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Intensive and Extensive Margins of India's Agricultural Trade

Implications for Export Diversification and Development

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ABSTRACT

This paper analyses relative contribution of intensive and extensive margins to growth in India's agricultural exports for the period 2001 to 2020. Two alternative approaches are employed to estimating export margins: the traditional approach of using export volume across product lines, and a robust method proposed by Hummels and Klenow (2005). The paper also examines the determinants of export margins through a standard gravity model. Traditional method of decomposing export growth shown that intensification of the export of existing products to existing destinations dominated export growth. The contribution of export diversification to export growth has remained subdued in the last two decades. Within the extensive margin, contribution of product diversification to export growth was more important than the contribution of geographic diversification. According to the Hummels and Klenow approach, during the 2001 to 2020 period, the extensive margin grew at 1.24 percent per annum, while the intensive margin increased at 0.23 percent. The contribution of growth at the extensive margin increased from 58.8 percent in 2001 to 70.2 percent in 2020. Gravity model results revealed that, among other variables, a positive and significant effect of free trade agreement on export margins. Broadly the study results point out that India's exports along the extensive margin has not been fully exploited and that export diversification holds the key to higher export growth in agricultural products. There is wide scope for expansion of India's agricultural exports through development of new product varieties and new markets.

Keywords: India's agricultural trade, export margins, export decomposition, gravity model

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1. Background

Trade patterns evolve over time and the evolution of trade has implications for economic growth through changes in the structural composition and destination markets of exports. Export growth is associated with greater export diversification. Over time, India's agricultural sector has become integrated with the world market, with a significant increase in volume of trade. This has been achieved through a progressive removal of trade barriers, multilateral and free trade agreements, and domestic policy that encourages farmers to produce for export and provides incentives to exporting firms. It is encouraging to note that India's agricultural exports have increased dramatically, moving from US$6.4 billion in 2001, to US$37.3 billion in 2019, to US$38.8 billion in 2020 (United Nations 2021). Import of agricultural products to India has also increased between 2001 and 2020, moving from US$1.2 billion to US$7.0 billion. These statistics show that the agricultural trade surplus has been in India's favor.

Many studies have analyzed the direction and determinants of India's agricultural trade flows. Studies have examined the competitiveness of agricultural exports, price distortions due to government interventions, trade policy and development, and trade protection (Misra and Rao 2003; Dhar 2007; Panda and Ganesh-Kumar 2009; Rao 2001; Hoda and Gulati 2013; Saini and Gulati 2017). A few studies have analyzed the effects of free trade agreements (including WTO) on India's agricultural trade flows (Veeramani and Saini 2010; Francis 2011; Jagdambe and Kannan 2020).

These studies, importantly, have ignored whether export growth is due to increases in the quantities of existing exports going to established destinations (intensive margin), or to the export of new products to existing markets, or to the extension of exports to new geographical markets (extensive margin). To the best of our knowledge, no empirical studies are available that decompose India's agricultural exports explicitly along these channels.

The recent literature provides empirical evidence from other countries on sources of growth in agricultural exports, distinguishing between the intensive and extensive margins. In an analysis of agro-food exports between 1996 and 2006 for 69 countries, Liapis (2009) found that intensive margin contributed more to growth in agricultural exports than extensive margin implying that firms sell more of existing products to their existing products. They also found that trade frictions have larger impact on trade margins than demand side factors. Currency depreciation found to have positive effect on both intensive and extensive margins of Pakistan's

agricultural exports (Ali 2020). Hejazi, Grant, and Peterson (2017) show that the U.S. tariff reduction increases the probability of maintaining existing trade relationship and that its impact on increasing new exports is larger than export of existing products.

A study by Zhang et al. (2017) estimated that the intensive margin contributed about 75 percent to growth in China's agricultural exports between 2006 and 2013. Among other factors, they found free trade agreements to have positive effects on intensive and extensive margins of agricultural exports. However, Sun and Li (2018) has shown that free trade agreement with ASEAN countries shifted the growth in China's agricultural exports to these countries from extensive margin (more varieties, low price, and small quantity of products) to intensive margin (less varieties, high price, and large quantity of products). Tariff reductions under EU preferential trade agreement (PTA) promote agricultural export diversification in developing countries, while it is found to reduce extensive margin in developed non-PTA countries (Scoppola, Raimondi, Olper 2018).

This study focuses mainly on calculating the intensive and extensive margins of India's agricultural exports and analyzing their determinants through a standard gravity model. The study uses two alternative approaches to estimating export margins: the traditional approach of using export volume across product lines and a robust method proposed by Hummels and Klenow (2005).

2. Data Source

The study uses export data from UN Comtrade, which is accessed through World Integrated Trade Solution (WITS) software. Data for the period 2001 to 2020 was compiled for analysis using the Harmonized System (HS) of industry classification system at the six-digit level. Coverage of products under agricultural trade is defined as per Annex 1 of the WTO Agreement on Agriculture, with the modification that fish and fish products are included in the present study.

Following the traditional method of decomposition, we are interested in observing the product categories that switch from a 0 value to a positive export value within the study period. To avoid noise in the data and to maintain consistency in the analysis, we have followed Evenett and Venables' (2002) method of setting a lower threshold of export value; in our case, any product export valued at less than US$1,000 is treated as no export, which removes

economically insignificant exports and avoids distortion in the analysis. We also excluded small island countries and war-torn countries to which exports occurred only occasionally and only on a few product lines. The data set comprises 162 partner countries and accounts for 97 percent of India's total exports; it includes over 700 product lines at the HS six-digit level. For Hummels and Klenow's decomposition approach, India was considered to have an export relationship with all countries for which it reported some positive export value for every year during the 2001–2020 period. Export by the rest of world to the partner country was measured as the sum of exports reported by all countries but India, in a given year.

3. Methodology

3.1. Decomposition methodology for export margins

Export expansion takes the form of increases in intensive or extensive margins, or the introduction of higher quality products (Feenstra 1994; Hummels and Klenow 2005). We use two different methods to analyze the contribution of intensive and extensive margins to India's agricultural export growth. In the first method, we decompose agricultural export growth following the work of Brenton and Newfarmer (2007) and Amurgo-Pacheco and Pierola (2008). This method counts active export lines and uses the export value of countries for decomposition analysis. The export growth is calculated over two points of time (t), allowing sufficient length of time between the base year (t_0) and the terminal year (t_1) within the sample period.

Consider that country j (India) exports individual products indexed by $i = 1, 2, \ldots I$, to destination countries given by $m = 1, 2, \ldots M$, and to the rest of the world given by r, during time period $t = 1, 2, \ldots T$. Let I_j denote all product categories exported by country j and let M_j refer to all destination countries to which country j exports. Trade patterns evolve through change in product categories (product diversification) and/or change in destination countries (geographical diversification). Considering these two dimensions, additional notations are introduced for better exposition of changes in agricultural exports.

Changes in exports of existing (old) products (v) to old destinations (c) can be expressed as,

$$\sum_{i \in I_{jv}} \sum_{m \in M_{jc}} \Delta X_{jmi} \quad \text{Eq. 1}$$

Extinction of exports of existing products (v–) to old destinations (c) or "death of product lines" is,

$$\sum_{i \in I_{jv-}} \sum_{m \in M_{jc}} X_{jmi} \quad \text{Eq. 2}$$

New exports of a set of existing products (v) to new destinations (n) can be expressed as,

$$\sum_{i \in I_{jv}} \sum_{m \in M_{jn}} X_{jmi} \quad \text{Eq. 3}$$

New exports of a set of new products (w) to old destinations (c) is given by,

$$\sum_{i \in I_{jw}} \sum_{m \in M_{jc}} X_{jmi} \quad \text{Eq. 4}$$

New exports of a set of new products (w) to new destinations (N) can be expressed as,

$$\sum_{i \in I_{jw}} \sum_{m \in M_{jN}} X_{jmi} \quad \text{Eq. 5}$$

Variations in the above quantities are calculated by adding exports across the product categories that provide changes in exports of country j associated with its trading partners over two points of time. The total change in the exports of country j can be expressed as,

$$\Delta X_j = \sum_{i \in I_{jv}} \sum_{m \in M_{jc}} \Delta X_{jmi} - \sum_{i \in I_{jv-}} \sum_{m \in M_{jc}} X_{jmi} + \sum_{i \in I_{jv}} \sum_{m \in M_{jn}} X_{jmi} + \sum_{i \in I_{jw}} \sum_{m \in M_{jc}} X_{jmi} + \sum_{i \in I_{jw}} \sum_{m \in M_{jN}} X_{jmi} \quad \text{Eq. 6}$$

The change in total exports can be calculated by dividing the above expressions by the overall change in exports (ΔX_j) and multiply by 100. The sum of the first two terms on the right-hand side of the equation refers to intensive margin and the sum of the last three terms provides extensive margin. Although this method of decomposition provides useful results, it does not indicate the relative importance of product categories as specified in world trading systems. We use an alternative method of decomposition proposed by Hummels and Klenow (2005), where export product categories are weighted by their share of world trade.

Let q_{jmi} denote quantity of exports and let p_{jmi} be the export price (unit values); the extensive margin (EM) for the country j can then be written as,

$$EM_{jm} = \frac{\sum_{i \in I_{jm}} p_{rmi} q_{rmi}}{\sum_{i \in I} p_{rmi} q_{rmi}}, \quad \text{Eq. 7}$$

where *r* is the reference country (rest of the world). Let I_{jm} denote the positive export of a set of product categories, that is, $X_{jmi} > 0$, meaning that country *j* has a positive export of product *i* to the country *m*. The numerator measures the total exports from country *r* to destination country *m*, with which country *j* has an export relationship, and the denominator represents the total exports of all categories of product from country *r* to destination country *m*. The extensive margin is thus the fraction of country *r*'s product categories in which country *j* exports to destination country *m*. Each category here is weighted by its importance in country *r*'s exports to country *m*. The importance of the product category is assessed without reference to country *j*'s export to country *m*. The value of the extensive margin ranges from 0 to 1.

For exporting country *j*, the intensive margin (IM) can be defined as,

$$IM_{jm} = \frac{\sum_{i \in I_{jm}} p_{jmi} q_{jmi}}{\sum_{i \in I_{jm}} p_{rmi} q_{rmi}} \qquad \text{Eq. 8}$$

The intensive margin measures the ratio of country *j*'s exports to destination country *m* to the rest of the world's exports to that country, in categories of product that country *j* exports to country *m*. The value of the intensive margin also lies between 0 and 1. The extensive margin will be higher if country *j* exports many different products (*i*) to country *m*, and the intensive margin will be higher if country *j* exports large amounts of fewer different products to country *m*. In this way, extensive margin captures the breadth of the country's export portfolio and intensive margin measures its depth (Veeramani, Aerath, Gupta 2018).

It can be seen that the product of the extensive and intensive margin provides a ratio of country *j*'s exports to the rest of world's exports to destination country *m*. This, in fact, shows the overall export share (export penetration rate) of country *j* relative to *r*'s exports to *m.* It is expressed as,

$$S_j = EM_{jm} \times IM_{jm} \qquad \text{Eq. 9}$$

3.2. Econometric analysis of export margins

After performing the export decomposition analysis, we analyze the factors influencing intensive and extensive margins. Given that the calculated margins are censored at 0 value, the ordinary least squares method of estimation gives biased results and the 0 value drops out of the estimation. The literature suggests that the Tobit model be used to deal with the censored data. While considering the censored structure of the data, a Tobit estimation also provides the

flexibility to analyze the factors influencing both the intensive and extensive margin of exports. The latent variable underlies the estimation of the Tobit regression model, which can be expressed as,

$$y^*_{mt} = x'\beta + u_{mt} \quad \text{Eq. 10}$$

$$y_{mt} = \begin{cases} y^*_{mt} \; if \; y^*_{mt} > 0 \\ 0 \; if y^*_{mt} \leq 0' \end{cases} \quad \text{Eq. 11}$$

where y^* is the latent variable, m is the partner country, x is the vector of gravity related explanatory variables, and t is time. (For notational brevity, we dropped the index j for India.)

Silva and Tenreyro (2006), however, contended that the Tobit estimation procedures yield inconsistent estimators of interest due to the presence of heteroscedasticity in the gravity equation. They suggest that this problem can be overcome by applying the Poisson pseudo-maximum-likelihood (PPML) method of estimation. Assuming a constant elasticity model, the gravity relationship between the dependent variable and the explanatory variables can be written in the exponential function as,

$$y_{mt} = \exp(x'\beta) + \varepsilon_{mt}, \quad \text{Eq. 12}$$

where $y_{mt} \geq 0$ and $E(\varepsilon_{mt}|x) = 0$. In the present study, we use both Tobit and PPML methods for estimating the gravity equation. A description of the explanatory variables used is provided in Table A1.

4. Growth in Exports between 2001 and 2020

Before we analyze the contribution of intensive and extensive margins to changes in exports, it is useful to examine the growth of India's exports to its 162 partner countries. Table 1 presents compound annual growth in exports, minimum and maximum growth, and dispersion of growth rates for the period 2001 to 2020, grouping countries under different geographical regions. Of these regions, India's exports to sub-Saharan Africa registered the highest annual growth, at 21.7 percent. The maximum country-level growth rate was also registered within this region (47.1 percent); however, the standard deviation of exports to countries in this region was slightly higher than in other regions.

Table 1. Percentage growth in exports by partner region, 2001 to 2020

Partner region	Annual growth rate (%)	Minimum (%)	Maximum (%)	Standard deviation
East Asia and Pacific	12.92	-1.27	43.85	10.288
Europe and Central Asia	9.74	-5.05	30.76	6.913
Latin America and the Caribbean	14.12	1.54	33.93	8.901
Middle East and North Africa	13.32	3.83	26.48	5.533
North America	11.05	9.75	12.35	1.840
South Asia	12.93	-3.92	22.71	9.884
Sub-Saharan Africa	21.70	0.80	47.12	11.285
Overall	**14.44**	**-5.05**	**47.12**	**9.845**

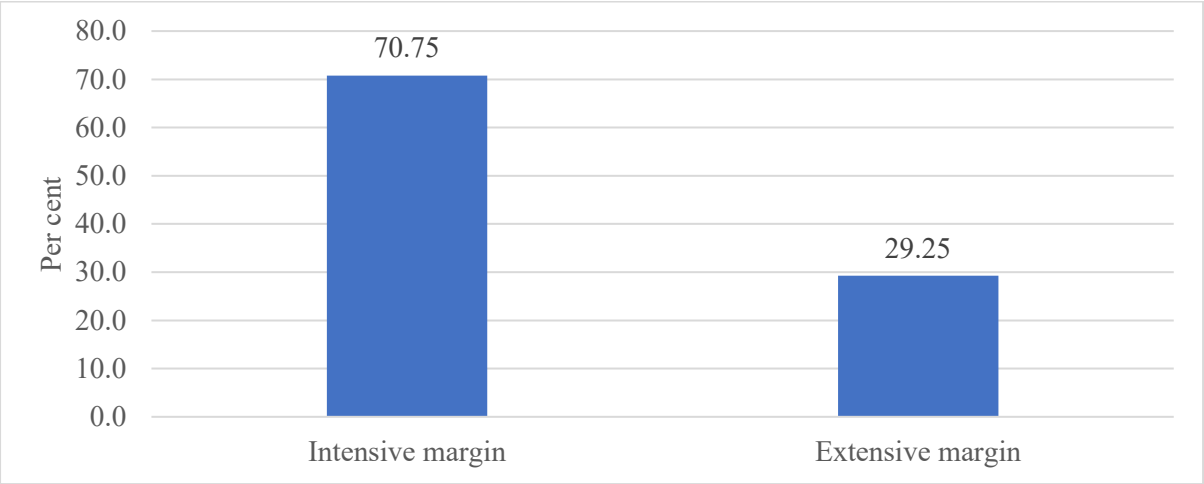
Source: Based on United Nations (2021).

Between 2001 and 2020, India's exports to the East Asia and Pacific region and to South Asia registered almost the same rate of growth, though minimum and maximum growth in exports exhibited some variation. Annual growth in exports to Europe and Central Asia was 9.7 percent during this period, and exports to North America grew by 11.1 percent. Exports to North America showed the lowest level of dispersion, implying stability in India's exports to that region.

5. Decomposition of Export Growth: Traditional Approach

This section provides a decomposition of India's bilateral exports into intensive and extensive margin, following Brenton and Newfarmer (2007) and Amurgo-Pacheco and Pierola (2008). This approach identifies changes in bilateral exports according to whether they are due to growth in intensive margin (intensification of exports of existing products to existing markets), or to growth in extensive margin (export of existing products to new markets, export of new products to existing markets or exports of new products to new markets). Essentially, extensive margin captures patterns of export diversification; these can be further divided into geographical diversification and product diversification.

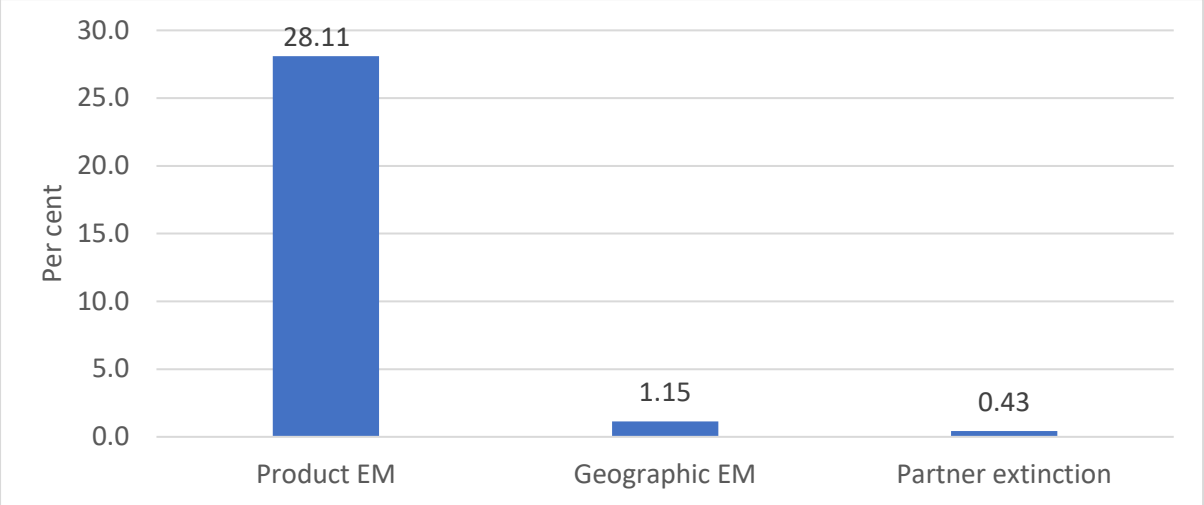
Figure 1. Percentage growth in intensive and extensive margins of India's exports, 2001 to 2020



Source: Based on United Nations (2021).

Figure 1 and 2 show the contribution of growth at intensive and extensive margins to India's exports at the aggregate level between 2001 and 2020. It can be seen that growth along intensive margins contributed 71 percent to total changes in exports, while growth along extensive margins contributed 29 percent. Higher export growth at the intensive margin indicates greater stability of existing trading relationships with partner countries; this is further reflected in lower rates of partner extinction (0.43 percent). Clearly, changes in exports are dominated by the intensification of exports of existing products to existing destinations. The contribution of export diversification to export growth has remained subdued in the last two decades; however, it appears to be an increasingly promising source of export expansion.

Figure 2. Percentage growth in product and geographic margins, and partner extinction of India's exports, 2001 to 2020



Source: Based on United Nations (2021).

At the extensive margin, product diversification is more important than geographical diversification; that is, export of new products to existing markets dominates exports of existing products to new markets. The product extensive margin contributed 28.1 percent to export growth, while the geographical extensive margin accounted for a meager 1.2 percent. This implies that on the export diversification front, India exports different products from the same industry to existing markets,[1] rather than exporting these products to new markets. Expansion through exporting new products to new geographies seems to be limited.

Table 2. India's intensive and extensive margin by destination country, 2001 to 2020

Partner name	Growth rate (%)	Intensive margin (%)	Extensive margin (%)	Geographical EM (%)	Product EM (%)	Partner extinction (%)
Iran, Islamic Rep.	21.05	98.73	1.27	0.42	0.84	0.0
Djibouti	26.48	98.06	1.94	0.02	1.91	0.0
United States	9.75	97.86	2.14	0.64	1.50	0.6
Benin	27.84	97.55	2.45	0.04	2.42	0.1
Saudi Arabia	9.11	97.34	2.66	1.72	0.93	0.0
Bangladesh	9.91	97.14	2.86	0.80	2.06	0.5
UAE	8.86	96.78	3.22	1.27	1.95	0.6
Sri Lanka	7.08	96.74	3.26	1.48	1.78	0.1
Bahrain	9.76	96.43	3.57	1.17	2.40	0.2
Kuwait	8.94	96.37	3.63	2.14	1.49	0.1
Israel	10.90	95.54	4.46	0.42	4.04	0.0
Liberia	38.55	95.16	4.84	0.02	4.82	0.0
Qatar	21.52	94.45	5.55	0.28	5.27	0.1
Egypt, Arab Rep.	8.50	93.39	6.61	1.82	4.79	0.0
Belgium	9.33	92.31	7.69	1.23	6.46	0.2
Cote d'Ivoire	22.39	92.05	7.95	0.05	7.90	0.0
Maldives	11.01	91.88	8.12	0.97	7.16	0.2
Yemen	10.30	91.83	8.17	5.81	2.36	0.0
Malaysia	9.35	91.64	8.36	1.16	7.19	0.6
South Africa	9.16	90.28	9.72	0.83	8.90	0.0
Afghanistan	22.05	89.50	10.50	0.25	10.25	0.0
Oman	11.60	89.45	10.55	1.11	9.44	1.1
Panama	21.62	89.35	10.65	0.40	10.25	0.0
Mauritius	11.37	89.27	10.73	1.26	9.47	0.2
Australia	10.97	88.53	11.47	1.14	10.34	0.7
Poland	5.64	86.63	13.37	4.87	8.51	0.2
Ireland	6.65	86.51	13.49	3.99	9.50	0.0

[1] For example, India's fishery sector exports a wider range of fish products (shrimps and prawns, crabs, etc.) to a destination country where already it was already exporting dried and salted fish.

Partner name	Growth rate (%)	Intensive margin (%)	Extensive margin (%)	Geographical EM (%)	Product EM (%)	Partner extinction (%)
United Kingdom	5.56	86.26	13.74	5.14	8.60	2.0
Honduras	12.64	84.75	15.25	2.88	12.37	0.0
Italy	6.65	84.15	15.85	2.03	13.82	0.2
Kenya	16.74	83.56	16.44	0.50	15.94	0.0
Comoros	22.10	83.46	16.54	0.00	16.54	0.1
Mozambique	19.62	83.38	16.62	0.13	16.49	0.1
Ukraine	10.63	82.95	17.05	3.57	13.48	0.5
New Zealand	14.42	82.60	17.40	2.20	15.20	0.1
Thailand	9.09	80.83	19.17	3.27	15.90	0.4
Kazakhstan	0.33	79.95	20.05	1.92	18.13	0.0
North Macedonia	14.22	79.74	20.26	0.61	19.65	0.0
Netherlands	7.63	79.17	20.83	2.69	18.15	0.1
Germany	6.26	78.79	21.21	9.89	11.32	22.6
Gabon	7.55	78.68	21.32	9.48	11.84	0.0
Eswatini	8.91	78.04	21.96	10.88	11.08	0.0
Morocco	17.83	77.97	22.03	3.17	18.87	0.0
Seychelles	7.17	77.92	22.08	2.91	19.17	1.5
Korea, Rep.	8.46	77.31	22.69	18.47	4.22	0.1
Greece	4.88	77.09	22.91	13.54	9.38	0.2
Jordan	10.08	76.33	23.67	0.99	22.68	0.0
Ethiopia (excludes Eritrea)	25.23	76.02	23.98	0.18	23.81	0.3
Singapore	4.41	75.67	24.33	7.95	16.38	0.2
Trinidad and Tobago	11.20	75.31	24.69	6.32	18.37	4.7
Guinea	43.41	73.75	26.25	1.37	24.87	0.1
Canada	12.35	73.01	26.99	0.46	26.52	0.0
Austria	6.58	71.49	28.51	9.26	19.25	7.6
Croatia	21.38	71.41	28.59	0.28	28.31	0.0
Vietnam	18.20	71.33	28.67	2.02	26.65	0.3
Turkey	15.57	70.72	29.28	2.14	27.15	0.2
Colombia	15.02	70.55	29.45	4.85	24.60	0.0
Albania	14.37	68.45	31.55	3.35	28.20	0.8
Japan	1.22	67.61	32.39	24.26	8.13	3.1
Nepal	21.67	67.18	32.82	0.01	32.81	0.0
Russian Federation	4.61	66.75	33.25	1.42	31.83	0.2
Malta	3.83	66.10	33.90	26.94	6.95	5.2
Bhutan	22.71	64.57	35.43	0.00	35.43	0.0
Tanzania	16.66	61.40	38.60	0.57	38.03	0.1
Zimbabwe	5.56	61.03	38.97	2.29	36.68	0.5
Denmark	7.84	60.67	39.33	10.13	29.20	0.9

Partner name	Growth rate (%)	Intensive margin (%)	Extensive margin (%)	Geographical EM (%)	Product EM (%)	Partner extinction (%)
Ghana	20.78	60.45	39.55	0.09	39.46	0.0
Guyana	18.62	59.83	40.17	0.18	39.98	2.4
Kyrgyz Republic	9.88	58.53	41.47	11.51	29.96	0.0
Ecuador	20.15	58.07	41.93	0.38	41.55	0.0
Philippines	4.81	58.04	41.96	28.48	13.48	1.8
Slovenia	6.02	56.70	43.30	11.59	31.72	0.3
Brazil	12.64	55.96	44.04	4.19	39.85	0.0
Syrian Arab Republic	15.16	55.43	44.57	1.42	43.15	0.0
Uganda	23.27	54.44	45.56	0.50	45.05	0.1
China	17.89	54.28	45.72	0.16	45.56	0.0
Cyprus	3.02	54.27	45.73	9.85	35.88	1.2
Libya	15.00	53.83	46.17	8.94	37.23	0.0
Mexico	4.36	52.56	47.44	5.64	41.80	0.0
Algeria	18.59	50.17	49.83	0.51	49.32	0.0

Source: Based on United Nations (2021).

India's performance along intensive and extensive margin at a disaggregate level by partner country is presented in Table 2. The table provides details of countries whose intensive margin is more than 50 percent, with 80 countries falling into this category. Interestingly, India's exports to these countries registered positive growth between 2001 and 2020. The highest growth in exports was to Guinea in West Africa (43.4 percent) and the lowest growth was in exports to Kazakhstan (0.3 percent). The growth of India's agricultural exports to major economies was largely driven by growth along the intensive margin In major export destinations such as the United States, the United Kingdom, Canada, Australia, United Arab Emirates, South Korea, Sri Lanka, Bangladesh, and Europe, growth at the intensive margin played a significant role in export growth. This implies that India already has well-established long-term trading relationships with these countries in terms of agricultural exports and that there remains little room for geographical diversification.

Among select export destination countries, growth at the extensive margin was higher for Algeria (49.8 percent), Mexico (47.4 percent), Libya (46.2 percent), Cyprus (45.7 percent), and China (45.7 percent). There is considerable heterogeneity in terms of the contribution of the geographical and product extensive margins of exports. A few countries have emerged as new markets for existing products, while some existing markets have received new exports, possibly from the same industry. Growth along the geographical extensive margin was the important driver of India's agricultural exports to a number of countries, including Philippines, Malta,

Japan, South Korea, Greece, Denmark, and Germany. In fact, growth at the geographical extensive margin was the highest for Philippines and the lowest for Bhutan. The product extensive margin, however, accounted for the increase in India's exports to most other countries; of these, the highest margin was registered for Algeria (49.3 percent); this was followed by China (45.6 percent) and Uganda (45.1 percent). Analysis indicates that the product extensive margin dominates the geographical extensive margin as the major driver of export diversification.

Between 2001 and 2020, India lost a few export destination markets for its existing products. The cost of partner extinction was calculated by summing the value of exports lost across products. Among partner countries, India's exports of existing products to Germany experienced by far the sharpest decline, decreasing by 22.6 percent. Significant losses in India's exports of existing products also occurred with Austria, Trinidad and Tobago, Malta, Japan, Guyana, and the United Kingdom. The loss of exports of certain products could be due mainly to product diversification and, to a lesser extent, to geographical diversification.

Table 3. Growth of India's intensive and extensive margins by top 50 countries, 2001 to 2020

Partner name	Growth rate (%)	Intensive margin (%)	Extensive margin (%)	Geographic EM (%)	Product EM (%)	Partner extinction (%)
Togo	47.12	1.33	98.67	0.00	98.67	0.0
Papua New Guinea	43.85	-0.03	100.03	0.08	99.95	0.0
Guinea	43.41	73.75	26.25	1.37	24.87	0.1
Senegal	39.94	4.88	95.12	0.04	95.08	0.0
Liberia	38.55	95.16	4.84	0.02	4.82	0.0
Equatorial Guinea	37.31	26.58	73.42	0.00	73.42	0.0
Burkina Faso	36.73	4.70	95.30	0.00	95.30	0.0
The Gambia	35.87	1.28	98.72	0.34	98.38	0.0
Mauritania	35.49	-0.43	100.43	0.20	100.23	0.0
Suriname	33.93	-0.44	100.44	0.00	100.44	0.0
Belarus	30.76	0.01	99.99	0.41	99.59	0.0
Bolivia	28.86	0.00	100.00	0.91	99.09	0.0
Benin	27.84	97.55	2.45	0.04	2.42	0.1
Cambodia	27.04	0.21	99.79	0.28	99.51	0.0
Costa Rica	26.74	-1.65	101.65	2.77	98.88	1.6
Djibouti	26.48	98.06	1.94	0.02	1.91	0.0
Rwanda	26.30	32.32	67.68	2.62	65.06	0.0
Madagascar	26.02	6.40	93.60	1.15	92.45	0.0
Zambia	25.75	9.46	90.54	1.69	88.85	0.0

Partner name	Growth rate (%)	Intensive margin (%)	Extensive margin (%)	Geographic EM (%)	Product EM (%)	Partner extinction (%)
Haiti	25.73	0.47	99.53	1.91	97.63	0.0
Dominican Republic	25.44	15.15	84.85	0.80	84.05	0.0
Ethiopia (excludes Eritrea)	25.23	76.02	23.98	0.18	23.81	0.3
Uzbekistan	24.25	11.73	88.27	1.67	86.60	1.0
Central African Republic	23.27	0.00	100.00	1.98	98.02	0.0
Uganda	23.27	54.44	45.56	0.50	45.05	0.1
Botswana	23.25	15.91	84.09	0.70	83.39	0.4
Malawi	22.76	43.63	56.37	1.21	55.16	0.5
Bhutan	22.71	64.57	35.43	0.00	35.43	0.0
Namibia	22.60	11.22	88.78	0.00	88.78	0.0
Cote d'Ivoire	22.39	92.05	7.95	0.05	7.90	0.0
Myanmar	22.18	26.24	73.76	1.28	72.48	0.8
Comoros	22.10	83.46	16.54	0.00	16.54	0.1
Afghanistan	22.05	89.50	10.50	0.25	10.25	0.0
Armenia	21.79	32.65	67.35	0.18	67.17	0.0
Luxembourg	21.75	0.00	100.00	4.05	95.95	0.0
Nepal	21.67	67.18	32.82	0.01	32.81	0.0
Panama	21.62	89.35	10.65	0.40	10.25	0.0
Qatar	21.52	94.45	5.55	0.28	5.27	0.1
Croatia	21.38	71.41	28.59	0.28	28.31	0.0
Iran, Islamic Rep.	21.05	98.73	1.27	0.42	0.84	0.0
Niger	20.91	6.86	93.14	0.66	92.48	0.0
El Salvador	20.88	35.00	65.00	0.32	64.68	0.0
Cameroon	20.84	4.28	95.72	2.83	92.89	0.0
Ghana	20.78	60.45	39.55	0.09	39.46	0.0
Ecuador	20.15	58.07	41.93	0.38	41.55	0.0
Peru	20.13	5.65	94.35	3.80	90.54	0.0
Burundi	19.75	-5.79	105.79	1.36	104.43	5.8
Guinea-Bissau	19.64	1.47	98.53	1.41	97.12	0.0
Mozambique	19.62	83.38	16.62	0.13	16.49	0.1
Hong Kong, China	19.15	1.13	98.87	0.12	98.75	0.1

Source: Based on United Nations (2021).

We have also analyzed the margins for the top 50 countries in terms of the growth of India's exports to these countries (Table 3). There is considerable variation in the contribution of growth at intensive and extensive margins to export growth. Between 2001 and 2020, in 24 out of 50 countries, growth at the intensive margin (more than 20 percent) was the largest

contributor to India's export growth; for the remaining countries, growth at the extensive margin was the most important source of India's export flows. Within the extensive margin, the contribution of product diversification to export growth was higher than geographical diversification; the latter was somewhat prominent for countries such as Luxembourg, Peru, Cameroon, Costa Rica, and Rwanda. Overall, for these high export growth destination markets, diversification of exports played a more significant role than did intensification of exports of existing products.

To check whether the results discussed above are peculiar to a particular time period, we conducted a decomposition analysis by shifting the time period within the overall sample period. The decomposition analysis was carried out between 2002 and 2019. The contribution of growth along the intensive and extensive margins to India's export growth at the aggregate level is provided in Figure A1. The results from this analysis confirm that the contribution of intensive margin to changes in agricultural exports is more than that of extensive margin; in fact, intensification of exports of existing products to partner countries seems to have strengthened during the period of analysis. Similarly, exports at the product extensive margin dominate the geographical extensive margin. Disaggregate analysis by partner countries also confirms that growth along the intensive margin contributes more to India's agricultural export growth than does extensive margin (Table A2). Interestingly, although shifts in India's export flows have caused changes in the relative positions of partner countries, more or less the same set of countries shows growth at the intensive margin to have contributed more than 50 percent to export growth. These results broadly confirm that India's agricultural export growth has occurred at the intensive, rather than the extensive, margin.

Table 4 shows the regional destinations of India's export flows. A regional analysis yields some interesting facts about the sources of India's export growth. For North America, growth at the intensive margin accounted for 97.2 percent of India's total export growth, and for South Asia it accounted for 85.8 percent. India's long-term trading relations with countries in these regions enabled the intensification of existing product exports. Growth along the intensive margin has also been a major driver of India's exports to the Middle East and North Africa region and to Sub-Saharan Africa.

Table 4. Percentage growth at intensive and extensive margins, by trading partner region

Partner region	Intensive margin (%)	Extensive margin (%)	Geographic EM (%)	Product EM (%)
East Asia and Pacific	45.41	54.59	2.14	52.45
Europe and Central Asia	46.41	53.59	8.24	45.35
Latin America and the Caribbean	40.29	59.71	13.30	46.41
Middle East and North Africa	58.88	41.12	1.28	39.84
North America	97.22	2.78	0.63	2.15
South Asia	85.81	14.19	0.97	13.22
Sub-Saharan Africa	55.88	44.12	1.12	43.00

Source: Based on United Nations (2021).

For Latin America and the Caribbean, East Asia and the Pacific, and Europe and Central Asia, extensive margin was the important contributor to India's increased exports; growth at the extensive margin in these regions accounted for 59.7, 54.6, and 53.6 percent, respectively, of growth in exports. Exports to Sub-Saharan Africa increased by 44.1 percent at the extensive margin, most of which was driven by product diversification. Product diversification has been an important component of export growth in East Asia and the Pacific, Latin America and the Caribbean, and Europe and Central Asia.

Table 5. Percentage growth at intensive and extensive margins, by partner income group

Partner income group	Intensive margin (%)	Extensive margin (%)	Geographic EM (%)	Product EM (%)
High income	70.83	29.17	1.03	28.14
Low income	54.81	45.19	3.03	42.16
Lower middle income	69.54	30.46	2.58	27.88
Upper middle income	59.44	40.56	0.34	40.22

Source: Based on United Nations (2021).

Table 5 shows the drivers of India's export growth by trading partner income group. Intensive margin was the major driver of India's exports to high and lower middle income countries, accounting for 70.8 and 69.5 percent of growth, respectively. Exports to low and upper middle income countries occurred largely along the extensive margin. For countries in that category, the share of extensive margin accounted for 45.2 and 40.6 percent, respectively. Within the extensive margin, product diversification contributed more to export growth than did geographical diversification. Interestingly, India's exports to low income countries and upper middle income countries have largely occurred at the product extensive margin, a phenomenon which may be attributable to the demand in these countries for diverse products at low prices.

Table 6. Percentage growth at intensive and extensive margins, by product type

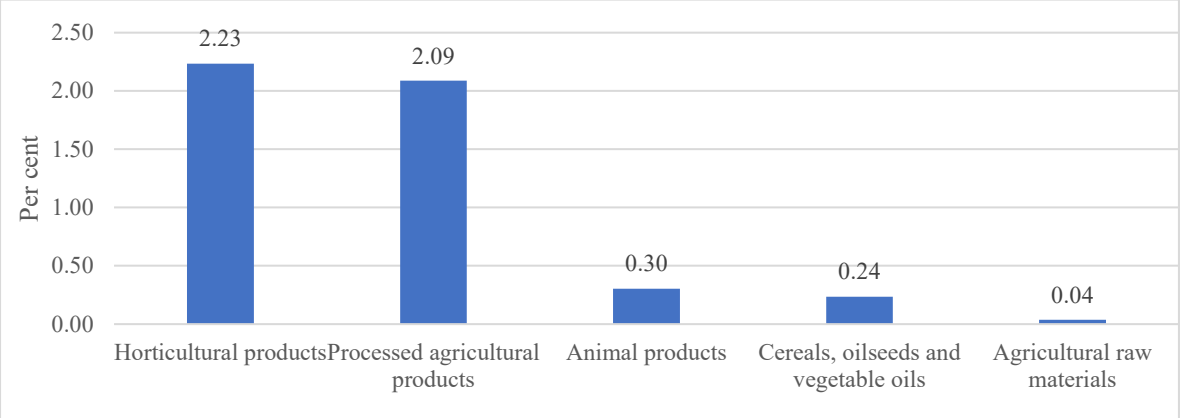
Product type	Intensive margin (%)	Extensive margin (%)	Geographic EM (%)	Product EM (%)
Animal products	70.88	29.12	1.01	28.11
Horticultural products	88.23	11.77	3.54	8.23
Cereals, oilseeds, and vegetable oils	58.61	41.39	1.73	39.66
Processed agricultural products	89.04	10.96	2.23	8.74
Agricultural raw materials	60.17	39.83	0.04	39.79

Source: Based on United Nations (2021).

Table 6 shows growth along intensive and extensive margins by type of product. We have grouped the products into different categories at the HS six-digit level, based on the nature of the products and the production processes. India's export growth across all product types was largely driven by intensifying the export of existing products. Between 2001 and 2020, growth along the intensive margin ranged from 60.2 percent on agricultural raw materials to 89.0 percent on processed agricultural products. Export of horticultural products grew mostly at the intensive margin, which accounted for 88.2 percent of growth. The contribution of growth at the extensive margin was as high as 41.4 percent on the export of cereals, oilseeds, and vegetable oils. Within this extensive margin, product diversification accounted for a substantial share (39.7 percent) of the growth of exports of cereals, oilseeds, and vegetable oils. Product extensive margin was also the major driver of exports of agricultural raw materials and animal products. On the whole, growth along both the intensive and extensive margins contributed to growth in exports at the product category level, though intensive margin accounted for the larger share.

Exports of products may decline and then become extinct (Figure 2). Reasons for this may include a decline or disappearance of global demand for a product, increased competition in the marketplace, quality concerns, or pest infestation. Between 2001 and 2020, the product extinction or product death margin was relatively high among horticultural products (2.2 percent) and processed agricultural products (2.1 percent); in fact, export of India's horticultural products and processed agricultural products often faced stringent export restrictions and, as a consequence, rejection of export lots, which may have resulted in product extinction over time.

Figure 3. Product extinction/death margin, product type



Source: Based on United Nations (2021).

At the aggregate level overall, a traditional analysis of the decomposition of India's exports shows that growth along the intensive margin was the major contributor to the expansion of exports, though growth at the extensive margin also showed promise. At the disaggregated partner country and regional level, however, the source of export growth varied. Increased export flows occurred at the intensive margin for most partner countries, while for some countries growth along the extensive margin—particularly product diversification—contributed significantly to export growth. While it is important to concentrate on intensifying exports of existing products, export diversification will stimulate exporting firms to produce new products or expand to new markets.

5.1. Factors Influencing Export Margins (Cross-sectional analysis)

This section analyzes the factors influencing the intensive and extensive margins, which we calculate using the traditional method. The cross-sectional analysis provides insights into the direction of the effects of gravity variables on the intensive margin, which was the major driver of change in agricultural exports. Given the censored data of the intensive margin, a Tobit censored estimation and the PPML method are used. Tobit results show that the closer the destination markets (low trade costs), the greater the intensification of exports to those markets (Table 7). The coefficient of partner GDP was positive and statistically significant; this implies that the larger the partner country, the more likely that high volumes of existing products will be exported to that destination. Having an official language in common had a statistically significant positive effect on growth at the intensive margin; for various geopolitical reasons, however, the effect of sharing a border was negative.

Results from the PPML estimation were very similar to the Tobit results, indicating heteroscedasticity was not a problem. The magnitude of the coefficients obtained through the PPML technique, however, was slightly higher than that of the Tobit results. As per the PPML results, a significantly larger increase in exports was correlated with reduced trade costs, larger partner countries, and a common official language. The goodness of fit of both the models was statistically significant.

Table 7. Factors affecting growth at the intensive margin of agricultural exports

Explanatory variables	Tobit results	PPML results
Ln distance	-0.1916*** (0.0523)	-0.3762*** (0.0996)
Ln GDP	0.0684*** (0.0204)	0.1376*** (0.0394)
Ln population	0.0052 (0.0260)	-0.0127 (0.0487)
Contiguity	-0.2700* (0.1606)	-0.5181* (0.2758)
Common official language	0.1346** (0.0656)	0.2395** (0.1243)
Free trade agreement	0.0742 (0.0700)	0.1145 (0.1218)
Constant	1.2332** (0.5549)	1.0778 (1.0196)
Number of observations	162	162
Log pseudolikelihood	-72.5492	-119.0320
F (6, 156)/ Wald chi2(6)	7.75	35.79
Prob > F/Prob > chi2	0.0000	0.0000
Pseudo R2	0.2171	0.0364

Source: Authors' estimates.
Note: Figures in parentheses are heteroscedasticity-corrected standard errors; PPML = Poisson pseudo-maximum-likelihood.

6. Decomposition of Export Growth: The Hummels and Klenow Approach

A limitation of the traditional approach of decomposition is that it provides equal weight to the product categories and that they are treated as the same type. For example, the active product categories are considered same whether a country diversifies its exports by start exporting shrimps and prawn or cotton waste, silk waste or waste of wool. But in terms of export earnings,

starting to export shrimps and prawn to the world market is worthier than exporting cotton waste as the former has potential for export expansion. With Hummels and Klenow's (2005) approach, however, new product lines are weighted by their share of world trade; this approach is considered to be more efficient than the traditional approach (WTO-UNCTAD 2012). The agricultural export decomposition results at the aggregate level, following the Hummels and Klenow approach, are provided in Table 8. These decomposition results are slightly different from those obtained through the traditional approach. This is because Hummels and Klenow approach considers only a set of observable product categories in which India has positive exports to its partner country. Between 2001 and 2020, the extensive margin[2] grew at 1.24 percent per annum, while the intensive margin increased by 0.23 percent per annum; thus, growth along the intensive margin has remained almost constant during the study period. Export share or export penetration rate is calculated as the product of the growth rate at the intensive and extensive margins. Growth along the extensive margin is the major contributor to the increase in India's agricultural exports.

[2] At the extensive margin, importance of a product category is assessed without reference to India's exports to partner countries in that category. This is to prevent a category from appearing important primarily because the country exports a large number of products to partner countries in a set of observable product categories (Hummels and Klenow 2005). A large extensive margin shows that the country exports a small amount of product in a set of observable categories in which rest of world (r) exports a lot to the partner countries. Both the intensive and extensive margins show the extent of competition that a country faces from the rest of the world.

Table 8. Trends in India's growth along intensive and extensive margins

Year	Intensive margin (%)	Extensive margin (%)	Growth in export penetration rate (%)
2001	0.0012	0.5877	0.0007
2002	0.0011	0.6298	0.0007
2003	0.0009	0.5889	0.0005
2004	0.0009	0.5810	0.0005
2005	0.0009	0.5658	0.0005
2006	0.0009	0.5735	0.0005
2007	0.0010	0.5887	0.0006
2008	0.0010	0.6225	0.0006
2009	0.0009	0.6222	0.0005
2010	0.0010	0.6257	0.0006
2011	0.0011	0.6447	0.0007
2012	0.0012	0.8436	0.0010
2013	0.0014	0.6337	0.0009
2014	0.0012	0.6475	0.0008
2015	0.0010	0.6376	0.0007
2016	0.0012	0.7270	0.0009
2017	0.0011	0.7320	0.0008
2018	0.0008	0.6773	0.0005
2019	0.0009	0.7312	0.0007
2020	0.0010	0.7024	0.0007
Growth rate	0.23	1.24	1.48

Source: Based on United Nations (2021).

In 2001, the contribution of growth at the extensive margin to India's overall export growth was 58.8 percent; that is, the fraction of exports of partner–product pairs in which India had export relations accounted for 58.8 percent. This implies that India's agricultural exports faced direct competition from the rest of the world. The contribution of growth at the extensive margin to overall export growth has increased gradually, moving from 62.6 percent in 2010 to 70.2 percent in 2020. These results imply that India has not fully exploited the potential for export growth along the extensive margin and that export diversification holds the key to higher export growth in agricultural products. Toward this end, India can expand its agricultural exports to new markets and develop new product ranges.

Table 9. India's exports growth at intensive and extensive margins, by top 20 countries

	Intensive margin (%)		Extensive margin (%)		Export penetration rate (%)	
Partner country	2001–2003	2018–2020	2001–2003	2018–2020	2001–2003	2018–2020
United States	0.0052	0.0066	0.9976	1.0000	0.0052	0.0066
China	0.0014	0.0054	0.6271	0.9094	0.0009	0.0049
Vietnam	0.0011	0.0047	0.4548	0.7918	0.0005	0.0037
Bangladesh	0.0039	0.0041	0.6158	0.7346	0.0024	0.0030
Iran, Islamic Rep.	0.0004	0.0053	0.4204	0.5122	0.0002	0.0027
United Arab Emirates	0.0022	0.0026	1.0000	1.0000	0.0022	0.0026
Saudi Arabia	0.0023	0.0027	0.7599	0.9346	0.0018	0.0025
Malaysia	0.0017	0.0014	0.8559	1.0000	0.0015	0.0014
Indonesia	0.0027	0.0023	0.5205	0.6109	0.0014	0.0014
Nepal	0.0003	0.0015	0.7537	0.9174	0.0002	0.0014
Netherlands	0.0014	0.0014	0.7653	0.9657	0.0010	0.0014
Japan	0.0032	0.0014	0.8444	0.9032	0.0027	0.0012
Iraq	0.0030	0.0020	0.1158	0.5564	0.0003	0.0011
United Kingdom	0.0017	0.0010	0.9673	1.0000	0.0016	0.0010
Thailand	0.0009	0.0012	0.5877	0.8259	0.0005	0.0010
Russian Federation	0.0025	0.0013	0.4256	0.6800	0.0011	0.0009
Belgium	0.0011	0.0013	0.5791	0.7120	0.0007	0.0009
Germany	0.0011	0.0009	0.8824	1.0000	0.0010	0.0009
Hong Kong, China	0.0004	0.0009	0.7120	0.9997	0.0003	0.0009
Canada	0.0005	0.0008	0.8174	1.0000	0.0004	0.0008

Source: Based on United Nations (2021).

Table 9 lists the sources of India's agricultural export growth by the top 20 export destinations. Between 2018 and 2020, India's export penetration rate was highest for the United States (0.66 percent); this was followed by China (0.49 percent) and Vietnam (0.37 percent). During this period, agricultural exports to Bangladesh, Iran, and the United Arab Emirates grew by 0.30, 0.27, and 0.26 percent, respectively. Between the periods 2001–2003 and 2018–2020, for countries such as the United States, China, Vietnam and Iran, India's agricultural exports grew significantly at the intensive margin; for all the sample countries, however, the contribution of growth along the extensive margin is much higher than that along the intensive margin.

For 12 out of 20 countries, during 2018–2020, the value of growth at the extensive margin was more than 90 percent, a significant increase from 2001–2003.[3] This implies that there is scope for robust expansion of India's agricultural exports through developing new product varieties; it further suggests that there is ample incentive for exporting firms to invest in product innovation and technological upgradation. Growth along the extensive margin was relatively low for Iran, Iraq, Indonesia, and the Russian Federation; this implies that India's agricultural products faced less competition in these countries than in other countries.

Table 10. India's exports growth at intensive and extensive margins, by partner region

Particulars	East Asia and Pacific (%)	Europe and Central Asia (%)	Latin America and the Caribbean (%)	Middle East and North Africa (%)	North America (%)	South Asia (%)	Sub-Saharan Africa (%)
Intensive margin							
2001–2003	0.0012	0.0008	0.0002	0.0010	0.0035	0.0012	0.0003
2008–2010	0.0014	0.0006	0.0001	0.0013	0.0022	0.0012	0.0001
2018–2020	0.0013	0.0005	0.0001	0.0013	0.0042	0.0013	0.0002
Extensive margin							
2001–2003	0.6627	0.5741	0.1386	0.6588	0.9550	0.6712	0.3461
2008–2010	0.7321	0.5789	0.1731	0.6741	0.9401	0.7513	0.4533
2018–2020	0.8344	0.6593	0.3185	0.7900	1.0000	0.8058	0.5687
Export penetration rate							
2001–2003	0.0008	0.0005	0.0000	0.0006	0.0033	0.0008	0.0001
2008–2010	0.0010	0.0004	0.0000	0.0009	0.0020	0.0009	0.0001
2018–2020	0.0011	0.0003	0.0000	0.0010	0.0051	0.0010	0.0001

Source: Based on United Nations (2021).

Growth of agricultural exports along the intensive and extensive margins at the regional level is provided in Table 10. During the 2001–2003 period, India's agricultural export penetration rate or export share was relatively high for North America, at 0.33 percent; this increased to 0.42 percent during the 2018–2020 period. Most of this increase in exports occurred at the extensive margin, implying that India's exports faced very high competition from the rest of the world. A similar situation was seen with other regions; there, however, the degree of competition was considerably less than in the North American markets. A significant proportion of the growth of India's agricultural exports to Latin America and the Caribbean occurred at the extensive margin; this increased from 13.9 percent during 2001–2003 to 31.8

[3] The study period (2001 to 2020) was divided into three sub-periods viz. 2001–2003, 2008–2010 and 2018–10 for analytical reasons; taking average of three-year value evens out inter-year fluctuations and the sub-period 2008–2010 reflects effect of global financial crisis of 2007-08 on export margins.

percent during 2018–2020. Growth at the extensive margin has slightly increased for Europe and Central Asia.

Table 11. Growth at the intensive and extensive margins, by partner income group

	High income countries (%)	Low income countries (%)	Lower middle income countries (%)	Upper middle income countries (%)
Particulars				
Intensive margin				
2001–2003	0.0012	0.0003	0.0012	0.0008
2008–2010	0.0010	0.0003	0.0013	0.0009
2018–2020	0.0010	0.0005	0.0009	0.0009
Extensive margin				
2001–2003	0.7106	0.3925	0.3770	0.5226
2008–2010	0.7305	0.4853	0.4616	0.5543
2018–2020	0.8510	0.5425	0.5825	0.6163
Export penetration rate				
2001–2003	0.0009	0.0001	0.0005	0.0004
2008–2010	0.0007	0.0001	0.0006	0.0005
2018–2020	0.0009	0.0003	0.0006	0.0005

Source: Based on United Nations (2021).

The growth of India's agricultural exports along the intensive and extensive margins, by partner income group, is shown in Table 11. There is robust competition for sustaining export share in high income countries due to various restrictions, including quality concerns; however, India's agricultural export penetration rate was relatively high for high income countries. This strong performance was attributable mainly to growth at the extensive margin and, to a lesser extent, to growth at the intensive margin. Growth along the extensive margin has increased across all income groups over time, though the rate of increase has been relatively low for upper middle income countries. These results confirm that there is great scope for the expansion of India's agricultural exports to new markets and for export expansion through the development of a new range of products. The higher value of growth along the intensive margin in India's trade with lower middle-income countries suggests that its trading relationship with these countries is a long-term and stable one.

Table 12. Growth at the intensive and extensive margins, by product type

Period	Animal products (%)	Horticultural products (%)	Cereals, oilseeds, and vegetable oils (%)	Processed agricultural products (%)	Agricultural raw materials (%)
Intensive margin					
2001–2003	0.0011	0.0010	0.0010	0.0010	0.0012
2008–2010	0.0012	0.0009	0.0009	0.0009	0.0012
2018–2020	0.0012	0.0009	0.0009	0.0009	0.0011
Extensive margin					
2001–2003	0.6391	0.5866	0.5899	0.5980	0.6500
2008–2010	0.6737	0.6161	0.6018	0.6139	0.6673
2018–2020	0.7799	0.6948	0.6823	0.7013	0.6959
Export penetration rate					
2001–2003	0.0007	0.0006	0.0006	0.0006	0.0008
2008–2010	0.0008	0.0005	0.0005	0.0005	0.0008
2018–2020	0.0009	0.0006	0.0006	0.0006	0.0008

Source: Based on United Nations (2021).

It is useful to analyze the drivers of agricultural exports by type of product. Growth in exports at the intensive margin was relatively high for animal products and agricultural raw materials; growth at the extensive margin, however, also turned out to be an important contributor to export growth across product groups (Table 12). The rate of growth along the extensive margin has increased for all the product groups over time, although it is low for agricultural raw materials. For animal products, the contribution of growth at the extensive margin to overall export growth has increased from 63.9 percent during the 2001–2003 period to 78.0 percent during 2018–2020 period, implying that India's exports of these products face competition from the rest of the world. Exports of horticultural products and of processed agricultural products also face competition in the world market; this is evident from the value of their growth at the extensive margin, which increased from 58.7 to 69.5 percent and from 59.8 to 70.1 percent, respectively, between the 2001–2003 and 2018–2020.

Table 13. Growth at intensive margin by partner region and product type

Particulars	Animal products (%)	Horticultural products (%)	Cereals, oilseeds and vegetable oils (%)	Processed agricultural products (%)	Agricultural raw materials (%)
2001–2003					
East Asia and Pacific	0.0013	0.0011	0.0012	0.0012	0.0015
Europe and Central Asia	0.0008	0.0008	0.0008	0.0009	0.0009
Latin America and the Caribbean	0.0001	0.0002	0.0002	0.0001	0.0000
Middle East and North Africa	0.0010	0.0009	0.0010	0.0010	0.0011
North America	0.0037	0.0033	0.0035	0.0034	0.0035
South Asia	0.0012	0.0012	0.0011	0.0012	0.0012
Sub-Saharan Africa	0.0003	0.0003	0.0003	0.0003	0.0003
2018–2020					
East Asia and Pacific	0.0018	0.0012	0.0012	0.0012	0.0019
Europe and Central Asia	0.0006	0.0005	0.0005	0.0005	0.0006
Latin America and the Caribbean	0.0001	0.0001	0.0001	0.0001	0.0001
Middle East and North Africa	0.0013	0.0012	0.0012	0.0012	0.0014
North America	0.0047	0.0040	0.0042	0.0042	0.0045
South Asia	0.0014	0.0012	0.0013	0.0012	0.0017
Sub-Saharan Africa	0.0002	0.0002	0.0002	0.0002	0.0002

Source: Based on United Nations (2021).

Decomposition results for product type across regions provide very useful insights into the regions where India's export specialization has taken place and the regions where new products are exported (Table 13). For animal products, between 2001–2003 and 2018–2020, the intensive margin increased in East Asia and the Pacific, the Middle East and North Africa, North America, and South Asia. For horticultural products, India's exports to its partner countries, relative to the rest of the world's exports to those countries, have increased in the Middle East and North Africa and in North America. In the case of cereals, oilseeds, and vegetable oils, the intensive margin has increased for the Middle East and North Africa, North America, and South Asia. For processed agricultural products, the intensive margin has increased in the countries of the Middle East and North Africa and in North America; similarly, for agricultural raw materials, the Middle East and North Africa, North America, and South Asia are the important destination markets. The analysis shows that the intensity of exports of India's agricultural products is concentrated in the countries of the Middle East and in North America.

Growth at the extensive margin by partner region and product type are provided in Table 14. For all the product types, the extensive margin increased across the regions between 2001–2003 and 2018–2020. Among the regions, the value of growth along the extensive margin was equal to 1.0 in North America during 2018–2020. This shows that there is robust competition for India's agricultural exports across the countries of this region. Growth at the extensive margin in 2018–2020 was also higher for all the product types in East Asia and the Pacific. The rate of increase at the extensive margin was higher for the countries of Latin America and the Caribbean than it was for other regions. The increased growth at the extensive margin was relatively high for animal products and horticultural products in this region; this means that there is great scope there for India's agricultural exports to compete with exports from the rest of the world. Except for in Latin America and the Caribbean and in Sub-Saharan Africa, growth along the extensive margin was relatively low for cereals, oilseeds, and vegetable oils; however, India has achieved a strong position in terms of rice exports to partner countries, outcompeting the rest of the world.

Table 14. Growth at the extensive margin, by partner region and product type

Particulars	Animal products (%)	Horticultural products (%)	Cereals, oilseeds and vegetable oils (%)	Processed agricultural products (%)	Agricultural raw materials (%)
2001–2003					
East Asia and Pacific	0.6788	0.6572	0.6589	0.6551	0.6545
Europe and Central Asia	0.6051	0.5493	0.5638	0.5867	0.6541
Latin America and the Caribbean	0.1385	0.1331	0.1371	0.1526	0.1295
Middle East and North Africa	0.6823	0.6434	0.6437	0.6737	0.6772
North America	0.9634	0.9467	0.9569	0.9543	0.9577
South Asia	0.7009	0.6571	0.6637	0.6690	0.7367
Sub-Saharan Africa	0.3703	0.3593	0.3609	0.3118	0.3825
2018–2020					
East Asia and Pacific	0.8603	0.8376	0.8214	0.8302	0.8338
Europe and Central Asia	0.7527	0.6384	0.6327	0.6682	0.7044
Latin America and the Caribbean	0.3306	0.3161	0.3087	0.3317	0.2591
Middle East and North Africa	0.8401	0.7889	0.7576	0.7970	0.7519
North America	1.0000	1.0000	1.0000	1.0000	1.0000
South Asia	0.8134	0.8087	0.7983	0.8089	0.7668
Sub-Saharan Africa	0.5864	0.5690	0.5711	0.5619	0.5827

Source: Based on United Nations (2021).

7. Factors Influencing Export Margins (Panel Data analysis)

This section explains the factors influencing growth at the intensive and extensive margins of India's agricultural exports, calculated based on Hummels and Klenow's approach. We first discuss the panel data Tobit models with random effects and then PPML results. Tobit results show that coefficients of the independent variables appear with the expected signs for both the intensive margin and extensive margin models (Table 15). The estimated models are statistically significant. For growth along the intensive margin, the magnitude of the coefficient of the independent variables is relatively small; nevertheless, Tobit regression results provide very useful insights into factors influencing the sources of growth in agricultural exports. Proximity to partner countries encourages intensity of exports and the GDP of the partner country (indicating the size of the economy) has a positive effect on the intensification of agricultural exports. The effect of a partner country's population is positive and statistically significant; this implies that there is a high absorption capacity for India's exports as compared to exports from the rest of the world. The coefficient of India's shared border with partner countries was positive and statistically significant for growth at the intensive margin.

Table 15. Panel Tobit regression results for export margins

Explanatory variables	Intensive margin	Extensive margin
Ln distance	-0.00020** (0.0001)	-0.1541*** (0.0294)
Ln GDP	0.00007*** (0.0000)	0.0223*** (0.0036)
Ln population	0.00014*** (0.0000)	0.0265*** (0.0087)
Common official language	0.00019 (0.0001)	0.1695*** (0.0392)
Contiguity	0.00079** (0.0004)	-0.1359 (0.1063)
Free trade agreement	0.00023 (0.0002)	0.1105** (0.0498)
Constant	-0.0009 (0.0011)	0.9821*** (0.2924)
Number of observations	3224	3224
Log likelihood	16153.568	2401.5484
Wald chi2(6)	64.56	109.31
Prob > chi2	0.0000	0.0000

Source: Authors' estimates.
Note: Figures in parenthesis are standard errors; *, **, and *** indicate statistical significance at the $p < 0.1$, $p < 0.05$, and $p < 0.01$ levels.

In the extensive margin model, the partner country's GDP and population have a significantly positive effect on the promotion of agricultural exports through developing new products and, as expected, distance is negatively associated with export diversification. The effect of a common official language on extensive margin was positive and statistically significant; this means that countries that share an official language with India tend to be more open to importing India's diverse agricultural products. Unlike in the intensive margin model, the effect of a free trade agreement (FTA) on extensive margin was positive and statistically significant, implying that an FTA enables exports to new markets and the development of new products for export.

Table 16. PPML results for export margins

Explanatory variables	Intensive margin	Extensive margin
Ln GDP	0.1937*** (0.0501)	0.2437*** (0.0065)
Ln population	0.2669*** (0.1013)	-0.0423*** (0.0094)
Ln distance	-0.5621*** (0.1884)	-0.4827*** (0.0206)
Common official language	0.0929 (0.2141)	0.4658*** (0.0230)
Contiguity	-0.2196 (0.3683)	-0.4014*** (0.0688)
Free trade agreement	0.2400** (0.1230)	0.2149*** (0.0280)
Constant	-9.4652*** (0.8160)	0.9596*** (0.2163)
Number of observations	3,224	3,224
Log pseudolikelihood	-12.7493	-1926.67
Wald chi2(6)	557.79	3229.73
Prob > chi2	0.000	0.0000
Pseudo R2	0.0532	0.0879

Source: Authors' estimates.
Note: Figures in parenthesis are robust standard errors; *, **, and *** indicate statistical significance at the $p < 0.1$, $p < 0.05$, and $p < 0.01$ levels; PPML = Poisson pseudo-maximum-likelihood.

Results from the PPML estimation are provided in Table 16. These results provide a sort of robustness check for the Tobit estimation. The PPML results for intensive and extensive margins are highly consistent with Tobit models; only the coefficient of the contiguity variable was negative and statistically significant. India shares borders with several countries; however, for geopolitical reasons, relations with these countries are not conducive to intensifying exports nor to expanding the diversity of products. The magnitude of coefficients of the independent variables are slightly higher than that of the Tobit model. The partner country's GDP has a

positive effect on intensive and extensive margin models, though the magnitude of its coefficient was higher for the extensive margin. This implies that the larger a partner country's economy, the greater the consumer demand for diverse products, especially food products.

The effect of a partner country's population on export margins, however, is quite varied. The coefficient of population on intensive margin was positive and statistically significant, whereas it was negative for extensive margin. This means that a rise in a partner country's population favors intensification of the export of existing agricultural products, rather than the export of a diverse range of products. This may be due to the long-term trading relations that India has with its partner countries which involves the export of particular products. Expectedly, the coefficient of distance was negative and statistically significant. The effect of a common official language on the diversification of India's agricultural exports was positive. FTAs strengthen both the intensive and the extensive margin of agricultural exports.

8. Conclusions and Policy Implications

The present study has analyzed the sources of India's agricultural export growth in terms of intensive and extensive margins. Two alternative approaches were used to estimate the export margins, that is, the traditional approach and a robust method proposed by Hummels and Klenow (2005). The traditional approach analyses the changes in bilateral exports at two points in time. Given a fixed set of partner countries, this approach identifies the extent to which changes in India's agricultural exports occurred, due to increase in exports of existing products to the existing destinations or extinction of exports – appearing zero value (intensive margin). The cause of disappearing zeros is identified as whether it is due to export of existing products to new destinations, export of a new product to existing destination or export of a new product to new destination (extensive margin). The intuition behind Hummels and Klenow's decomposition method is based on: relative value of exports in the set of observable product categories in which India and the rest of world has positive exports to partner countries (intensive margin), and relative number of positive exports in the set of observable product categories by India and the rest of the world (extensive margin). In a way, the latter approach can be considered as weighted index of the intensive and extensive margins.

India's exports registered at a higher rate in low income countries such as those in Sub-Saharan Africa, though this occurred at a higher level of dispersion. The traditional approach of decomposing agricultural export growth has shown that, between 2001 and 2020, growth at the

intensive margin accounted for 71 percent of the increase in exports and growth along the extensive margin accounted for 29 percent. This implies that intensification of the export of existing products to existing destinations dominated export growth, and that the contribution of product diversification to export growth is more important than the contribution of geographic diversification.

Analysis of export margins for the top 50 high export growth destination countries shows a considerable variation in the contribution of growth at the intensive and extensive margins. Between 2001 and 2020, for 24 out of the 50 countries, growth along the intensive margin—at more than 20 percent—contributed significantly to India's increased export growth. For the remainder of the countries, growth at the extensive margin was the important source of increased exports. Within the extensive margin, the contribution of product diversification was higher than that of geographic diversification. There were, however, some exceptions to this, in that for countries such as Luxembourg, Peru, Cameroon, Costa Rica and Rwanda, geographic diversification was the prominent source of India's increased exports.

At the regional level, growth at the intensive margin contributed 97.2 percent to India's total growth in exports to North America and it contributed 85.8 percent to growth in exports to South Asia. In the case of Latin America and the Caribbean, East Asia and the Pacific, Europe and Central Asia, and sub-Saharan Africa, growth at the extensive margin was the important contributor to India's export growth. In the case of increased exports at the product-type level, the contribution of growth along the intensive margin ranged from 60.2 percent on agricultural raw materials to 89.0 percent on processed agricultural products. Export of horticultural products has grown mostly at the intensive margin (88.2 percent), and for export of cereals, oilseeds and vegetable oils, growth along the extensive margin contributed as much as 41.4 percent to export growth, of which product diversification accounted for a substantial share.

According to the Hummels and Klenow approach, at the aggregate level during the 2001 to 2020 period, the extensive margin grew at 1.24 percent per annum, while the intensive margin increased at 0.23 percent; thus, during this period, the intensive margin remained almost constant. The contribution of growth along the extensive margin to total export growth increased from 58.8 percent in 2001 to 70.2 percent in 2020. This implies that growth of India's exports along the extensive margin has not been fully exploited and that export diversification holds the key to higher export growth in agricultural products.

Among India's top 20 export destinations, the agricultural export penetration rate was highest for the United States, at 0.66 percent; this was followed by China at 0.49 percent, and Vietnam at 0.37 percent during 2018–2020. For these countries, growth in exports at the intensive margin has improved significantly between the periods 2001–2003 and 2018–2020; for all the sample countries, however, the contribution of growth along the extensive margin was much higher than that along the intensive margin. Among the regions, the agricultural export penetration rate was relatively high for North America during the study period and most of the increase in exports occurred at the extensive margin.

For exports at the product-type level, growth along the intensive margin was relatively high for animal products and agricultural raw materials, while growth at the extensive margin was an important contributor to export growth across other product groups. Analysis has shown that intensity of export of India's agricultural products was concentrated in North America and the countries of the Middle East. With the value of growth along the extensive margin equal to 1.0 for North America, India's agricultural products faced stiff competition in the United States and Canada. Gravity analysis has shown that proximity to destination markets, economic size and population of partner country, a common official language, and the existence of a free trade agreement had positive and significant effects on India's export margins during the study period. The results broadly imply that export diversification holds the key to further expansion of exports. There is wide scope for expansion of India's agricultural exports through development of new product varieties and new markets; there is also ample incentive for exporting firms to invest in product innovation and technological upgradation.

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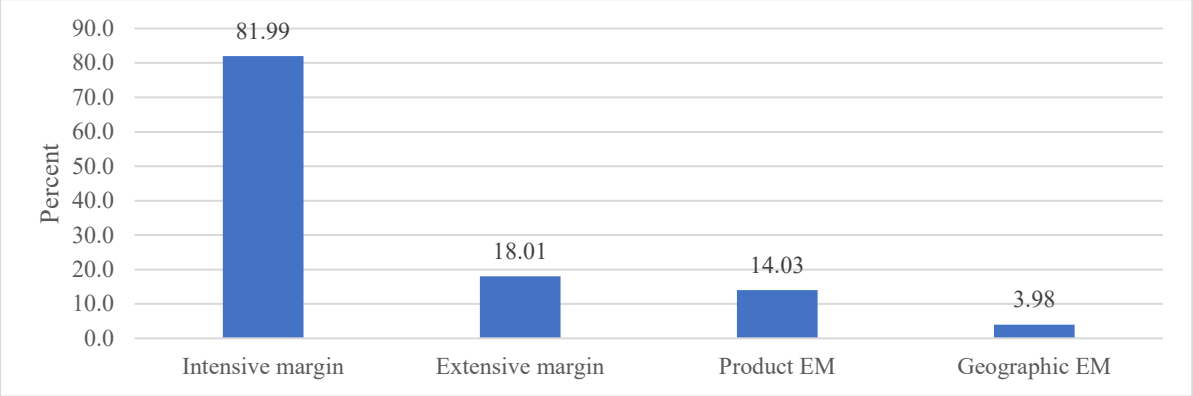
Annex

Table A1. Description of variables used in regression models

Variables	Description	Data source
Ln GDP	Log of gross domestic product of partner countries	World Development Indicators, World Bank (https://databank.worldbank.org/source/world-development-indicators)
Ln population	Log of population of partner countries	World Development Indicators, World Bank (https://databank.worldbank.org/source/world-development-indicators)
Ln distance	Log of distance between capitals	CEPII website (http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=8)
Common official language	Dummy variable equal to 1 if countries share common official language and 0 otherwise	CEPII website http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=8
Contiguity	Dummy variable equal to 1 if countries are contiguous and 0 otherwise	CEPII website http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=8
Free trade agreement	Dummy variable equal to 1 if countries belong to common regional trade agreement and 0 otherwise	Department of Commerce, Ministry of Commerce and Industry, Government of India (https://commerce.gov.in/international-trade/trade-agreements/)

Figure A1. Contribution of growth along intensive and extensive margins to the overall growth of India's exports, 2002–2019



Source: Based on United Nations (2021)

Table A2. Growth at India's intensive margin and extensive margin by destination countries, 2002–2019

Partner country	CAGR in exports between 2002 and 2019 (%)	Intensive margin	Extensive margin	Geographic EM	Product EM
Saudi Arabia	10.57	99.18	0.82	0.06	0.76
Djibouti	26.43	99.04	0.96	0.10	0.86
Guinea	30.96	97.72	2.28	0.02	2.25
Tajikistan	7.54	97.42	2.58	0.97	1.61
Benin	32.30	97.17	2.83	0.01	2.82
United States	9.84	96.90	3.10	0.55	2.55
United Arab Emirates	10.22	96.41	3.59	0.69	2.89
Yemen	11.57	96.00	4.00	2.95	1.05
Malaysia	6.54	95.46	4.54	2.14	2.40
Bangladesh	8.03	94.97	5.03	1.72	3.31
Togo	13.48	94.81	5.19	0.03	5.16
Kuwait	10.62	94.48	5.52	0.47	5.05
Kenya	14.02	94.30	5.70	0.33	5.37
Sri Lanka	4.85	94.12	5.88	1.87	4.00
Australia	9.85	93.84	6.16	3.28	2.88
Mauritius	11.25	93.09	6.91	0.87	6.04
Oman	12.41	92.48	7.52	0.64	6.88
Israel	11.47	92.14	7.86	2.13	5.73
Belgium	7.98	92.04	7.96	1.57	6.39
Egypt, Arab Rep.	13.44	92.02	7.98	0.96	7.02
Argentina	18.73	91.73	8.27	0.99	7.28
Sierra Leone	17.93	91.59	8.41	4.06	4.35
Kazakhstan	4.69	91.40	8.60	1.21	7.39
Norway	16.07	91.26	8.74	0.90	7.83
Tanzania	10.22	91.04	8.96	0.82	8.14
Italy	9.29	90.58	9.42	4.84	4.58
Vietnam	19.65	89.94	10.06	0.20	9.85
Qatar	22.86	89.45	10.55	0.49	10.07
Bahrain	11.79	89.30	10.70	2.22	8.48
Germany	7.22	87.35	12.65	3.70	8.95
Iran, Islamic Rep.	31.36	86.66	13.34	0.07	13.27
Comoros	1.90	86.51	13.49	7.94	5.55
Japan	2.83	85.95	14.05	7.48	6.57
Gabon	4.94	85.93	14.07	10.47	3.61
Canada	12.28	85.88	14.12	1.31	12.80
Netherlands	9.99	84.57	15.43	2.00	13.43
France	8.27	84.54	15.46	5.72	9.74
Greece	6.62	84.45	15.55	8.81	6.74

Partner country	CAGR in exports between 2002 and 2019 (%)	Intensive margin	Extensive margin	Geographic EM	Product EM
Poland	10.27	83.83	16.17	4.66	11.50
Ethiopia (excludes Eritrea)	22.63	83.77	16.23	1.88	14.35
Lithuania	15.91	83.39	16.61	6.86	9.74
Cote d'Ivoire	17.53	83.08	16.92	0.94	15.98
Trinidad and Tobago	8.64	82.59	17.41	1.93	15.48
Kyrgyz Republic	10.62	82.44	17.56	11.82	5.74
Tunisia	13.84	82.22	17.78	2.79	14.99
Myanmar	22.73	81.88	18.12	1.80	16.31
Congo, Rep.	13.09	81.18	18.82	2.97	15.85
Burkina Faso	21.68	80.57	19.43	0.12	19.30
Lebanon	10.94	79.78	20.22	7.17	13.05
United Kingdom	6.11	79.05	20.95	4.07	16.88
New Zealand	12.24	78.53	21.47	3.82	17.65
Maldives	12.29	77.66	22.34	3.45	18.88
Botswana	20.27	76.85	23.15	3.07	20.08
Colombia	18.18	76.57	23.43	1.54	21.89
China	18.95	76.50	23.50	0.75	22.74
Burundi	17.50	76.39	23.61	5.26	18.35
Seychelles	7.83	75.80	24.20	1.40	22.80
Jordan	10.91	75.70	24.30	1.36	22.94
Ireland	8.58	75.35	24.65	6.87	17.77
Spain	6.01	74.25	25.75	19.16	6.58
South Africa	0.47	74.24	25.76	10.59	15.17
Albania	22.51	73.92	26.08	2.15	23.93
Nepal	23.15	73.79	26.21	0.03	26.17
Slovenia	9.41	73.38	26.62	0.62	26.00
Chile	20.52	72.66	27.34	0.59	26.75
Ecuador	22.62	72.52	27.48	1.45	26.04
Iraq	14.41	72.08	27.92	1.62	26.30
Mozambique	1.80	71.66	28.34	9.47	18.87
Ukraine	10.32	70.82	29.18	7.45	21.73
Cyprus	7.57	70.67	29.33	11.90	17.43
Croatia	16.31	70.46	29.54	0.25	29.29
Niger	26.96	69.58	30.42	0.51	29.91
Angola	9.09	67.75	32.25	6.61	25.64
Thailand	12.90	67.38	32.62	1.49	31.13
Afghanistan	21.42	66.65	33.35	1.07	32.28
Bulgaria	9.38	66.16	33.84	20.33	13.51
Syrian Arab Republic	16.00	63.02	36.98	3.17	33.82
Singapore	3.99	62.67	37.33	15.23	22.10

Partner country	CAGR in exports between 2002 and 2019 (%)	Intensive margin	Extensive margin	Geographic EM	Product EM
Malta	6.20	61.95	38.05	32.34	5.72
Uganda	19.96	61.77	38.23	0.43	37.79
The Gambia	22.36	60.28	39.72	0.00	39.72
Nigeria	5.01	58.83	41.17	2.11	39.07
Switzerland	4.03	58.54	41.46	3.60	37.87
Sweden	10.21	57.98	42.02	4.24	37.79
Korea, Rep.	7.99	57.51	42.49	15.84	26.64
Ghana	9.08	56.95	43.05	1.67	41.38
Brazil	15.71	56.56	43.44	1.57	41.88
Mexico	8.56	56.01	43.99	1.69	42.30
Georgia	7.35	55.41	44.59	6.79	37.80
North Macedonia	19.54	55.19	44.81	4.81	39.99
Libya	12.74	51.30	48.70	20.69	28.02

Source: Based on United Nations (2021)
Note: CAGR = compound annual growth rate.

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