Optimal export tax rates of cocoa beans: A vector error correction model approach

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Aiming to support downstream cocoa processing industries, the Indonesian Government announced an export tax on cocoa beans in 2010. This paper investigates whether the Indonesian Government has imposed an optimal tax rate and examines the determinants of cocoa bean export growth using data from Ivory Coast, Ghana and Indonesia for 1970–2011 and applying a vector error correction model. This study highlights the interdependence of major cocoa exporting countries' policy and reveals that Indonesia currently imposes a tax rate that is above its optimal rate.

Key words: cocoa beans, export taxes, Indonesia, optimal tax rates , vector error correction model.

1. Introduction

Trade policies remain vital for Indonesian agricultural sectors. The country favours import-competing sectors such as rice, sugar and soybeans (Fane and Warr 2008). For export-competing sectors, the Indonesian Government concentrates on developing the food processing industries, valued at $US24 billion in 2005.

This study focusses on the Indonesian cocoa sector. The sector produced 800 thousand tonnes of cocoa in 2009, with 55 per cent of its domestic production being exported. The Indonesian Government argues that there is not enough incentive for developing domestic cocoa processing industries. Downstream industries often experience shortages in cocoa bean supply. Therefore, the Indonesian Government announced an export tax in May 2010.

The export tax was established to promote investments in downstream value-added activities in Indonesia.[1] Unfortunately, since the introduction of the cocoa bean export tax in mid-2010, both cocoa bean exports and domestic

production have been decreasing. In 2011, exports were valued at US $617,090, down from US$1 million the previous year. The percentage of export to total domestic production decreased from 55 per cent in 2009 to 29 per cent in 2011.

One important policy question is whether the tax rate is optimum. A 2008 study by the International Cocoa Organization (ICCO) suggests that Indonesia's optimum tax rate is approximately 11 per cent (ICCO 2008). However, this rate is calculated using elasticities derived by a 1990s study (Akiyama and Larson 1994). Moreover, the rate is sensitive to the magnitude of export supply elasticities, which vary between studies (Burger 2008; ICCO 2008). Taking lessons from Thailand's export of rice, it is argued that for agricultural commodities, the true long-run demand elasticity is highly uncertain and could even vary significantly over time (Warr 2001). This suggests the importance of an updated analysis.

Using data from the top three exporters, Ivory Coast, Ghana and Indonesia, covering 1970–2011, this study investigates the optimal tax rate and the determinants of Indonesia's cocoa bean export growth using a vector error correction model (VECM) to deal with cointegration and simultaneity issues. A literature search suggests that existing studies on cocoa beans use methods (mostly the ordinary least squares model) that are unable to address these two problems (Burger 2008). Thus, the present study provides an alternative method of calculating the optimal tax rate using newer datasets than that presented in the comprehensive study by Yilmaz (1999), who uses a computable general equilibrium model.

The remainder of this paper is organised as follows. Section 2 reviews trends in the cocoa bean market. Section 3 presents a simple theoretical framework for calculating the optimal tax rate. Section 4 defines the data and describes the empirical methodology used in this study. Section 5 presents the results from the empirical analysis. Section 6 concludes.

2. Trends in cocoa bean markets

As a tropical tree crop, cocoa is produced in developing countries on and around the equator. Changes in cocoa supply from major exporting countries, particularly Ivory Coast, cause continuing fluctuations in the world cocoa bean market. Whereas Figures 1 and 2 present no common pattern in yield and export volume across three major exporting countries, Figure 3 suggests that trends in cocoa bean export prices have been consistently similar across major exporting countries. Figure 2 reveals Indonesia's and Ghana's increasing trends in export quantity between 2000 and 2010 and, in contrast, Ivory Coast's decreasing export quantity.

As indicated by common trends in the export price across competing exporters, an export tax may lead to a reduction in market share. Cocoa beans are primarily used in the manufacturing of chocolate confectioneries. A few multinational companies control global chocolate production
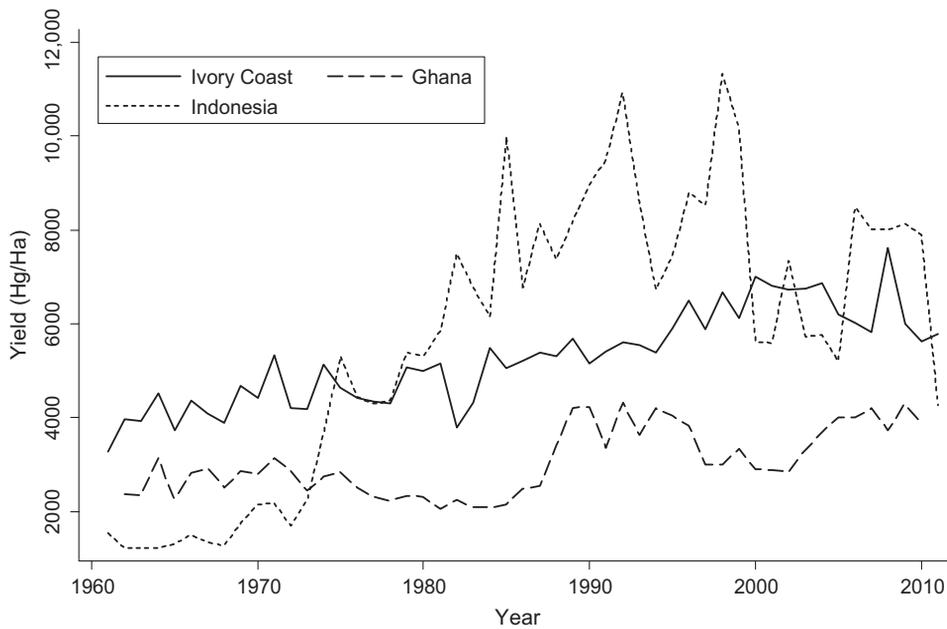
Figure 1 Cocoa bean yield (1961–2011). Source: Author's calculation using area and production statistics from the FAO (2012) for data up to 2010; Indonesia's 2011 figure is derived from production and area statistics stated by the Director General of Plantation at the Republic of Indonesia Ministry of Agriculture (Handoyo 2012a,b); and author's forecast for 2011 data for Ivory Coast and Ghana.

(Yilmaz 1999) and governments in big exporting countries can affect the world price of cocoa beans (Yilmaz 1999). The top three exporters also share similar markets, including Europe and North America. Indonesia has a limited area of production compared to the other exporters (Figure 4).

Most studies on export taxes on cocoa beans focus on the optimal or welfare-maximising export tax rate (Akiyama and Larson 1994; Yilmaz 1999; Burger 2008; ICCO 2008). Estimates of optimal export tax rates vary between studies, possibly due to different methods of estimation and data coverage. Given the dynamic nature of the global cocoa bean market, updated estimates of the tax rates are required, taking into account simultaneity between prices and volume of exports, as well as cointegration issues following previous studies (Goldstein and Khan 1978; Riedel 1988; Muscatelli *et al.* 1992).

3. A simple theoretical framework

Closely following Yilmaz (1999), this section presents a simple theoretical framework to calculate the optimum export tax rate. Let us assume that
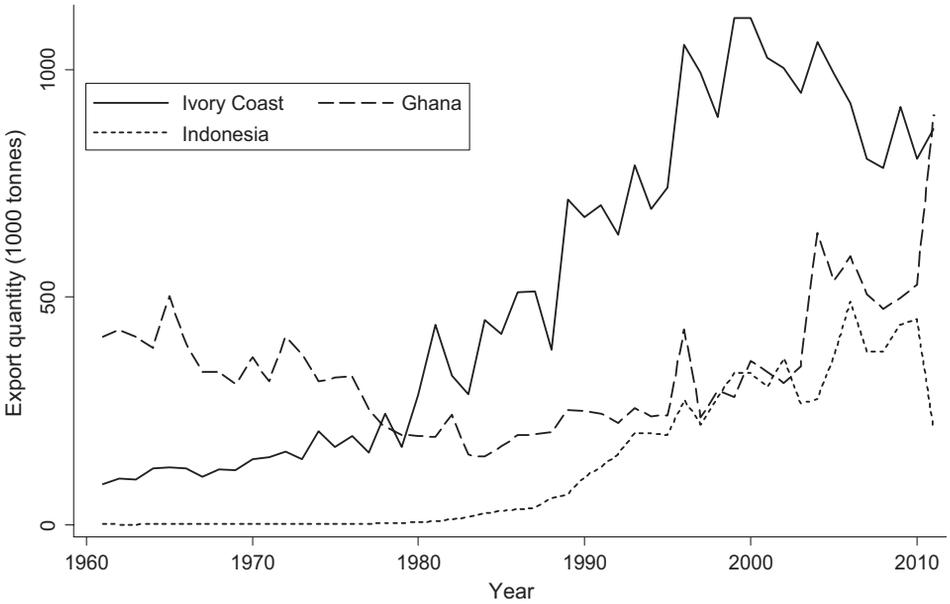
Figure 2 Cocoa bean export quantity (1961–2011). Source: FAO (2012) for data up to 2009; USDA (2012) for 2010 and 2011 data for Ghana; Indonesia's 2011 figure is based on a statement by the Director General of Aromatic and Herbal Plantation at the Republic of Indonesia Ministry of Agriculture (Sukanto 2012); Indonesia's 2010 figure is derived from data from the Secretary of the Indonesian Cocoa Association (Prihtiyani 2012); Ivory Coast's 2010 and 2011 data are derived from information about its contribution to the world market, where world total cocoa bean export is calculated from the known volume of exports from Ghana and the percentage contribution of Ghana to the world market (Simoes and Hidalgo 2011).

there are N countries producing and exporting the commodity to consumers in the rest of the world (ROW). Assuming that consumers cannot affect the world price, the world demand is a function of the world price:

$$D = D(p), D' < 0. \tag{1}$$

The log linear supply function for country i, $i = 1, 2,…, N$ is a function of the domestic price of cocoa:

$$Q_i = g_i((1 - \tau_i)p), g_i' > 0, i = 1, 2, …, N, \tag{2}$$

where τ_i is the ad valorem export tax in country i.

The producer price in country i is

$$p_i = (1 - \tau_i)p(\cdot). \tag{3}$$

Residual demand facing country i, D_i, is defined as the world demand minus supply in the other producing countries and, therefore, is a function of export tax rates of other producing countries:
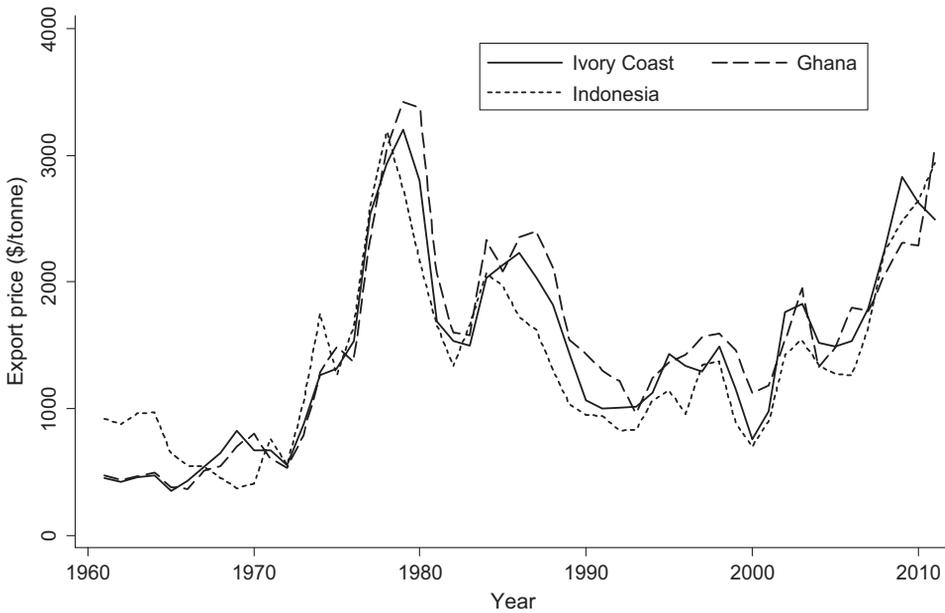
Figure 3 Cocoa bean export price (1961–2011). Source: FAO (2012) for data up to 2009; price is based on the per unit export value index (i.e. export value divided by export quantity); data for Ghana for 2010 and 2011 are derived from the farm gate producer price published by USDA (2012), where the farm gate price is assumed to be 70 per cent of the free on board price (USDA 2012); the Ivory Coast 2010 export price is assumed to be the same as the 2010 world price, while the 2011 Ivory Coast export price is derived from the 2010 figure, taking into account the percentage change in the world's cocoa bean price in 2010–2011. Since 2007, the percentage change in the Ivory Coast's export price has been similar to the world's percentage change; Indonesia's export prices in 2010 and 2011 are per unit export value indices using export value data announced by the Republic of Indonesia Ministry of Trade (Handoyo 2012a,b).

$$D_i(p, \tau_{-i}) = D(p) - D_{ROW}, \tag{4}$$

where $D_{ROW} = \sum_{j \neq i}^{N} g_j((1 - \tau_j)p)$, $D_{i,p} < 0$ and $D_{i,\tau j} > 0$ for $j \neq i$. τ_{-i} is an $N - 1$ vector which contains export tax rates of countries excluding country i.

World market equilibrium is achieved when, at a given p, D_i is equal to the supply produced by country i, Q_i:

$$D_i(p, \tau_{-i}) = Q_i((1 - \tau_i)p), i = 1, 2, \ldots, N. \tag{5}$$

Solving the equilibrium condition, the world price can be written as an increasing function of the export tax rates in countries $i = 1,2,\ldots,N$.

$$p = p(\tau_1, , \tau_N). \tag{6}$$

Marginal changes imply

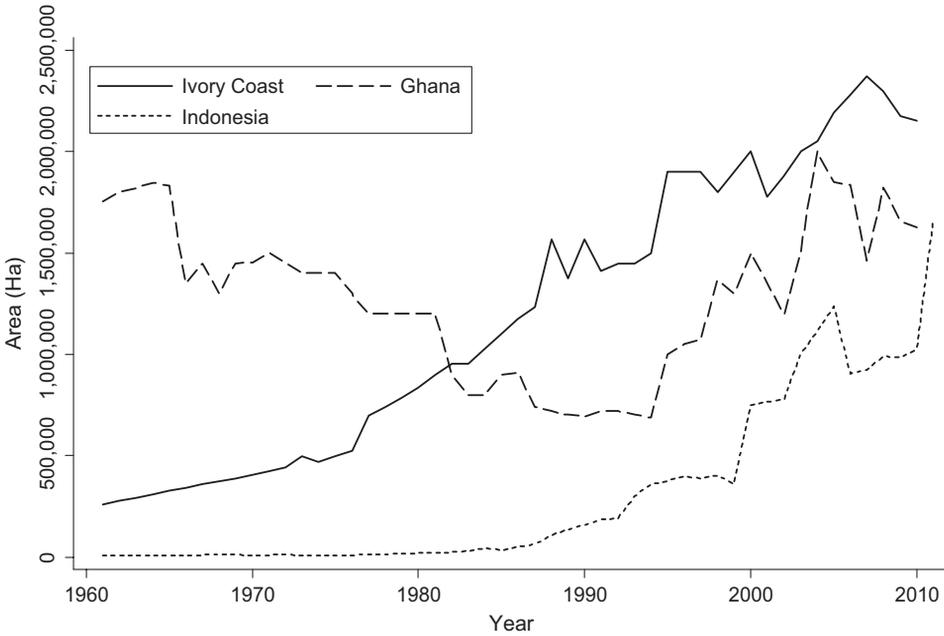$$\delta Q_i(\cdot) = \delta D(\cdot) - \delta Q. \tag{7}$$

Figure 4 Area used for cocoa bean plantation (1961–2011). Source: Area statistics are from the FAO (2012) for data up to until 2010; the 2011 figure for Ghana is derived from USDA (2012); Indonesia's 2011 figure is based on a statement by the Director General of Plantation at the Republic of Indonesia Ministry of Agriculture (Handoyo 2012a,b); and the author has forecast the 2011 data for Ivory Coast.

For a given change in D_i, that is, δD_i, this study obtains:

$$\frac{\delta Q_i}{\delta p} = \underbrace{\left(\frac{\delta D_i}{\delta p}\frac{p}{D_i}\right)}_{\eta_i}\frac{D_i}{p} - \underbrace{\left(\frac{\delta Q_{ROW}}{\delta p}\frac{p}{Q_{ROW}}\right)}_{\sigma_{ROW}}\underbrace{\left(\frac{Q_{ROW}}{D_i}\right)}_{S_{ROW}}\frac{D_i}{p} \qquad (8)$$

or

$$\frac{\delta Q_i}{\delta p} = -(\eta_i + \sigma_{ROW}S_{ROW})\frac{D_i}{p}, \qquad (9)$$

where $-\eta_i$ is the demand elasticity for country i, σ_{ROW} the supply elasticity of the rest of the world and S_{ROW} the rest of the world's share in total world production. The effect of a change in Q_i on the world's market price, p, can be written as:

$$\frac{\delta_p}{\delta_{Q_i}} = -\left(\frac{p}{Q_i}\right)\frac{S_i}{\eta_i + \sigma_{ROW}(1 - S_i)}, \qquad (10)$$

where S_i is the share of country i in total world production; that is, $S_{ROW} + S_i = 1$. The last factor on the right-hand side of the equation is the inverse of the demand elasticity for country i.

Social welfare of country Π_i is equivalent to the profits of the cocoa sectors, plus tax revenue from cocoa exports. Country i takes other countries' export tax rates $\bar{\tau}_j$ for $j \neq i$ as given and chooses its export tax rate to maximise its social welfare:

$$\prod_i = p(\tau_i, \bar{\tau}_{-i})Q_i(p(\cdot), \bar{\tau}_{-i}) - C(Q_i), \qquad (11)$$

where the total cost of producing D_i amount of cocoa is $C(D_i)$. At the profit maximising output, marginal cost is equal to the domestic price:

$$\frac{\delta C(Q)}{\delta Q_i} = (1 - \tau_i^*)p. \qquad (12)$$

The first-order condition for the welfare maximisation of country i is:

$$\frac{\delta \prod_i}{\delta \tau_i} = \frac{\delta p}{\delta \tau_i}\left(D_i + p(\cdot)\frac{\delta D_i}{\delta p}\right) - \frac{\delta C_i}{\delta \tau_i} = 0. \qquad (13)$$

Assuming $\frac{\delta Q_i}{\delta \tau_i} \neq 0$ and $\frac{\delta C_i}{\delta Q_i} = p + Q_i\frac{\delta p}{\delta Q_i}$ and substituting $\frac{\delta C_i}{\delta Q_i}$ and $\frac{\delta p}{\delta Q_i}$ from previous derivations suggests

$$\tau_i^* = \frac{S_i}{\eta_i + \sigma_{\mathrm{ROW}}(1 - S_i)}. \qquad (14)$$

Equation (14) simply suggests that the optimal tax rate rises with the country's market share in world production (S_i) and decreases with the world's demand elasticity for country i (η_i) and the rest of the world's supply elasticity (σ_{ROW}). To illustrate, this study sets $\eta_{INDONESIA} = 1.60$, $\eta_{GHANA} = 0.90$, $\eta_{COTED'IVOIRE} = 0.92$ and $\sigma_{ROW} = 0.55$, as suggested in ICCO (2008). Based on Figure 5, for Indonesia, the actual tax rate in 2011 (5 per cent) is below the simulated optimal tax rate.[2] Section 4 clarifies whether the assumed parameters are supported by robust empirical results.

4. Data and empirical methodology

Trade data for 1970–2009 are taken from FAO statistics (FAO 2012). Export data for 2010 and 2011 are compiled from various sources.[3] This study also takes production and area data (from which yield index can be derived) for 1970–2010 from the FAO statistics.[4] Real GDP of the three countries' trading partners, foreign direct investment (FDI) net inflows (per cent of

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[2] As of December 2012, the tax rate was still set at 5 per cent.
[3] See footnotes in Figures 2 and 3 for the sources of export quantity and price data.
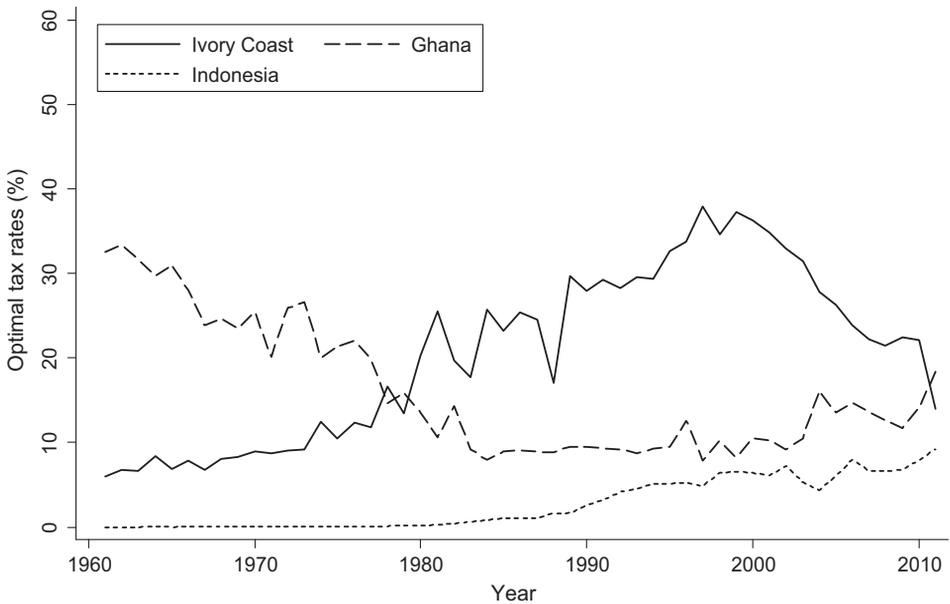[4] See footnotes in Figures 1 and 4 for the sources of data in 2011.

Figure 5 Simulated optimal tax rates (parameters based on previous studies). Notes: Export demand elasticities for Indonesia, Ivory Coast and Ghana are 1.60, 0.92 and 0.90, respectively. This study follows the ICCO (2008) by setting the world's supply elasticity as 0.55.

GDP) and percentage of agricultural land are taken from World Development Indicators Online (World Bank 2012).[5] FDI is included to proxy foreign investors' access to the domestic market.[6] Easy access for foreign processing companies may push domestic demand for cocoa beans and, therefore, reduce exports share.

This study also takes into account the availability of agricultural land (*AGRILAND*) and the role of the Government by including recent measures of relative rates of assistance (RRA) in the estimation (Anderson and Valenzuela 2008).[7] In addition, to take into account the impacts of increased demand for processed cocoa, this study includes export quantity of cocoa powder and cake (*PROCQX*) in the VECM estimation. Finally, this study includes the polity2 index (*POLITY*), a composite index of the political regime, where polity2 ranging from −10 to −6 indicates autocracies and +6 to

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[5] Where data on trade weights are not available, this study uses the average of real GDP of the nine major importing countries. Compared to world GDP, this proxy has much stronger correlation to variation in export quantity.

[6] The WDI only has data for 1975, 1975 and 1981 for Ivory Coast, Ghana and Indonesia, respectively. This study completes the dataset for the 1970–1974 period for Ivory Coast and Ghana by using data from UNCTAD (2012). For Indonesia, WDI is sourced from Azam and Lukman (2010).

[7] RRA_{it} is defined as the percentage by which the price of farm relative to nonfarm tradables is above what it would be if the national government had not distorted prices in those goods-producing sectors.

+10 indicates democracies (Marshall *et al.* 2011). In countries where cocoa bean exports are primary sources of government revenues, as demonstrated by political turmoil in Ivory Coast, the political regime may be significant for export flows.

The present study uses an annual dataset that covers the period 1970 to 2011.[8] Table 1 presents a summary of statistics, dividing the observations into four periods. Definitions are provided in the notes section of Table 1. It is immediately evident from the export quantity that the Indonesian cocoa bean sector has progressed very well. However, Indonesia has relatively limited agricultural land. In recent years, the government has increased its support of the agricultural sectors compared to other countries, as indicated by variable *RRA*.

This study uses a VECM to distinguish the long-run relationship between the two variables (potentially drifting together) and the short-run dynamics (Engle and Granger 1987). For each economy, the multivariate cointegration model is defined as follows (Johansen and Juselius 1990):

$$\Delta X_t = \mu + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \prod X_{t-1} + \delta t + \in_t,$$

where X_t is an $(n \times 1)$ column vector of p variables; μ is an $(n \times 1)$ vector of constant terms; Γ represents coefficient matrices; Δ is a difference operator; δt is the time trend; and $\in_t \sim N(0, \Sigma)$. The coefficient matrix contains information about the long-run relationships.

The Dickey–Fuller test suggests the presence of unit roots in levels for most variables, as presented in Table 2, indicating that the VECM is preferred. The trace test suggests that Ivory Coast, Ghana and Indonesia data series have a maximum of two cointegrating relationships. To fit cointegrating VECM, the number of lags is specified based on criterion information test results.

5. Results

5.1. Vector error correction model

Table 3 presents the estimates of factors influencing export growth.[9] All variables in Table 1 are redefined to allow natural logarithm transformation. Due to their negative values, this study adds a positive number (i.e. 10) to *FDI*, *RRA* and *POLITY*. *EXP*, *EXQ*, *GDP* and *PROCQX* are rescaled relative to the base year, where 1970 is set to 100.

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[8] Missing data are imputed by assuming other variables used in Table 3 to be exogenous variables. In total, 34 cells are imputed: 3 cells of *EXP*, 1 cell of *FDI*, 6 cells of *AGRILAND*, 21 cells of *RRA* and 3 cells of *PROCQX*.
[9] The complete results of the VECM for variables other than export growth can be obtained from the author.

Table 1 Summary of statistics

Variable	1971–1979			1980–1989			1990–1999			2000–2011		
	Ivory Coast	Ghana	Indonesia	Ivory Coast	Ghana	Indonesia	Ivory Coast	Ghana	Indonesia	Ivory Coast	Ghana	Indonesia
EXQ	176,960.10	302,991.80	1,550.89	432,452.70	195,039.40	28,859.70	829,405.10	268,800.70	208,888.10	937,202.30	502,040.80	355,227.20
	32,437.01	70,765.39	958.94	128,823.00	32,933.12	20,996.65	172,162.60	60,376.35	71,166.29	107,072.50	164,105.20	82,519.87
EXP	0.98	0.96	1.06	1.01	1.12	0.87	0.99	1.13	0.86	1.01	1.03	0.88
	0.05	0.07	0.17	0.06	0.11	0.09	0.05	0.10	0.08	0.07	0.13	0.10
GDP	861,000.00	861,000.00	861,000.00	1,110,000.00	1,110,000.00	856,000.00	1,810,000.00	1,460,000.00	3,840,000.00	3,480,000.00	1,610,000.00	3,460,000.00
	75,600.00	75,600.00	75,600.00	107,000.00	107,000.00	274,000.00	680,000.00	130,000.00	1,060,000.00	930,000.00	629,000.00	983,000.00
FDI	1.10	0.51	1.87	0.56	0.19	0.38	1.62	1.73	1.13	1.87	4.23	0.72
	0.52	0.86	1.37	0.24	0.15	0.17	1.18	1.31	1.19	0.36	3.06	1.68
AGRILAND	52.67	51.91	21.08	56.60	54.01	22.18	61.28	58.00	23.51	61.10	66.67	28.52
	1.15	0.56	0.08	1.77	0.81	1.60	1.06	2.50	0.63	5.55	3.18	6.11
RRA	−0.45	−0.40	−0.18	−0.47	−0.29	−0.18	−0.36	−0.10	−0.20	−0.29	−0.15	0.03
	0.11	0.13	0.09	0.06	0.24	0.09	0.04	0.07	0.07	0.09	0.08	0.05
POLITY	−9.00	−3.67	−7.00	−9.00	−5.70	−7.00	−5.90	−0.70	−5.50	0.67	7.00	7.33
	0.00	5.22	0.00	0.00	4.11	0.00	1.79	2.98	4.09	1.56	1.81	0.98
PROCQX	12,790.89	14,573.89	620.33	24,259.70	7681.20	2061.70	15,984.10	9,930.70	12,422.30	1,756,166.00	15,496.44	38,336.08
	3048.23	5209.08	915.39	5201.55	1677.00	2978.45	13,971.77	7824.10	7635.27	5,976,826.00	4851.17	17,128.32

Notes: The first row shows the mean and the second row shows the standard deviation. *EXQ* is cocoa bean export quantity (tonne); *EXP* is the ratio of the cocoa bean export price to the world price (multiplied by 100); *GDP* is the trade-weighted average of trading partners' real GDP ($ million); *FDI* is foreign direct investment, net inflows (% of GDP)); *AGRILAND* is agricultural land (% of land area); *RRA* is rates of relative assistance; *POLITY* is the polity2 index, where polity2 ranging from −10 to −6 indicates autocracies and +6 to +10 indicates democracies (Marshall *et al.* 2011); and *PROCQX* is the cocoa powder and cake export quantity (tonne). Source: Author's calculation using data from the FAO (2012), World Bank (2012), Marshall *et al.* (2011) and Anderson and Valenzuela (2008).

Table 2 The Dickey–Fuller unit root test

Variable	Ivory Coast		Ghana		Indonesia	
	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
EXQ	−4.179	0.001	−2.680	0.078	−4.786	0.000
EXP	−1.404	0.580	−0.361	0.916	−2.212	0.202
GDP	−1.521	0.523	−1.780	0.390	−1.367	0.598
FDI	−2.164	0.219	−0.009	0.958	−3.552	0.007
AGRILAND	−0.758	0.831	2.759	1.000	−0.167	0.942
RRA	−1.125	0.705	−1.669	0.447	−1.870	0.346
POLITY	−0.379	0.914	−2.225	0.197	−0.532	0.886
PROCQX	−5.532	0.000	−2.453	0.127	−1.826	0.368

Notes: The null hypothesis is the variable is nonstationary.

As comparisons, columns (1) and (2) of Table 3 present results from pooled ordinary least squares regression and fixed-effect regression results, respectively, while columns (3) to (8) present the VECM results. *L.D.EXP* in column (2) presents an unexpected sign of the export demand elasticity.

In columns (3) to (5), which provide results for Ivory Coast and Ghana, the estimates of the coefficients ECM1 are negative, significant and less than one, indicating that the series meet re-equilibrating properties. Setting the ranks at 2, *LD.EXP* is not significant for either country. After increasing the ranks to 7, *LD.EXP* remains insignificant for Ivory Coast but becomes significant for Ghana.

Compared to Ghana, export growth in Ivory Coast is more responsive to change in demand from the world market, as indicated by *LD.GDP*. None of the other right-hand-side variables in column (i) are significant, except *RRA* and *POLITY*. In Ivory Coast, political conditions are closely related with volatility in cocoa bean export, as suggested by *POLITY*. Given its substantial contribution to the national economy, cocoa has been viewed as a 'political weapon' in Ivory Coast, and is a key income source for military and government expenditure. In 2011, the government imposed an export ban, leading to a spike in the world's cocoa price (Blas 2011).

Columns (5) and (6) of Table 3 investigate the determinants of cocoa bean export growth in Ghana. The sign of the coefficient for *LD.EXP* is unexpected. Positive price elasticities of export demand are not uncommon (Houthakker and Magee 1969; Bahmani-Oskooee 1986; Haniotis *et al.* 1988). Yet, previous studies tend to ignore this issue. Positive elasticities may be associated with the market structure. In the case of US wheat exports, the oligopolistic structure of the world wheat market means that wheat import demand often includes nonprice considerations (Haniotis *et al.* 1988). Similar explanations may apply to the cocoa bean market.

The geographical distribution of cocoa production is limited. Given low substitutability between cocoa beans from differing countries, increased relative export prices would not necessarily lead to a significant decrease in

Table 3　VECM Results (1970–2011)

Dependent variable D.EXQ	Pooled		Ivory Coast		Ghana		Indonesia	
	1	2	3	4	5	6	7	8
LD.EXQ	−0.438 (0.093)	−0.486* (0.050)	−0.380* (0.019)	−0.131 (0.867)	−0.211 (0.089)	0.121 (0.899)	−0.25 (0.130)	0.892 (0.218)
L2D.EXQ	—	—	−0.352* (0.025)	−0.975 (0.070)	0.117 (0.341)	0.198 (0.808)	—	0.463 (0.427)
L3D.EXQ	—	—	—	−0.77 (0.099)	—	0.11 (0.855)	—	0.104 (0.775)
L4D.EXQ	—	—	—	−0.687 (0.071)	—	0.184 (0.697)	—	−0.310* (0.041)
LD.EXP	0.629 (0.067)	0.660* (0.040)	0.818 (0.087)	0.478 (0.837)	0.787*** (0.001)	1.687 (0.314)	0.176 (0.731)	−5.332*** (0.000)
L2D.EXP	—	—	0.802 (0.098)	0.465 (0.802)	0.632* (0.020)	1.756 (0.146)	—	−4.541*** (0.000)
L3D.EXP	—	—	—	0.757 (0.641)	—	0.736 (0.635)	—	−3.914*** (0.000)
L4D.EXP	—	—	—	1.197 (0.363)	—	0.278 (0.822)	—	−1.328*** (0.000)
LD.GDP	0.057 (0.583)	0.056 (0.594)	0.980* (0.015)	3.531 (0.083)	−0.17 (0.296)	−0.543 (0.743)	−0.345 (0.305)	0.568** (0.006)
L2D.GDP	—	—	0.366 (0.314)	2.702 (0.137)	−0.259* (0.047)	−0.666 (0.524)	—	0.919*** (0.000)
L3D.GDP	—	—	—	1.216 (0.281)	—	−0.571 (0.571)	—	−0.343 (0.090)
L4D.GDP	—	—	—	0.367 (0.719)	—	−0.152 (0.835)	—	−0.681 (0.079)
LD.FDI	0.017 (0.950)	0.076 (0.776)	−1.597 (0.107)	−5.005 (0.168)	−0.477 (0.085)	−0.576 (0.745)	2.226 (0.053)	10.222** (0.004)
L2D.FDI	—	—	−0.447 (0.600)	−3.022 (0.380)	0.386 (0.236)	0.224 (0.906)	—	8.644** (0.004)
L3D.FDI	—	—	—	−1.23 (0.636)	—	−0.039 (0.983)	—	6.033** (0.001)
L4D.FDI	—	—	—	1.686 (0.322)	—	0.473 (0.704)	—	2.893** (0.004)
LD.AGRILAND	1.928* (0.014)	2.283* (0.012)	1.635 (0.689)	6.025 (0.548)	10.099*** (0.000)	6.887 (0.549)	−2.579 (0.296)	0.999 (0.835)
L2D.AGRILAND	—	—	−6.096 (0.242)	6.092 (0.637)	−2.095 (0.589)	−5.592 (0.793)	—	−13.293* (0.026)
L3D.AGRILAND	—	—	—	4.184 (0.672)	—	7.483 (0.758)	—	−17.012* (0.017)
L4D.AGRILAND	—	—	—	1.895	—	−6.53	—	−9.822
LD.RRA	0.253 (0.898)	−0.111 (0.948)	20.555*** (0.000)	54.666* (0.015)	−8.636*** (0.000)	−17.535 (0.387)	14.113 (0.357)	114.658*** (0.000)
L2D.RRA	—	—	5.916 (0.331)	33.219 (0.149)	−4.730* (0.021)	−12.928 (0.400)	—	96.569*** (0.000)
L3D.RRA	—	—	—	41.765 (0.068)	—	−5.03 (0.686)	—	91.670*** (0.000)
L4D.RRA	—	—	—	14.584 (0.345)	—	−4.381 (0.518)	—	60.058*** (0.000)
LD.POLITY	−0.114 (0.055)	−0.106* (0.029)	0.395* (0.015)	0.734 (0.091)	−0.158** (0.002)	−0.173 (0.405)	0.341 (0.584)	2.254 (0.169)
L2D.POLITY	—	—	0.014 (0.925)	0.373 (0.499)	0.035 (0.469)	−0.006 (0.974)	—	2.176 (0.092)
L3D.POLITY	—	—	—	1.083* (0.028)	—	−0.134 (0.432)	—	2.256* (0.031)
L4D.POLITY	—	—	—	0.299 (0.481)	—	0.068 (0.695)	—	−0.5 (0.226)
LD.PROCQX	0.008 (0.217)	0.006 (0.082)	−0.004 (0.693)	−0.017 (0.898)	−0.274*** (0.000)	−0.319 (0.493)	−0.008 (0.766)	−0.106*** (0.000)

Table 3 (*Continued*)

Dependent variable	Pooled		Ivory Coast		Ghana		Indonesia	
D.EXQ	1	2	3	4	5	6	7	8
L2D.PROCQX	—	—	−0.002 (0.888)	0.035 (0.304)	−0.142* (0.026)	−0.141 (0.783)	—	−0.093*** (0.000)
L3D.PROCQX	—	—	—	0.019 (0.509)	—	−0.092 (0.835)	—	−0.102*** (0.000)
L4D.PROCQX	—	—	—	0.026 (0.309)	—	−0.013 (0.961)	—	−0.059** (0.002)
Ghana FE	—	−0.05 (0.240)	—	—	—	—	—	—
Indonesia FE	—	0.215** (0.007)	—	—	—	—	—	—
Time trend	0.107** (−0.002)	—	−0.001 (0.791)	0 (1.000)	−0.005 (0.096)	0 (0.989)	−0.007 (0.304)	0 (0.998)
Constant	0.054 (−0.083)		0.099 (−0.203)	0.116 (−0.179)	0.103 (−0.484)	0.073 (−0.723)	2.822 (−0.089)	0.437 (−0.696)
Error correction term								
ECM1	—	—	−0.555**	−1.445	−0.639***	−1.251	−0.559*	−1.825*
ECM2	—	—	−0.351**	−0.406	−0.413***	−1.535	1.187**	4.962***
ECM3	—	—	—	−4.08	—	0.038	—	−1.121***
ECM4	—	—	—	4.955	—	0.467	—	−6.251*
ECM5	—	—	—	−14.481	—	3.848	—	7.194
ECM6	—	—	—	−44.885	—	21.362	—	−154.054***
ECM7	—	—	—	0.059	—	0.096	—	−1.023
Number of lags	—	—	3	5	3	5	2	5
Number of ranks	—	—	2	7	2	7	2	7
Log-likelihood	−61.928	−54.797	575.841	3946.677	497.446	3871.733	219.788	3250.784
SBIC	—	—	−10.122	−143.712	−6.855	−140.454	−0.393	−113.456
AIC	141.856	131.595	−831.682	−7565.354	−674.892	−7415.466	−247.575	−6173.568
HQIC	—	—	−14.293	−152.041	−11.026	−148.782	−2.981	−121.784
Number of observations	147	147	48	48	48	48	48	46

Note: For all columns, p-values are in parentheses. *, ** and *** denote p-values are <5, 1 and 0.1%, respectively. 'D' denotes differenced variables, while 'L' denotes lagged variables. Variables are redefined: EXQ is (ln) cocoa bean export quantity index (1970 = 100); EXP is (ln) ratio of cocoa bean export price to the world price index (1970 = 100); GDP is (ln) real GDP index (1970 = 100); FDI is (ln) (10+foreign direct investment, net inflows (% of GDP)); $AGRILAND$ is (ln) agricultural land (% of land area); RRA is (ln) (10+rates of relative assistance) (Marshall *et al.* 2011); $POLITY$ is (ln) (10+polity2 index), where polity2 ranging from −10 to −6 indicates autocracies and +6 to +10 indicates democracies (Marshall *et al.* 2011); and $PROCQX$ is (ln) cocoa powder and cake export quantity index (1970 = 100). AIC, Akaike information criterion; FE, fixed effects; HQIC, Hannan-Quinn information criterion; SBIC, Schwartz Bayesian information criterion.

demand for cocoa bean exports from Ivory Coast and Ghana. Indeed, given the characteristics of chocolate products, demand for cocoa beans has been monotonically increasing, regardless of price changes. As their shares in cocoa bean global production increase, changes in their export price will affect competitors' prices. Such complexities may not be captured by the simplified model applied in this study.

Focusing on 2000 onward, when Ivory Coast started losing its market share, Table 4 presents a negative price elasticity for the country at 5.4. Once *POLITY* and *RRA* are included, the derived elasticity becomes 1.3.

Column (5) of Table 3 suggests a negative association between processed cocoa bean export growth and cocoa bean export growth in Ghana. The 1994 *Ghana Investment Promotion Act* guarantees the freedom for non-Ghanaians to run enterprises in food processing, reducing incentives to export cocoa beans. Furthermore, this study finds that pro-agricultural policy bias is negatively associated with export growth in Ghana, as indicated by *LD.RRA*, which is in line with a previous study (Anderson and Brückner 2011).

Columns (7) and (8) of Table 3 investigate the determinants of cocoa bean export growth in Indonesia. Column (7) fits the model with two lags and shows that none of the right-hand-side variables are statistically significant. Under specifying the number of lags in a VECM can significantly increase the finite sample bias in the parameter estimates and lead to serial correlation (Gonzalo 1994). Although the serial correlation test suggests no evidence of

Table 4 Re-estimated Ivory Coast VECM (2000–2011)

Dependent variable: *D.EXQ*	(1)	(2)
LD.EXQ	3.406 (0.089)	1.148*** (0.000)
L2D.EXQ	2.154 (0.069)	—
L3D.EXQ	1.597 (0.112)	—
LD.EXP	−5.407* (0.048)	−1.387*** (0.000)
L2D.EXP	−2.802 (0.070)	—
L3D.EXP	−1.482 (0.203)	—
LD. POLITY	—	−0.671** (0.002)
LD.RRA	—	1.464 (0.548)
Time trend	0.001 (0.929)	0.000 (0.968)
Constant	−0.246* (0.030)	−0.022 (0.372)
Error correction terms		
ECM1	−6.397*	−2.129***
ECM2	—	0.006
Number of lags	4	2
Number of ranks	1	2
Log-likelihood	223.505	493.915
SBIC	−36.495	−81.955
AIC	−429.01	−955.831
HQIC	−37.616	−84.078
Number of observations	11	11

Note: For all columns, *p*-values are in parentheses. *, ** and *** denote *p*-values are <5, 1 and 0.1%, respectively. AIC, Akaike information criterion; HQIC, Hannan-Quinn information criterion; SBIC, Schwartz Bayesian information criterion.

serial correlation in the residuals at lag order two, this study refits the model with five lags in Column (8) of Table 3. It also increases the rank to seven.

Column (8) of Table 3 suggests that *EXP*, *GDP*, *FDI*, *RRA* and *PROCQX* in the last period affect cocoa bean export performance in Indonesia. The coefficient for a change in the price ratio suggests a relatively elastic demand for Indonesian cocoa beans. Increased world demand for processed cocoa would lead to decreased cocoa bean exports. A 10 per cent increase in demand for processed cocoa export is associated with a 1 per cent decrease in cocoa beans exports. Furthermore, the FDI coefficient is positive. Given that the contribution of the cocoa sector to Indonesia's total GDP is <1 per cent, this might simply reflect ease of doing business in Indonesia, which would positively affect not only cocoa sectors but also other export-competing sectors.

Indonesian cocoa bean exports respond to change in global demand at a much slower pace than Ivory Coast cocoa bean exports, as indicated by variable *LD.GDP*. A change in the relative availability of agricultural land decreases cocoa bean export growth in Indonesia, as indicated by the significance of coefficient *L2D.AGRILAND*. Identifying specific reasons for these findings is beyond the scope of this study; however, one possible mechanism is that as income per capita grows, domestic demand for processed cocoa might increase, reducing incentives for exporting cocoa beans. Unlike Ghana, pro-agricultural bias policy in Indonesia tends to promote exporting.

5.2 Simulations of optimal tax rates

This study recalculates optimal export taxes. Elasticities of export demand for each economy are indicated by the coefficient for *LD.EXP*. Given the lack of robustness and positive coefficients for export price elasticities for Ghana and Ivory Coast, two scenarios are imposed. Scenario 1 sets both Ghana and Ivory Coast's elasticities to 1, which is relatively close to the Ivory Coast's elasticity suggested in column (2) of Table 5. Scenario 2 sets the elasticities to 5 for both countries to illustrate the differences in tax rates when they have similar export demand elasticities. Indonesia's elasticity is set to 5.332, based on column (8) of Table 3.

Compared to the initial estimates (Figure 5), Figure 6 suggests lower rates for Indonesia. The 2011 rate should be 2 per cent below the current rate; that is, 5 per cent. In 2011, Ivory Coast kept its export rate at 14 per cent. As with Ghana, the country has been generally imposing higher export tax rates than other exporting countries. Tax rates were between 28 and 34 per cent in the 1994–1998 period. Since 1998, the Ghanaian Government strategy has been to gradually decrease the export tax rate to 15 per cent by 2004.

Figure 6 clearly demonstrates that the optimal tax rates of the three exporting countries have been 'converging' as their market shares have become more equally divided. Comparing Scenario 1 and Scenario 2, as

Table 5   Welfare analysis

Annual average (in US$)	Period			
	1971–1979	1980–1989	1990–1999	2000–2009
(i) Small country case				
Percentage tax rate (%)	0.0	0.3	1.7	2.3
	0.0	0.2	0.4	0.3
Change in consumer surplus (*CS*)	1944.3	61,146.5	1,510,180.0	10,300,000.0
	2945.5	88,943.6	1,591,022.0	6,987,760.0
Change in producer surplus (*PS*)	−3289.9	−239,205.0	−5,589,331.0	−23,000,000.0
	5108.8	240,244.4	3,845,176.0	13,700,000.0
Government tax revenue (*REV₁*)	1345.3	178,046.7	4,079,004.0	12,700,000.0
	2164.1	159,997.4	2,490,806.0	7,059,935.0
Net welfare effect: Small country case (*NET₁*)	−0.2	−11.7	−146.4	−530.1
	0.4	8.6	108.3	437.3
(ii) Large country case				
Additional government tax revenue (*REV₂*)	1,345.3	178,046.7	4,079,004.0	12,700,000.0
	2,164.1	159,997.4	2,490,806.0	7,059,935.0
Net welfare effect: Large country case (*NET₂*)	82.7	26,376.2	1,565,002.0	14,100,000.0
	148.6	26,835.8	1,573,429.0	10,900,000.0

Source: Author's calculation.
Note: The first row shows the mean and the second row shows the standard deviation. Net welfare effects (NET_1 and NET_2) are consumer price index-adjusted.
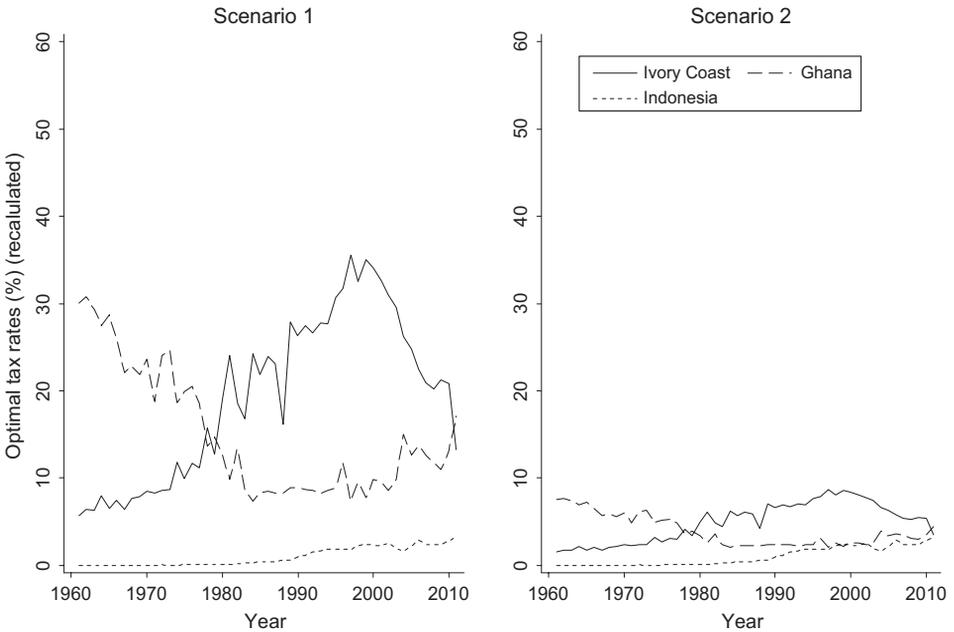

Figure 6 Simulated optimal taxes. Notes: Scenario 1: export demand elasticities for Ivory Coast and Ghana are 1, whereas Scenario 2 sets them as 5. Indonesia's export demand elasticity is set at 5.332 in both simulations. This study follows the ICCO (2008) by setting the world's supply elasticity at 0.55.

demand elasticities of Ivory Coast and Ghana increase, the 'rate of convergence' also speeds up. Compared to Yilmaz (1999), the data coverage in this study, which includes the period 2000 onwards when Ivory Coast has been gradually losing its market share, demonstrates a more pessimistic situation for the Ivory Coast.

Figure 7 presents a simple partial equilibrium welfare analysis of export taxes according to the size of the exporting economy in a comparative static setting. The approach follows previous studies (Bouët and Laborde Debucquet 2010; Abbott 2012).

Figure 7(a) presents the case of a small country imposing an export tax. The domestic price is set at P_0, which equates to the initial world price. Given the price level, domestic consumption is D_0 and domestic supply is X_0, so that the export quantity is $(X_0 - D_0)$. The introduction of an export tax reduces the domestic price to $P_1 = (1 - (\tau/100))P_0$, where τ is the percentage of the tax rate. This export tax decreases the supply level to X_1, increases domestic consumption to D_1 and decreases exports to $(X_1 - D_1)$, where $(X_1 - D_1) < (X_0 - D_0)$. It is assumed that domestic producers are indifferent between selling their agricultural commodities to local buyers and exporters. By definition, the world price remains at P_0. The welfare implications from this policy are increased consumer surplus (Area A), decreased producer surplus (Total A + B + C + D) and increased government tax revenue (Area C), leading to net welfare loss to the economy, as denoted by Area B and D; that is, dead-weight losses.

Figure 7(b) illustrates the welfare impacts of an export tax on a large economy. In such a case, the country is assumed to have a significant export share in the world market, such that its decreased production pushes the world price up to P_2. Domestic consumer and producer surpluses are
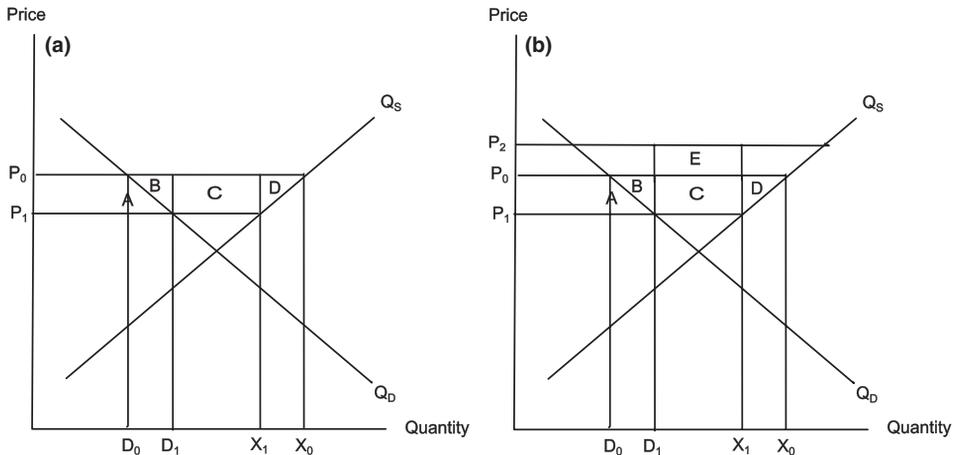

Figure 7 A partial equilibrium welfare analysis of export taxes (a) small country and (b) large country.

identical to the case of a small economy. However, government tax revenue is increased by (C + E) compared to the initial point as the unit tax is now $(P_2 - P_1)$, while export quantity is $(X_1 - D_1)$. The export tax may provide net welfare gains to the economy if the additional tax revenue for increased world prices (E) is larger than dead-weight losses (B + D).

To quantify the above theoretical predictions, some assumptions of parameters are required. Total domestic production and export quantity are taken from the FAO Statistics (FAO 2012), from which we can derive domestic consumption. Tax rates are derived from VECM outcomes, from which the post-tax price level (P_1) can be calculated. It is assumed that domestic demand and supply price elasticities are -0.4 and 0.4, respectively, based on the UNCTAD (2004) agriculture trade policy simulation model, which suggests that elasticities of demand and supply of cocoa beans in Indonesia are -0.31 and 0.45, respectively.

Given P_1 and assumed elasticities, D_1 and X_1 can be calculated, and, therefore, consumer surplus (CS), producer surplus (PS) and government tax revenue (REV_1) can be calculated, giving NET_1 as the net welfare effect. This study assumes that a 1 per cent export tax will increase the world price by 1 per cent or $P_2 = P_0(1 + 0.01\tau)$. The additional tax revenue is included in REV_2. The consumer price index (2005 = 100) is used in this study to remove inflationary effects (World Bank 2012). The adjusted net welfare effect is ADJ_NET_2.

Table 5 presents the net welfare effects. At one decimal point, the simulated optimal tax rate has been greater than zero since the 1990s. Under a large country assumption, the above welfare analysis suggests that the net welfare cost of no tax until 2009, a year before the introduction of the export tax is US$157.1 million. The cost would be compensated by the annual net welfare benefit in 2010 from the introduction of a 10 per cent tax in 2010.

The above simulation may underestimate further benefits of export taxes. The results may not take into account: (i) the welfare benefit of an export tax on processed cocoa industries; (ii) the policy's contribution to food security programs; and (iii) its role in justifying infant industry argument providing temporary protection or subsidisation of a domestic manufacturing industry that may offset the distortionary effect created by tariff escalation on processed goods (Piermartini 2004).

Table 6 provides an oversimplified cost–benefit analysis. The benefit of the export tax in 2011 is at the minimum $361 million, while the cost is $634 million. Future studies should look at other indirect costs and benefits. Although export taxes provide the government valuable development finance, corruption may mean that the welfare distribution is not proportional among different societal groups. Furthermore, previous studies question the effectiveness of the infant industry argument as under protectionism domestic producers substitute advanced technologies with low-growth alternatives, thereby inhibiting economic growth (Ohyama *et al.* 2004; Melitz 2005; Cummings *et al.* 2006; Sauré 2007).

Table 6 A simplified cost–benefit analysis of cocoa beans export tax

Benefits	Stylised facts	Costs	Stylised facts
Improvements in processed cocoa industries	In 2011, the cocoa processing industry increased its production by 65% or $302 million (Source: *Indonesia Finance Today*)	Decrease in cocoa bean exports	In 2011, cocoa exports decreased by 50%, causing loss valued at $634 million (Source: author's calculation)
Export tax revenue	In 2011, at 5% tax rate and $2600 per tonne, cocoa bean export generated $59 million (Source: author's calculation)	—	—
Total benefits	At least $361 million in 2011	Total costs	At least $634 million in 2011

6. Conclusion

This study is premised on the basis that updated analysis of optimal export tax rates of cocoa beans is needed. It finds that the role of access for foreign investors, the extent of processed cocoa bean export orientation and government assistance in cocoa bean export growth may vary between countries. Indonesia's current 5 per cent tax rate is 2 per cent above its optimal rate. In contrast, Ivory Coast seems to have inelastic export demand and its supply to the global market is influenced more by change in the domestic economy in particular political conditions, than price factors.

There is growing concern about the possibility of Indonesia becoming a cocoa bean importer in the future. The Indonesian Cocoa Industry Association estimated that in 2012 the local processing industry already absorbed 80 per cent of cocoa bean production, while the processing industry increased its production by 35 per cent. In contrast, the Cocoa National Movement has not demonstrated successful outcomes (Arthur 2012; Pardomuan and Taylor 2012). Many farmers have responded to the export taxes by changing production to corn, rubber and palm oil (Laoli 2011; Arthur 2012). Policies that ease constraints on factor markets and improve technical assistance to farmers may provide better opportunities for the Indonesian cocoa sector than a blunt trade policy, as in other agricultural sectors (Permani 2011).

One caveat to this paper is that the partial equilibrium models ignore intersectoral linkages and often do not take limited resources into account. However, a general equilibrium model requires information that is often difficult to find. Thus, a partial equilibrium analysis offers a good alternative, particularly to analyse trade in a good which does not contribute to a large part of total trade and, therefore, has limited impacts on the whole economy. This criteria fits the characteristics of cocoa beans, whose exports have been contributing <1 per cent to total GDP since the 1980s.

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