economic Research (NBER).

Galarza, F. and J. Díaz (2015), "Productividad total de factores en la agricultura peruana: estimación y determinantes", *Economía*, vol. 38, No. 76, Lima, Pontifical Catholic University of Peru.

Gechert, S. and others (2019), "Death to the Cobb-Douglas production function? A quantitative survey of the capital-labor substitution elasticity", *Working Paper*, Kiel, Leibniz Information Centre for Economics (ZBW).

Glancey, K. (1998), "Determinants of growth and profitability in small entrepreneurial firms", *International Journal of Entrepreneurial Behavior & Research*, vol. 41, No. 1, Bingley, Emerald Publishing.
Gollin, D., D. Lagakos and M. Waugh (2014), "The agricultural productivity gap", *The Quarterly Journal of Economics*, vol. 129, No. 2, Oxford, Oxford University Press.
Gonçalves, D. and A. Martins (2016), "The determinants of TFP growth in the Portuguese manufacturing sector", *GEE Papers*, No. 62, Lisbon, Office for Strategy and Studies.
Griliches, Z. and J. Mairesse (1995), "Production functions: the search for identification", *NBER Working Paper*, No. 5067, Cambridge, National Bureau of Economic Research (NBER).
Heady, E. and J. Dillon (1961), "Agricultural production functions", *American Journal of Agricultural Economics*, vol. 43, No. 1, Hoboken, Wiley.
İmrohoroğlu, A., S. İmrohoroğlu and M. Üngör (2013), "Agricultural productivity and growth in Turkey", *Macroeconomic Dynamics*, vol. 18, No. 5, Cambridge, Cambridge University Press.
Ivanic, M. and W. Martin (2018), "Sectoral productivity growth and poverty reduction: national and global impacts", *World Development*, vol. 109, Amsterdam, Elsevier.
Johnson, D. (2000), "Population, food, and knowledge", *American Economic Review*, vol. 90, No. 1, Nashville, American Economic Association (AEA).
Jorgenson, D. (1991), "Productivity and economic growth", *Fifty Years of Economic Measurement: The Jubilee of the Conference on Research in Income and Wealth*, Chicago, University of Chicago Press.
Kendrick, J. (1961), *Productivity Trends in the United States*, Princeton, Princeton University Press.
Lagakos, D. and M. Waugh (2013), "Selection, agriculture, and cross-country productivity differences", *American Economic Review*, vol. 103, No. 2, Nashville, American Economic Association (AEA).
Loderer, C. and U. Waelchli (2010), "Firm age and performance", *MPRA Paper*, No. 26450, Munich, Ludwig Maximilian University of Munich.
Majumdar, S. (1997), "The impact of size and age on firm-level performance: some evidence from India", *Review of Industrial Organization*, vol. 12, No. 2, Berlin, Springer.
McArthur, J. and G. McCord (2017), "Fertilizing growth: agricultural inputs and their effects in economic development", *Journal of Development Economics*, No. 127, Amsterdam, Elsevier.
McMillan, M. and D. Rodrik (2011), "Globalization, structural change and productivity growth", *NBER Working Paper*, No. 17143, Cambridge, National Bureau of Economic Research (NBER).
Mellor, J. (2000), "Faster more equitable growth: the relation between growth in agriculture and poverty reduction", *Consulting Assistance on Economic Reform II: Discussion Paper*, No. 70, Cambridge, Harvard University.
Mundlak, Y. (1961), "Empirical production function free of management bias", *Journal of Farm Economics*, vol. 43, No. 1, Hoboken, Wiley.
Mundlak, Y., R. Butzer and D. Larson (2008), *Heterogeneous Technology and Panel Data: The Case of The Agricultural Production Function*, Washington, D.C., World Bank.
Nelson, C., J. Braden and J. Roh (1989), "Asset fixity and investment asymmetry in agriculture", *American Journal of Agricultural Economics*, vol. 71, No. 4, Hoboken, Wiley.
Nelson, R. and S. Winter (2009), *An Evolutionary Theory of Economic Change*, Massachusetts, Harvard University Press.
Ngai, L. and C. Pissarides (2007), "Structural change in a multisector model of growth", *American Economic Review*, vol. 97, No. 1, Nashville, American Economic Association (AEA).
Olley, G. and A. Pakes (1996), "The dynamics of productivity in the telecommunications equipment industry", *Econometrica*, vol. 64, No. 6, Cleveland, The Econometric Society.
Peltzman, S. (1977), "The gains and losses from industrial concentration", *The Journal of Law and Economics*, vol. 20, No. 2, Chicago, University of Chicago Press.
Restuccia, D., D. Yang and X. Zhu (2008), "Agriculture and aggregate productivity: a quantitative cross-country analysis", *Journal of Monetary Economics*, vol. 55, No. 2, Amsterdam, Elsevier.
Roberts, M. and J. Tybout (1997), "The decision to export in Colombia: an empirical model of entry with sunk costs", *The American Economic Review*, vol. 87, No. 4, Nashville, American Economic Association (AEA).
Romer, P. (1994), "The origins of endogenous growth", *Journal of Economic Perspectives*, vol. 8, No. 1, Nashville, American Economic Association (AEA).
___(1986), "Increasing returns and long-run growth", *Journal of Political Economy*, vol. 94, No. 5, Chicago, University of Chicago Press.
Rosenzweig, M. and H. Binswanger (1993), "Wealth, weather risk and the composition and profitability of agricultural investments", *The Economic Journal*, vol. 103, No. 416, Oxford, Oxford University Press.

Ruttan, V. (2001), *Technology, Growth, and Development: An Induced Innovation Perspective*, Oxford, Oxford University Press.
Sahal, D. (1981), "The farm tractor and the nature of technological innovation", *Research Policy*, vol. 10, Amsterdam, Elsevier.
Scarpetta, S. and others (2000), "Economic growth in the OECD area: recent trends at the aggregate and sectoral level", *OECD Economics Department Working Paper*, No. 248, Paris, Organisation for Economic Co-operation and Development (OECD).
Solow, R. (1957), "Technical change and the aggregate production function", *The Review of Economics and Statistics*, vol. 39, No. 3, Cambridge, The MIT Press.
Stierwald, A. (2009), "Determinants of firm profitability: the effect of productivity and its persistence", Melbourne, University of Melbourne.
Syrquin, M. (1988), "Patterns of structural change", *Handbook of Development Economics*, vol. 1, Amsterdam, Elsevier.
Syverson, C. (2011), "What determines productivity?", *Journal of Economic Literature*, vol. 49, No. 2, Nashville, American Economic Association (AEA).
Tan, J. (2003), "Curvilinear relationship between organizational slack and firm performance: evidence from Chinese state enterprises", *European Management Journal*, vol. 21, No. 6, Amsterdam, Elsevier.
Tintner, G. (1944), "A note on the derivation of production functions from farm records", *Econometrica*, vol. 12, No. 1, Cleveland, The Econometric Society.
Van Beveren, I. (2012), "Total factor productivity estimation: a practical review", *Journal of Economic Surveys*, vol. 26, No. 1, Hoboken, Wiley.
Van Biesebroeck, J. (2007), "Robustness of productivity estimates", *The Journal of Industrial Economics*, vol. 55, No. 3, Hoboken, Wiley.
Vieira Filho, J., A. Campos and C. Ferreira (2005), "Abordagem alternativa do crescimento agrícola: um modelo de dinâmica evolucionária", *Revista Brasileira de Inovação*, vol. 4, No. 2, Campinas, State University of Campinas.
Vieira Filho, J. and A. Fishlow (2017), *Agricultura e indústria no Brasil: inovação e competitividade*, Brasilia, Institute for Applied Economic Research (IPEA).
Yutopoulos, P. and L. Lau (1974), "On modeling the agricultural sector in developing economies", *Journal of Development Economics*, vol. 1, No. 2, Amsterdam, Elsevier.
Zouaghi, F., M. Sánchez-García and S. Hirsch (2017), "What drives firm profitability? A multilevel approach to the Spanish agri-food sector", *Spanish Journal of Agricultural Research*, vol. 15, No. 3, Madrid, Ministry of Agriculture, Fisheries and Food.

Annex A1

Table A1.1
Ecuador: correlation matrix of the determinants of profitability in the crop-growing sector, 2007–2017

	ROA	k	r	HHI	d.IED	PTF	d.Exportación	Antigüedad	IPC Agri	$\Delta PIBpc$
ROA	1									
k	-0.121***	1								
r	-0.200***	0.326***	1							
HHI	0.0259**	-0.0217	-0.229***	1						
d.IED	-0.0146	0.149***	0.211***	0.0342***	1					
PTF	0.0164	0.512***	0.343***	-0.0217	0.182***	1				
d.Exportación	-0.0145	0.260***	0.119***	0.0340***	0.218***	0.346***	1			
Antigüedad	-0.0257**	0.0817***	0.0299*	-0.0124	0.146***	0.186***	0.111***	1		
IPC Agri	-0.0346***	0.0150	0.300***	-0.765***	-0.0447***	0.0223	-0.0561***	0.0216*	1	
$\Delta PIBpc$	-0.0150	0.00349	-0.0691***	0.454***	0.0139	-0.0120	0.0101	-0.0302**	-0.491***	1

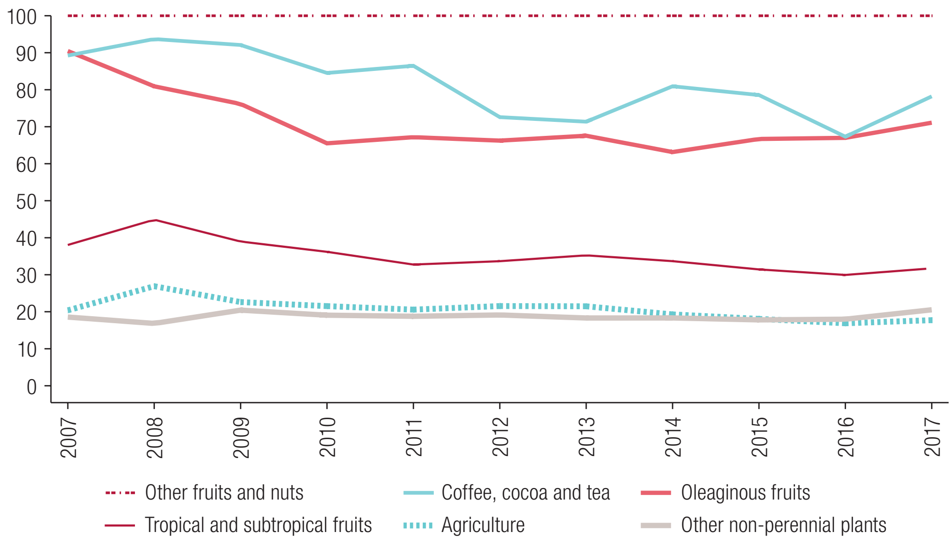
Source: Prepared by the authors, on the basis of Superintendency of Companies, Securities and Insurance.
Note: Table of Pearson correlation coefficients. * $p<0.1$; ** $p<0.05$; *** $p<0.01$. ROA: return on assets; k: capital stock in logarithm; r: real dollar value of firms' land in logarithm; HHI: Herfindahl-Hirschman index; $d.IED$: dummy variable (1 if the firm has foreign direct investment and 0 otherwise); PTF: total factor productivity; $d.\ Exportación$: dummy variable (1 if the firm exports and 0 otherwise); $Antigüedad$: age of the firm; $IPC\ Agri$: consumer price index for goods in the crop-growing sector; $\Delta PIBpc$: GDP per capita growth rate.

Table A1.2
Ecuador: descriptive statistics of variables used to estimate the production function by year, 2007–2017

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Y	13.53	13.43	13.59	13.57	13.62	13.51	13.62	13.67	13.62	13.54	13.63	13.58
	(1.523)	(1.678)	(1.667)	(1.812)	(1.743)	(1.873)	(1.829)	(1.789)	(1.843)	(1.940)	(1.883)	(1.811)
K	12.39	12.18	12.64	12.56	12.61	12.65	12.72	12.79	12.76	12.74	12.81	12.66
	(2.151)	(2.531)	(2.052)	(2.100)	(2.274)	(2.093)	(2.018)	(2.051)	(2.186)	(2.299)	(2.181)	(2.176)
L	3.371	2.988	3.219	3.416	3.505	3.229	3.202	3.191	3.183	3.148	3.313	3.248
	(1.711)	(1.870)	(1.911)	(1.833)	(1.826)	(1.807)	(1.805)	(1.793)	(1.782)	(1.776)	(1.635)	(1.796)
M	12.15	12.10	12.24	12.26	12.13	11.86	11.82	11.85	11.20	11.11	11.80	11.79
	(2.048)	(2.076)	(2.080)	(1.966)	(2.297)	(2.545)	(2.586)	(2.314)	(2.369)	(2.391)	(2.470)	(2.366)
N	250	413	582	634	709	735	759	760	834	872	805	7 353

Source: Prepared by the authors, on the basis of Superintendency of Companies, Securities and Insurance.
Note: Y: sales revenue; K: capital stock; L: number of employees; M: input costs (including raw material consumption).

Figure A1.1
Ecuador: market concentration in the crop-growing sector measured by the CR4 concentration ratio
(Percentages)



Source: Prepared by the authors, on the basis of Superintendency of Companies, Securities and Insurance.

Figure A1.2
Ecuador: main indicators of the agribusiness sector, 2007–2017

A. Return on assets

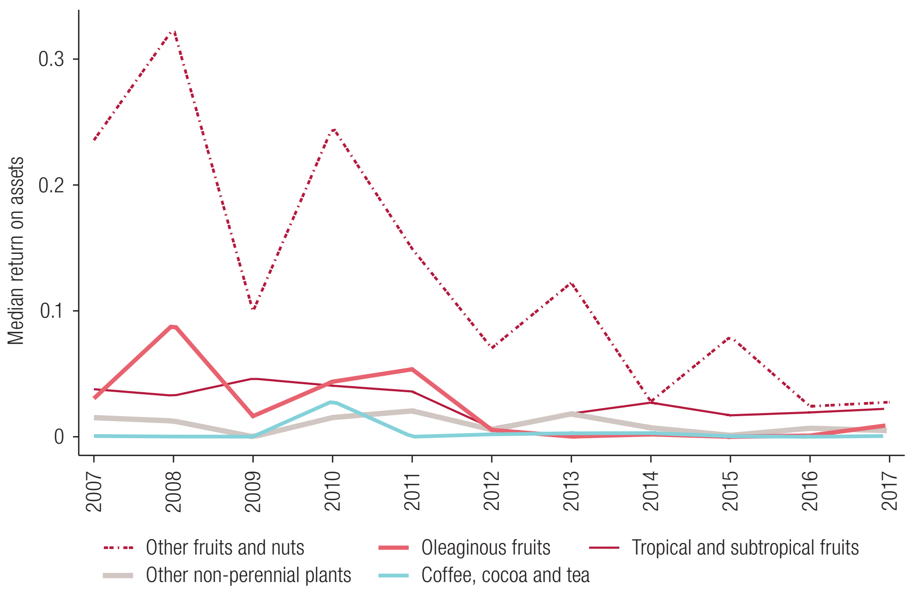
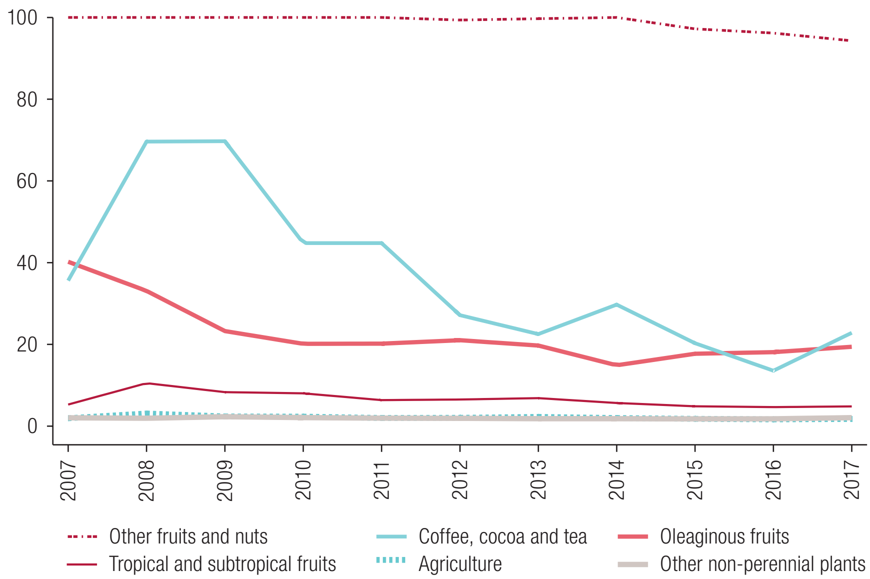


Figure A1.2 (continuation)

B. Herfindahl-Hirschman index

(percentages)



C. Growth of the crop-growing sector

(percentages)

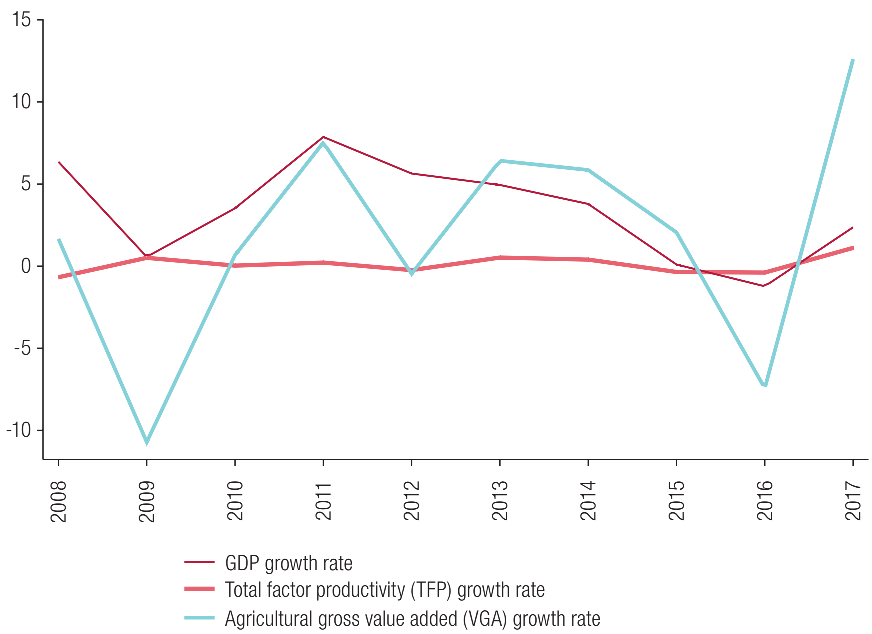
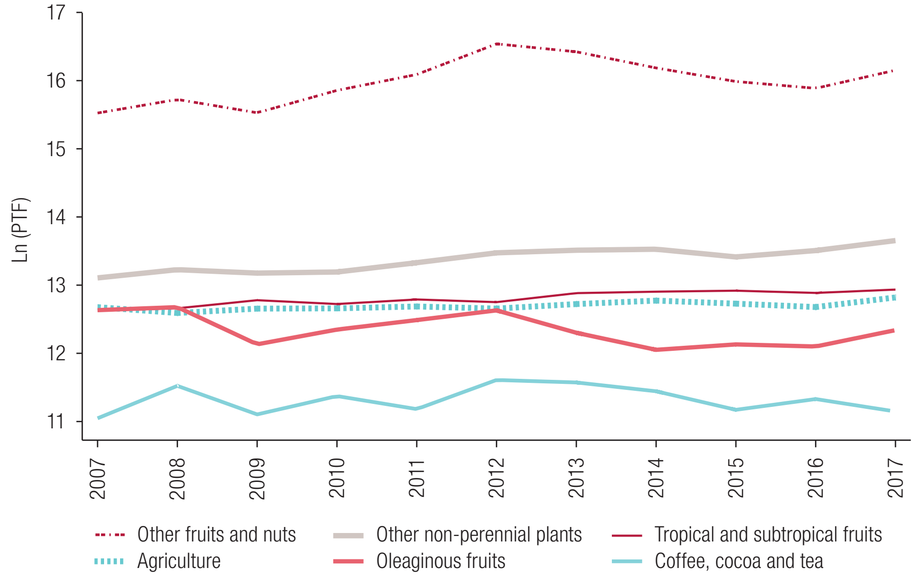


Figure A1.2 (concluded)

D. Total factor productivity (TFP) by subsector



Source: Prepared by the authors.