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# Optimal export taxes – the case of cocoa in Côte d'Ivoire

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## **Abstract**

*Export taxes can provide additional welfare to large exporters, an argument for interventions in many primary commodity exporting countries. We investigate the benefits of export taxation for Côte d'Ivoire, the dominant exporter of cocoa. Where many applications treat the formula for optimal export taxes incorrectly as a prescription, we take the endogeneity of the exporter's share into account. We also distinguish between short-term and long-term effects, relevant for a tree crop like cocoa and we allow for a normal commercial margin between export and farm gate prices. Results are calculated via simulations in a model, in which the age-compositions of the tree stocks of major producing countries are distinguished. Simulations over a period of 15 years show that higher levels of export taxation do not change overall revenues of Côte d'Ivoire on a longer term, but lead to strong redistribution from farmers to the central authorities.*

**Key words: optimal export tax, primary commodities, cocoa, Côte d'Ivoire, vintage model**

## **1. Introduction**

Economists generally argue that free trade is more efficient and a better choice for any country. An exception is made, however, for the case where a country has such a dominant position in the world market that its own behaviour affects the world market price. In such cases, welfare of the country can be improved by imposing tariffs or taxes (Corden, 1974). This increases the country's welfare, but world welfare is not enhanced, however, as the improvement for the country is less than the cost to other importing and exporting countries.

For a dominant exporting country the reasoning is, that an export tax reduces the price to its own producers. They respond by producing less. The lower supply to the world market raises the world market price. So the country produces less, and makes therefore less costs, but the price of what is exported is higher. If the country's share or the price flexibility in the world market is large enough, the higher price can more than compensate for the lower supply.

This raised the question as to what level of export taxes would be optimal. An extremely high tax may reduce supply by so much that the higher price cannot offer sufficient compensation. Hence, there is likely to be some level of taxation that maximizes the country's welfare.

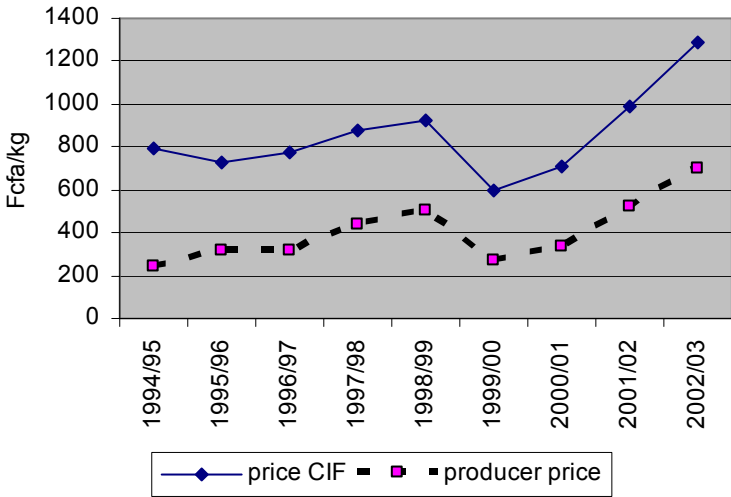
In this paper we investigate if this effect occurs for a large exporter of primary commodities, namely Côte d'Ivoire in the case of cocoa. This application raises a number of additional questions. One is how to adapt the framework to a tree crop, for which short term supply responses can be quite different from long term responses. For the application, both supply responses in the Côte d'Ivoire and those in other producing countries are relevant. The other issue is, that while theory treats the taxes as a wedge between world market price and producer price, the reality is that there are also commercial costs that reduce the share of producer prices in the world market price. We address the question if the nature of these commercial costs make a difference for the optimal rate of taxation. Finally, and most importantly in our case, distributional issues are addressed. While producer prices are directly contributing to the income of farm households, the income raised by taxes accrues to the government and/or whatever central agencies collect them. The welfare effects of gains to any of these beneficiaries may not be the same.

Optimal export taxes have been addressed in earlier papers. Notable applications of the theory are to the case of cotton exports from the USA in the pre-war years (Irwin, 2002) and to rice exports from

Thailand (Warr, 2003). It has been applied quite often to the case of cocoa, and in particular to Côte d'Ivoire. McIntyre and Varangis (2001) calculated an optimal tariff of 30%. And recently the International Cocoa Organization published new calculations, which for Côte d'Ivoire came at 34% (ICCO, 2007).

A problem with all the application to Côte d'Ivoire is that the interpretation of the formula is incorrect: the authors take the formula for optimal taxation to be prescriptive, (“with this share, and these elasticities, the rate should be ....”) whereas it should be seen as an equilibrium equation in which the share is sensitive to the tax. More on this in section 2.

Cocoa taxation has a long history in Côte d'Ivoire. For many years, the country operated a system in which producer prices, and all remunerations to the later stages of handling were regulated through the *Caisse de Stabilisation*. The system was abandoned in 1999. The share of the producer price in the final world market prices stood at 43% in 1995/96, and was, some years after liberalisation, not much higher: 52% in 2002/03. More recent data show that the producer share in the export price has fallen to 41%. The implicit taxation that was part of the *Caisse* procedure, was after its demise replaced by a system of cesses and taxes. Some of the proceeds went to representative organisations and the export tax went to the government. In 2002/03, total levies for non-governmental purposes amounted to 8% of the CIF price, the export tax to 20%. The commercial costs equalled another 20% of the CIF price. Figure 1 shows the producer price of cocoa beans in Côte d'Ivoire and the world market price, both in Franc CFA (1 euro equals 656 Fcfa).



**Figure 1. CIF prices and producer prices for cocoa beans in Côte d'Ivoire 1994/95-2002/03**

Over the same period, Côte d'Ivoire increased its production of cocoa substantially, from around 0.870 million tonnes in 1994/95 to 1.3 million tonnes in 2002/03. Côte d'Ivoire’s share in world production increased thereby from about 33% to 43%. This increase in production took place despite the dramatic halving of the producer prices in 1990, and the only partial compensation provided for the devaluation (by 50%) of the value of the Fcfa in January 1994. Compared with other major producers, Ivorian producers receive a rather small share of the world market price. In Ghana it was approximately the same, but in Brazil, Indonesia and Malaysia, producer prices were around 75% or more of the world market price. This low level of relative producer prices, and the role of the state and central representative organisation in setting the wedge between the prices, were the reason for undertaking the study on the levels of export taxation.

**2. Optimal export taxes**

The classic derivation of the rate of optimal export taxation goes as follows.

The producer price is  $(1-t)p_m$ , where  $t$  signifies the rate of taxation (and other proportional costs), and  $p_m$  the price in the world market. The producer decides on the level of production that maximizes his profits.

$$\text{Max } q \cdot (1-t)p_m - f(q),$$

where  $q$  refers to the level of production and  $f(q)$  are the costs to reach this level  $q$ . The first-order condition is:

$$(1) \quad (1-t)p_m = \partial f(q)/\partial q$$

The marginal costs should equal the price.

The country finds itself in the world market, where other producing and consuming countries operate.  $Q$  represents the production of the country,  $Q_r$  that of the rest of the world and  $D$  the world demand. There is equilibrium between demand and supply in the world:

$$(2) \quad Q + Q_r = D$$

This implies for marginal changes:

$$(3) \quad dQ + dQ_r = dD$$

or

$$(4) \quad dQ = dD - dQ_r$$

For a given change of  $Q$ ,  $dQ$ , we have:

$$(5) \quad dQ = \partial D/\partial p_m dp_m - \partial Q_r/\partial p_m dp_m$$

or

$$(6) \quad dQ/dp_m = \partial D/\partial p_m \cdot D/p_m - \partial Q_r/\partial p_m \cdot Q_r/D \cdot D/p_m$$

If the supply elasticity of the rest of the world is  $\sigma$  and the demand elasticity is  $-\delta$  we can write:

$$(7) \quad dQ/dp_m = [-\delta - \sigma \cdot Q_r/D] D/p_m$$

or

$$(8) \quad dQ/dp_m = -[\delta + \sigma \cdot S_r] D/p_m$$

where  $S_r$  is the share of the Rest of the World in total world production.

The effect of a change in  $Q$  on the world market price is therefore

$$(9) \quad dp_m/dQ = -\frac{p_m}{D} \cdot \frac{1}{\delta + \sigma \cdot S_r}$$

or

$$(10) \quad dp_m/dQ = -\frac{p_m}{Q} \cdot \frac{S}{\delta + \sigma \cdot (1-S)}$$

where  $S$  is the share of the country in world production (with :  $S_r + S = 1$ .) The last factor on the RHS is the inverse of the demand elasticity facing the exporting country.

To find the optimal tax rate the country optimises:

$$(11) \quad p_m \cdot Q - f(Q)$$

That is, the country optimises total revenues minus production costs.

Unlike a monopolists, the country has only tax rate  $t$  as instrument at its disposal. Maximisation of (11) with respect to  $t$ , taking into account that the world market price is influenced by the choice leads to:

$$(12) \quad \frac{\partial p_m}{\partial t} \cdot Q + p_m \cdot \frac{\partial Q}{\partial t} - \frac{\partial f(Q)}{\partial t} = 0$$

or

$$(13) \quad \frac{\partial p_m}{\partial Q} \cdot \frac{\partial Q}{\partial t} \cdot Q + p_m \cdot \frac{\partial Q}{\partial t} - \frac{\partial f}{\partial Q} \cdot \frac{\partial Q}{\partial t} = 0$$

or

$$(14) \quad (\frac{\partial p_m}{\partial Q} \cdot Q + p_m - \frac{\partial f}{\partial Q}) \cdot \frac{\partial Q}{\partial t} = 0$$

or

$$(15) \quad \frac{\partial f}{\partial Q} = p_m + Q \cdot \frac{\partial p_m}{\partial Q}, \text{ assuming that } \frac{\partial Q}{\partial t} \text{ is not zero.}$$

We now use formula (1) that  $\frac{\partial f}{\partial Q} = (1-t)p_m$ .

$$(16) \quad (1-t)p_m = p_m + Q \cdot \frac{\partial p_m}{\partial Q}$$

So, using (10):

$$(17) \quad (1-t)p_m = p_m - Q \cdot \frac{p_m}{Q} \cdot \frac{S}{\delta + \sigma \cdot (1-S)}$$

or

$$(18) \quad 1-t = 1 - \frac{S}{\delta + \sigma \cdot (1-S)}$$

or

$$(19) \quad t = \frac{S}{\delta + \sigma \cdot (1-S)}$$

Thus, the optimal tax rises with  $S$ , and falls with  $\delta$  and  $\sigma$ . The more responsive the other producers or consumers are, the lower is the optimal tax, at given share. But note that in the derivation, an important element is the optimal response by producers to changes in after-tax prices. The share of the country is therefore not fixed, but must be a variable to render the formula relevant. Formula (19) should hold *ex-post*: only if the share and tax show this relationship, the optimal tax is reached. A very high share, in this formula, therefore should coincide with a very high level of taxation, which seems to go even beyond unity. This would (following Corden, 1974) typically apply to cases where further growth of production would harm the country's welfare. This is the case of immiserizing growth. As can be seen from (8), the inverse of the RHS of (19) is the demand elasticity facing the country. Hence, (only) if the elasticity is greater than 1, is the level of  $t$  between 0 and 1. The case of a small demand elasticity facing the country, is a necessary condition for immiserizing growth to occur.

We now consider the case of commercial services to play a role in transmitting the world market prices (after tax) to the producers. This concerns mostly the costs of transport, storage, post-harvest processing, (re)packaging etc. In case these costs are not related to the price of the product, the formula for the optimal rate of taxation does not change. Obviously, the higher the costs, the greater the wedge between producer price and world market price and the lower production, but all this is captured in the smaller share that would result and need not affect the optimal rate otherwise. In case of commercial costs that are proportional to the world market price, the following formula for the optimal rate of taxation results. In the formula  $c$  stands for the commercial costs' share of the world market price, so that the producer price  $p$  can be written as  $p = (1-t-c)p_m$ . In this case the optimal rate of taxation is

$$(20) \quad t = (1-c) \frac{S}{\delta + \sigma \cdot (1-S)}.$$

The optimal tax rate is therefore lower, the higher the commercial share is. Note that a higher commercial share also implies lower producer prices and lower market share and, with higher  $c$  and lower  $S$ , lower values of the optimal rate.

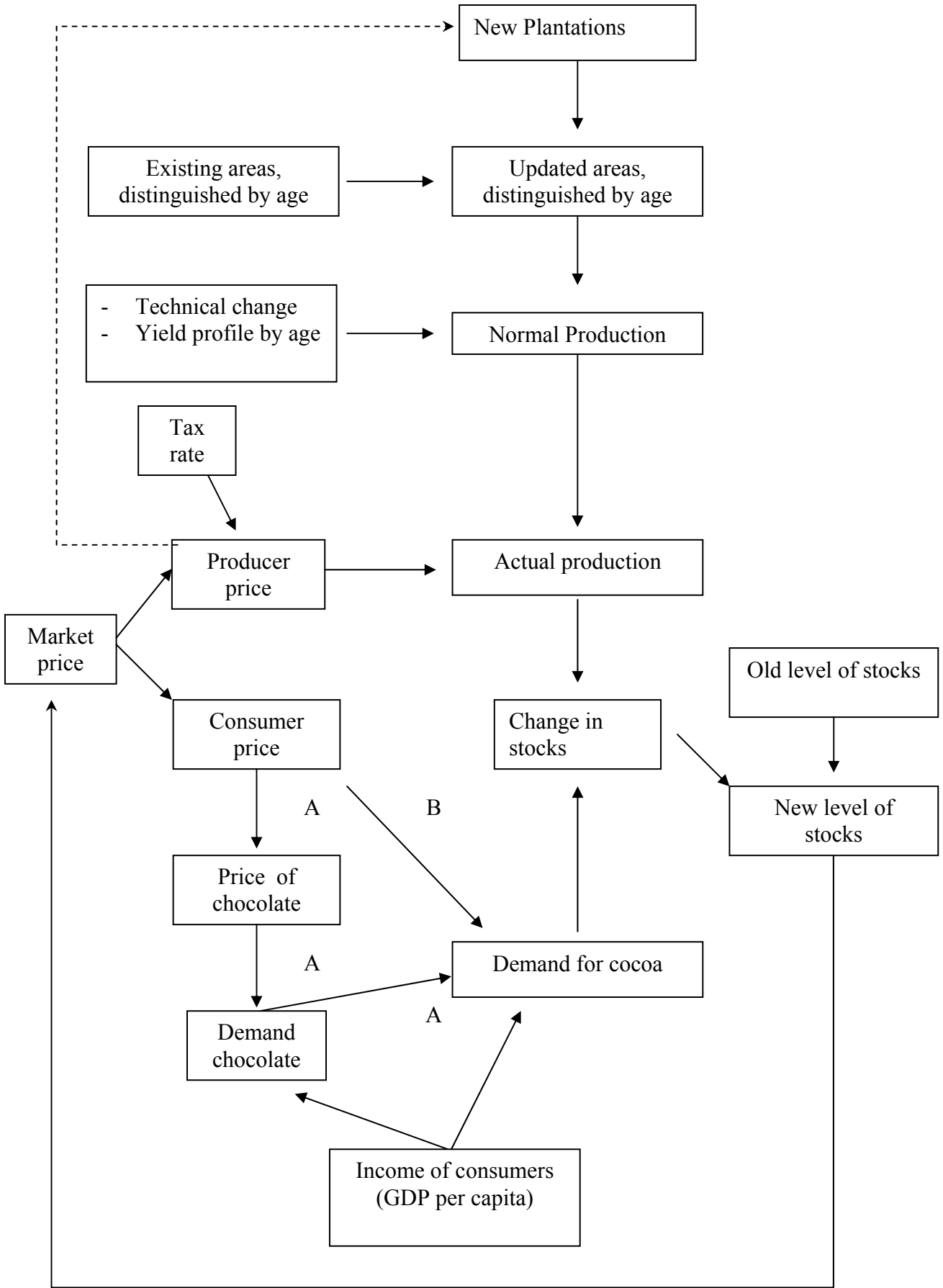
### 3. Application to the cocoa market

As mentioned earlier, the value of optimal tax rate cannot be calculated from the formula as it is. Knowledge of elasticities and shares in the market (and share of commercial costs) is not enough to give the optimal rate. There is one exception: if the thus calculated rate coincides with the actual rate, then the equilibrium condition is satisfied, and the actual rate might be optimal. To establish an optimal rate different from the observed rate requires simulation in a model. The model must be reliable enough to display the actual demand conditions facing the country, and include information on the actual commercial costs involved (and if these are proportional to the world market price).

To this end, an existing model was employed developed by Burger and Smit (2000). Data that underpinned the analysis as to the actual costs of commercially moving cocoa beans from the hinterland to the export harbour are based on a study by the Ivorian research institute BNEDT.

The model analysis was done through a partial equilibrium model. Results would not be very different if a general-equilibrium model were used, as Yilmaz (1999) shows. The cocoa market model was developed by Burger and Smit (2000). The market is described through separate models for each major producing country. Major producers are Côte d'Ivoire with some 40% of the market, Ghana and Indonesia with about 20%, and Brazil, Nigeria, Cameroon, Malaysia. On the demand side we followed two approaches, one in which separate major consuming countries were distinguished, including the chocolate industry and their demand for cocoa products, and one in which we included a direct global demand function for cocoa beans. Prices are determined annually as a function of the level of stocks, relative to consumption, known as the stock-to-grindings ratio. Supply responds to prices in two ways, a short-term response based on existing production capacity, here called 'normal production', and a longer-term response in which the planted area is adjusted. New planted area starts yielding after three years after which production per ha follows a yield profile with rising and later-on decreasing yields as the trees become older. The age-composition of the planted area thus is important for establishing the 'normal production' levels.

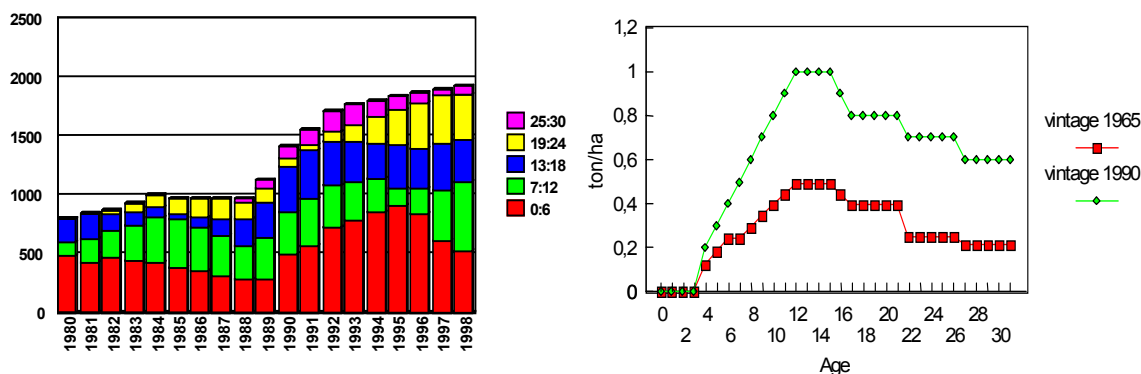
Figure 2 sketches the various relationships. The bottom part shows the demand side, modelled via the demand for chocolate (A) or, alternatively, as direct demand for beans (B). The top part of the figure shows how short-term responses are modelled on the basis of existing production capacity (normal production). This production capacity itself may also respond to price changes in the form of additional area planted with cocoa. Depending on the level of technology at the time of planting a certain yield profile applies. This then leads to higher production levels in later years. Higher production implies increases in stocks with a negative effect on the prices and on subsequent supply, and a positive effect on demand.



**Figure 2 : Structure of the model**



Major building blocks of the model are the *vintage* composition of the stock of cocoa trees in each of the countries, and the yield profile that together with the areas by age represent the ‘normal’ production levels. Actual production differs from normal production due to changes in real producer prices. Figures 3a and 3b show the vintage composition for Côte d'Ivoire and the yield profiles corresponding to two years of planting. The higher profile for later years shows the change in planting material used.



**Figures 3a Age composition (1000 ha) 1980-1998; Figure 3b. Yield profiles 1980, 1995**

Normal production is calculated as  $QP_t = \sum_i A_{it} Y_{i,t-i}$ , where,  $Y_{i,t-i}$  indicates the yield per ha of the area

$A$  of age  $i$ , remaining in year  $t$ , planted in year  $t-i$ . Based on this, the actual production is seen as proportional to ‘normal production’, but with an additional multiplicative factor representing the price effect.

Estimated supply functions for the major producing countries are ( $qp$  is normal production,  $qe$  the actual production;  $p$  the real (1990) producer price)

For Côte d'Ivoire:

$$\ln(qe/qp) = -0.848 + 0.148 \ln(p_{t-1}) \quad R^2=0.25 ; \text{ period } 1974-2001 \\ (t=2.6)$$

For Ghana (with a dummy for two drought years):

$$\ln(qe/qp) = -2.035 + 0.237 \ln(p_t) - 0.39 \text{ dum}_{82,83}; \quad R^2=0.67; \text{ period } 1974-2001 \\ (t=3.8)$$

For Indonesia:

$$\ln(qe/qp) = -1.314 + 0.183 \ln(p_t) ; \quad R^2=0.24; \text{ period } 1983-2001 \\ (t=2.3)$$

For other major countries the estimated short-term supply elasticities were 0.196 for Malaysia, 0.204 for Nigeria, 0.252 for Cameroon and 0.33 for Brazil. Taking all countries together, the supply elasticity is about 0.17.

Long term supply response is modelled by making new planting a function of the price. As no reliable data are available on new planted area, we used fixed elasticities to include this effect: we introduced in the model an elasticity of 2 for new plantings in Ghana and Indonesia to represent the world outside Côte d'Ivoire, and used for Côte d'Ivoire itself an elasticity of 0.5.

Demand for cocoa is modelled indirectly through the chocolate market and directly through an estimated demand function ( $C$  is cocoa grindings) at world level. In this paper, we confine ourselves to the latter, which was estimated (similar to Gilbert & Varangis, 2003) as:

$$\ln(C_t) = 4.362 + 0.534 * \ln(GDP/capita) - 0.168 * \ln(RealPrice_{t-1}) + 0.397 \ln(C_{t-1})$$

(2.9)
(-3.8)
(3.2)

The equation was estimated by 2SLS on data for 1975-2000 ;  $R^2 = 0.99$   
 This estimation gives a short-term elasticity of -0.17 and a long-term value of -0.28.

The model is closed by an equation relating the relative changes in world market prices to relative changes in stocks ( $z$ ), with the change in stocks equal to the balance between supply and grindings. The equation includes both stocks itself and the stock-to-grindings ratio, both relating to (the end of) the previous year.

$$d\ln(p_t) = -0.11 - 0.81 d\ln(z_{t-1}) - 0.157 \ln(z_{t-1}/C_{t-1}) ; R^2=0.58 ; \text{period} = 1975 - 1995$$

(4.6)
(1.6)

Through this stock change mechanism, the model displays a gradual adjustment to a shock. An increase of the Ivorian taxes from 28% to 40%, for example, first leads – over a period of 3 years – to 6% lower stock-to-grinding ratio and eventually – after 10 years – settles at a level 2% lower than before.

This model allows us to simulate various levels of taxation and calculate its effects on the welfare of the country as a whole, and that of Côte d'Ivoire's producers in particular.

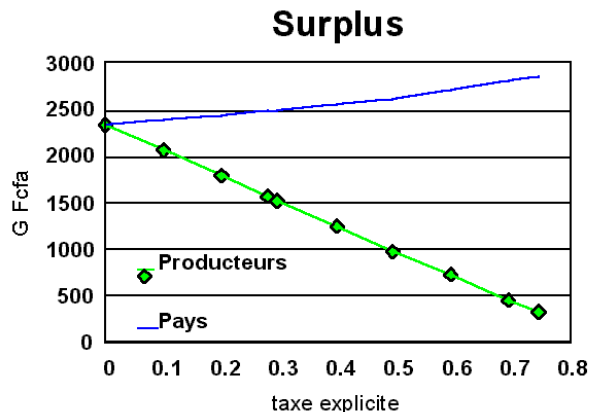
#### 4. Results of various simulations

We now present the results of simulations with the model over a period of 16 years, assuming various levels of taxes for Côte d'Ivoire.

The first simulation is for the case where long-term responses in terms of additional plantings is not included. Hence, in this case, only the short term supply elasticities apply.

**Table 1 : Surplus and tax revenues,  
no new planting response**

Billion Fcfa Tax rate	Surplus Producers	Surplus Country
0	2337	2337
10	2067	2388
20	1796	2441
28	1580	2485
40	1257	2557
70	457	2809

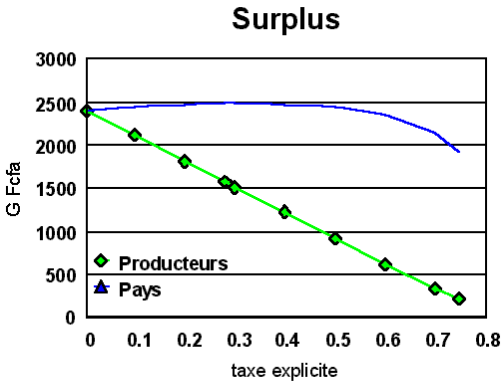


The simulation shows that the overall welfare for the country is not very responsive to changes in tax rate, but the producer surplus is. At the ruling rates of 28% in 2002, producer welfare stood at just above 1580 billion Fcfa, and this falls to 1257 for a tax rate of 40%. Country’s welfare rises by less than 100 billion Fcfa for the same change in taxes.

Taking possible additional plantings into account, the simulations show a slightly different picture, with falling surplus for the country at high levels of taxation (due to lower world market prices caused by additional production capacity elsewhere).

**Table 2 : Surplus and tax revenues,  
With new planting response**

Billion Fcfa Tax rate	Surplus Producers	Surplus Country
0	2400	2400
10	2111	2441
20	1817	2471
28	1580	2485
40	1222	2482
70	347	2136



Again, the changes in country’s welfare are but small. Most of the impact of different levels of taxation is on the distribution between the producers and the beneficiaries of the taxes, that is the state and the central organisations collecting the money.

Other simulations, with a smaller demand elasticity, show an equally flat curve for the country’s welfare, and an optimal rate of taxation that is actually lower, namely 21% in stead of 33% that was found above. This shows how deceptive the straightforward application of the formula can be: a smaller demand elasticity should normally increase the optimal tax. The simulation shows however, how the more rigid demand leads to much higher prices for higher taxes, which trigger much stronger planting responses outside Côte d'Ivoire and these rather soon reduce the country’s surplus.

**5. Conclusion and further discussion**

There is a conclusion and a further thought. The conclusion of the analysis is that the case of Côte d'Ivoire shows that the country, with a present share of over 40%, would not or hardly benefit from changes in the export taxation. In the longer-term it may even suffer from imposing high tax rates. Taxation does however affect farmers substantially, and their welfare is severely affected by the high levels of taxation (and high levels of commercial costs) that now exist. This conclusion is not much

different from what Akiyama (1982) already concluded: it is the distribution that counts. Yet, in spite of the relatively low producer prices, the supply from Côte d'Ivoire has grown substantially over the last decade so that even the low prices appear to attract farmers.

Two further issues emerge. One is whether the country is better off with high or low taxation. High taxation brings less income to producers and more revenues to central organisations, including the state itself. The literature on the 'resource curse' and economic growth shows that point resources generally contribute less to economic growth than non point resources. This would favour a model in which income is transferred to the millions of farmers rather than taxed centrally. On the other hand, higher producer prices for farmers may predominantly trigger further production of cocoa, which – as the model shows – would not increase their aggregate income. The crucial element in both systems is how the recipients spend the money they receive. The lesson from Bevan, Collier and Gunning (1989) was that farmers spend income sensibly. But investment opportunities in Côte d'Ivoire are not wide spread and open to cocoa producers. Saving accounts may provide the vehicle to make the money available for investors.

The other issue is if there is not a case for the government to tax the sector to a limited extent, namely to the extent that other people in the economy are taxed. The overall level of taxation in Côte d'Ivoire is about 15%. To have farmers pay taxes at this rate, one should have an export tax so high that the resulting producer price is 15% below what it would be without an export tax. To this end, the model is run without an export tax first. Subsequently a tax rate is determined that would bring producer prices at 85% of the no-tax price. This level of export taxes comes out at 15.8%, if we take new planting responses into account.

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